P-01: PLUMBING SPECIFICATIONS

BUILDING & BUILDING INFRA

UP TO BUILDING HEIGHT 100m

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1. SANITARY FIXTURES & FITTINGS

A) SCOPE

The scope of this section consists of but is not necessarily limited to installation, testing and commissioning of following items:

a. Sanitary appliances and fixtures for toilets. (Installation only)

b. Chromium plated brass/other fittings (Installation only)

c. Sinks (Installation only)

d. Accessories e.g. towel rods, toilet paper holders, soap dish, liquid soap dispensers, towel rails, coat hooks etc. (Installation only)

e. Hand driers, drinking water fountains etc. (Installation only)

Whether specifically mentioned or not the Contractor shall provide for all appliances and fixtures all fixing devices, nuts, bolts, screws, hangers, supports, accessories as required for complete installation.

All exposed pipes within toilets and near appliances/fixtures shall be of chromium plated brass or copper unless otherwise specified.

B) GENERAL REQUIREMENT

Sanitary appliances and fixtures for toilets, chromium plated brass fittings, stainless steel sinks, bathroom accessories like towel rods, toilet paper holders, soap dish, liquid soap dispensers, towel rails coat hooks etc and mirrors, hand driers, drinking water fountains etc as listed in the relevant items in the Schedule of Quantities shall be supplied free of cost by the Owner's Site Representative. The rates shall be inclusive of accessories (in such case) required for installation. All sanitary fixtures and fittings shall received from the Owner's Site Representative and thereafter be stored under covered roof and handled carefully to prevent any damage by the Contractor.

All appliances, fixtures and fittings shall be provided with all such accessories as are required to complete the item in working condition whether specifically mentioned or not in the Schedule of Quantities, specifications, drawings. Accessories shall include proper fixing arrangements, brackets, nuts, bolts, washers, screws and required connection pieces.

The sanitary fixtures and fittings shall be installed at the correct assigned position as shown on the drawings and as directed by the Architect / Owner's Site Representative and shall fully meet with the aesthetic and symmetrical requirements as demanded by the Architect / Interior Designer

All fixtures and accessories shall be fixed in accordance with a set pattern matching the tiles or interior finish as per Architect requirements. Wherever necessary, the fittings shall be cantered to dimensions and pattern as called for.

Fixing screws shall be half round head chromium plated (CP) brass screws, with CP brass washers unless otherwise specified.

Fixtures shall be installed by skilled workman with appropriate tools according to the best trade practice.

All appliances, fittings and fixtures shall be fixed in a neat workmanlike manner true to level and to heights shown on the drawings and in accordance with the manufacturer's recommendations. Care shall be taken to fix all inlet and outlet pipes at correct positions. Faulty locations shall be made good and any damage to the finished floor, tiling, plaster, paint, insulation or terrace shall be made good by the Contractor at his own cost. Fixtures shall be mounted rigid, plumb and true to alignment.

All materials shall be rust proofed ; materials in direct or indirect contact shall be compatible to prevent electrolytic or chemical (bimetallic) corrosion.

Wall flanges shall be provided on all walls, floors, columns etc. wherever supply and disposal pipes pierce through them. These wall caps shall be or chromium plated brass fittings and the receiving pipes and shall be large enough to cover the punctures properly.

Sanitary appliances, subject to the type of appliance and specific requirements, shall be fixed in accordance with the relevant standards and the following :

i. Contractor shall, during the entire period of installation and afterwards protect the appliances by providing suitable cover or any other protection so as to absolutely prevent any damage to the appliances until handing over (The original protective wrapping shall be left in position for as long as possible)

ii. The appliances shall be placed in correct position or marked out in order that pipe work can be fixed or partially fixed first.

iii. The appliance shall be fixed in a manner such that it will facilitate subsequent removal if necessary.

iv. The appliance shall be securely fixed. Manufacturer's brackets and fixing methods shall be used wherever possible. Compatible rust-proofed fixings shall be used. Fixing shall be done in manners that minimize noise transmission.

v. Appliances shall not be bedded (e.g. WC pans, pedestal units) in thick strong mortar that could crack the unit (e.g. ceramic unit)

vi. Pipe connections shall be made with demountable unions. Pipe work shall not be fixed in a manner that it supports or partially supports and appliance.

vii. Appliances shall be fixed true to level firmly fixed to anchor or supports provided by the manufacturer and additional anchors or supports where necessary.

Sizes of sanitary fixtures given in the Specifications or in the Schedule of Quantities are for identification with reference to the catalogues of make considered. Dimensions of similar models of other makes may very within $\pm$ 10% and the same shall be provided and no claim for extra payment shall be entertained NOR shall any payment be deducted on this account.

The contractor shall fix all plumbing fittings such as water faucets, shower fittings, mixing valves etc. in accordance with manufacturer's instructions and connect to piping system. The contractor shall supply all fixing materials such as screws, rawl plugs, unions, collars, compression fittings etc., as required.

Joints / gaps between all sanitary appliances / fixtures and the floor / walls shall be caulked with an approved mildew resistant sealant, having antifungal properties, of colour and shade to match that of the appliances / fixture and the floor / wall to the extent possible.

i. **Water Closet**

Water Closet shall be wash down or symphonic wash down type floor or wall mounted set, as shown in the drawings, designed for low volume flushing from 3-6 litres of water, flushed by means of a flushing cistern or an exposed or concealed type (as detailed in the drawings or as directed by the Owner's Site Representative). Flush pipe / bend shall be connected to the WC by means of a suitable rubber adaptor. Wall hung WC shall be supported by CI floor mounted chair which shall be fixed in a manner as approved by the Owners Site Representative.

Each WC set shall be provided with approved quality of seat, rubber buffers and chromium plated hinges. Seat shall be so fixed that it remains absolutely stationary in vertical position without falling down on the WC.

Each WC shall be provided with 110 mm dia (OD) PVC Pan connector connecting the ceramic outlet of WC to CI pipe.

ii. Urinals

Urinals shall be lipped type half stall with glazed vitreous China of size as called for in the Bill of Quantities.

Half stall urinals shall be provided with 15mm dia CP spreader, 32mm dia CP domical waste and CP cast brass bottle trap with pipe and wall flange and shall be fixed to wall by CI brackets, CI wall clips and CP brass screws as recommended by manufacturer complete as directed by the Owner's Site Representative.

Flushing for urinals shall be by means of no hand operation, infrared electric flush valve with complete kit of plumbing, electrical and electronic items, infrared photo cells, solenoid valve transformer and electrical connection. The automatic flush sensor plate shall be flush and press fitted and be of high quality mirror polish finish. Each urinal shall be provided with one flush valve unit.

Flush pipes shall be GI pipes concealed in wall chase but with chromium plated bends at inlet and outlet.

Urinal Partitions

Urinal partitions shall be white glazed vitreous china of size specified in the Schedule of Quantities.

Porcelain partitions shall be fixed at proper heights with CP brass bolts, anchor fasteners and MS clips as recommended by the manufacturer and directed by the Owner's Site Representative.

iii. Cisterns

Low level flushing cistern (exposed or concealed) shall be provided for WC in specified toilets. Contractor shall install cistern in accordance to the manufacturer's specification to the satisfaction of the Owner Site Representative. Provision of flush valve shall be made for Public / Staff toilets.

iv. Wash Basin

Wash basins shall be of size, shape and type specified in the Schedule of Quantities.

Each basin shall be provided with painted MS angle or CI brackets and clips and the basin securely fixed to wall/counter slab. Placing of basins over the brackets without secure fixing shall

not be accepted. The MS angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make , brand and colour as approved by the Owner's Site Representative. The cost of fixing the basin shall be inclusive of supply and installation of brackets as described above.

Each basin shall be provided with 32mm dia CP waste with overflow, pop-up waste or rubber plug and CP brass chain as specified in the Schedule of Quantities.

Each basin shall be provided with hot and cold water mixing fitting or as specified in the Schedule of Quantities.

v. Sinks

Sinks shall be stainless steel or any other material as specified in the Schedule of Quantities.

Each sink shall be provided with painted MS or CI brackets and clips and securely fixed. Counter top sinks shall be fixed with suitable painted angle iron brackets or clips as recommended by the manufacturer. Each sink shall be provided with 40mm dia CP waste and rubber plug with CP brass chain as given in the Schedule of Quantities. The MS angle shall be provided with two coats of red oxide primer and two coats of synthetic enamel paint of make, brand and colour as approved by the Owner's site representative.

Sanitary fittings for sinks shall be deck mounted or wall mounted CP swivel faucets with or without hot and cold water mixing fittings as specified in the Schedule of Quantities. Installation of fittings shall be measured and paid for separately.

vi. Shower Set

Shower set shall comprise of two CP brass concealed stop cocks, four/five way auto-diverter, adjustable type over-head shower with CP shower arm , all with CP wall flanges of approved quality all as specified in the Schedule of Quantities. Bath spout, hand showers and pop up wastes shall also be provided wherever, specified. Wall flanges shall be kept clear off the finished wall. Wall flanges embedded in the finishing shall not be accepted.

vii. Flow Control Device

Approved / rated flow control fitment in brass body, chrome outer cover, rated for flow / discharge of the fixture.

viii. Toilet Paper Holder

Toilet paper holder shall be white glazed vitreous china or chrome plated of size, shape and type specified in the Schedule of Quantities.

Porcelain toilet paper holder shall be fixed in walls and set in cement mortar 1:2 (1 cement : 2 coarse sand) and fixed in relation to the tiling work.

The latter (chrome) shall be fixed by means of screws/capping having finish similar to the toilet paper holder in wall/temper partitions with raw l plugs or nylon sleeves. When fixed on timber partition, it shall be fixed on a solid wooden base member provided by the Owner's Site Representative.

ix. Towel Rail

Towel rail shall be chromium plated brass or of stainless steel or powder coated brass of size, shape and type specified in the Schedule of Quantities.

Towel rail shall be fixed with screws/capping having finish similar to the towel rail in wall with rawl plugs or nylon sleeves and shall include cutting and making good as required or directed by the Owner's Site Representative.

x. Janitor's Sink

Janitor's sink shall be stainless steel, single bowl type of size as called for in the Schedule of Quantities, provided with painted R.S. or CI brackets and clips and securely fixed. Each sink shall be provided with 40mm dia CP waste. Fixing shall be as directed by the Owner's Site Representative.

The supply fittings for Janitor's sink shall be wall mounted type of size as mentioned in Schedule of Quantities.

xi. Drinking Water Fountain

Drinking water fountain shall be well mounting type made of vitreous china, stainless steel or any other material as given in the Schedule of Quantities.

The drinking water fountain shall be with anti-squirt bubble less, self closing valve type with automatic volume regulator.

The drinking water fountain shall be provided with an anti-splash back and integral strainer with 32mm or 40mm cast brass trap.

xii. Liquid Soap Dispenser

Liquid Soap Dispenser shall be wall/counter mounted suitable for dispensing liquid soaps, lotions, detergents. The cover shall lock to body with concealed locking arrangement, opened only be key provided.

Liquid soap dispenser body and shank shall be of high impact resistance material. The piston and spout shall be stainless steel with 1 litre capacity polyethylene container.

The valve shall operate with less than 2.27 Kg (5 lbs) of force.

C) TOILETS FOR THE DISABLED

Where specified, in washroom facilities designed to accommodate physically disabled, accessories shall be provided as directed by the Owner's Site Representative.

Stainless steel garb brass of required size suitable for concealed or exposed mounting and opened non-slip gripping surface shall be provided in all washroom. The flushing cistern/valve shall be provided with chromium plated long handles.

D) MOCKUP AND TRIAL ASSEMBLY

The installation of the Sanitary fixtures and fittings shall be as per the shop drawings approved by the Architect/Consultant.

The contractor shall have to assemble at least one set of each type of sanitary fixtures and fittings in order to determine precisely the required supply and disposal connections. Relevant instructions from manufacturers shall be followed as applicable. This trial assembly shall be

developed to determine the location of puncture holes, holding devices etc. which will be required for final installation of all sanitary fixtures and fittings. The above assembly shall be subject to final approval by the Architect / Interior Designer.

The fixtures in the trial assembly can be re-used for final installation without any additional payments for fixing or dismantling of the fixtures.

E) SUPPORTING AND FIXING DEVICES

The contractor shall provide all the necessary supporting and fixing devices to install the sanitary fixtures and fittings securely in position. The fixing devices shall be rigidly anchored into the building structure. The devices shall be rust resistant and shall be so fixed that they do not present an unsightly appearance in the final assembly SS:304 Nut Bolts & screw. Where the location demands, the Architect may instruct the contractor to provide chromium plated or other similarly finished fixing devices. In such circumstances the contractor shall arrange to supply the fixing devices and shall be installed complete with appropriate vibration isolating pads, washers and gaskets.

F) FINAL INSTALLATION

The contractor shall install all sanitary fixtures and fittings in their final position in accordance with approved trial assemblies and as shown on drawings. The installation shall be complete with all supply and waste connections. The connection between building and piping system and the sanitary fixtures shall be through proper unions and flanges to facilitate removal/replacement of sanitary fixtures without disturbing the built in piping system. All unions and flanges shall match in appearance with other exposed fittings.

Fixtures shall be mounted rigid, plumb and to alignment. The outlets of water closet pans and similar appliances shall be examined to ensure that outlet ends are butting on the receiving pipes before making the joints. It shall be ensured that the receiving pipes are clear of obstruction. When fixtures are being mounted, attention shall be paid to the possibility of movement and settlement by other causes. Overflows shall be made to ensure that necessary anchoring devices have been provided for supporting water closets, wash basins, sinks and other appliances.

G) PROTECTION AGAINST DAMAGE

The contractor shall take every precaution to protect all sanitary fixtures against damage, misuse, cracking, staining, breakage and pilferage by providing proper wrapping and locking arrangement till the completion of the installation. At the time of handing over, the contractor shall clean, disinfect and polish all the fixtures and fittings. Any fixtures and fittings found damaged, cracked chipped stained or scratched shall be removed and new fixtures and fittings free from defects shall be installed at his own cost to complete the work.

H) MEASUREMENT

i. Rate for fixing only of sanitary fixtures accessories, CP fittings shall etc. include all items, and operations stated in the respective specifications and bill of quantities and nothing extra is payable.

ii. Rates for all items under specifications para above shall be inclusive of cutting holes and chases and making good the same, CP screws, nuts, bolts and any fixing arrangements required and recommended by manufacturers, testing and commissioning and making good to the satisfaction of the Owner's Site Representative.

I) TESTING AND ACCEPTANCE

All appliances, fixtures and fittings shall be tested before and after installation. Water seals of all appliances shall be tested. The contractor shall block the ends of waste and ventilation pipes and shall conduct an air test/water test.

I. The sanitary fixtures form the final terminal units of the water supply and drainage system and shall meet the performance needs as a terminal unit. Each fixture shall be inspected for scratches or chippings and alignment before acceptance.

II. The following design flows shall be verified and validated for acceptance.

W.C	Flush valve	15 ltrs to 20 ltrs	Provide test 32 dia valves connection at the lowest per flush floor & higest floor.
	Flushing Cistern	5 – 7 lit	Fill time between two consecutive flushes
Lavatory Basin	Cold/Hot water Pillar taps or Single lever fixture		15 lpm max. 10 lpm min
	Full Basin drain time		3 min. to be measured & validated.
Sink	CW/HW Pillar taps or Single lever mixer		15 lpm max. 10 lpm min
	Full sink drain time		3 min. to be measured & validated.
Bath tub	Faucet Cold/Hot water Shower		20 – 30 lpm
	Full tub drain time		10 min. to be measured & validated.

All tests shall be conducted at each and every fixture except for flush valves which shall be at the lowest and highest test connections to be made on each riser/down take. The contractor shall make the temporary valve connections which shall be plugged with a brass plug after validation.

2. WATER SUPPLY WORKS

The scope of this section comprises the supply, installation, testing and commissioning of piping network for water supply works for internal & external services .
The Contractor shall make all necessary application and arrangements for his work to be inspected by the Local Authorities. The Contractor shall be solely responsible for obtaining the Authorities approval of his works prior to the handing over of the complete water supply / distribution installation to the Owner.

Piping material shall be as follows:

Building Height (<30m)			
Down take	**Terrace Loop**	**Rising Main**	**Internal**
Inside the shaft: Pipes: uPVC Schedule 40, ASTM-D1785 Fittings : SCH 80 ASTM-D2467. Or cPVC	Pipes: uPVC (UV treated), Schedule 40, ASTM-D1785 Fittings : SCH 80 ASTM-D2467. Pipes to coated with 2 coats of latex UV resistant	a) Inside the shaft & Roof cPVC Up to 50 mm -SDR-11, IS15778/ D2846 and fittings as per ASTM- D2846-SDR 11 Above 50mm: cPVC SCH 40, ASTM F441 with fittings cPVC SCH 80 ASTM F-439 b) For hydro Pneumatic : IS 1239, G.I class "B" with G.I malleable fittings c) All Buried pipes to be coated and wrapped.	cPVC (Cold & Hot) Up to 50 mm -SDR-11, Pipes as per IS15778/D2846 and fittings as per ASTM-D2846 - SDR 11 Above 50mm - cPVC SCH 40, ASTM F441 with fittings cPVC SCH 80 ASTM F-439
Building Height (>30mm and less <70m)			
Down take	**Terrace Loop**	**Rising Main**	**Internal**
Pipes: CPVC Up to 50 mm : SDR-11, Pipes as per IS15778/D2846 and fittings as per ASTM-D2846 - SDR 11 Above 50mm - SCH 40, ASTM F441 with fittings SCH 80 ASTM F-439	Pipes: CPVC Up to 50 mm -SDR-11, Pipes as per IS15778/ D2846 and fittings as per ASTM- D2846 - SDR 11 Above 50mm - SCH 40, ASTM F441 with fittings SCH 80 ASTM F-439	Pipes: IS:1239 G.I Class "B" Fittings: G.I Malleable iron All Buried pipes to be wrapped & coated as specified .	cPVC (Cold & Hot) Up to 50 mm : SDR-11, Pipes as per IS15778/D2846 and fittings as per ASTM-D2846 - SDR 11 Above 50mm : cPVC SCH 40, ASTM F441 with fittings cPVC SCH 80 ASTM F-439
Building Height (>70mm and less <100m)			
Down take	**Terrace Loop**	**Rising Main**	**Internal**
Pipes: CPVC Up to 50 mm -SDR-11, Pipes as per IS15778/D2846 and fittings as per ASTM-D2846 - SDR 11 Above 50mm: SCH 40, ASTM F441 with fittings SCH- 80 ASTM F-439	Pipes: CPVC Up to 50 mm -SDR-11, Pipes as per IS15778/ D2846 and fittings as per ASTM- D2846 - SDR 11 Above 50mm - SCH 40, ASTM F441 with fittings SCH 80 ASTM F-439	Pipes: GI 'C' Class IS:1239 Pipe with welded joints or grooved fittings. Fittings: G.I Malleable iron All Buried pipes to be wrapped & coated as specified .	cPVC (Cold & Hot) Up to 50 mm : SDR-11, Pipes as per IS15778/D2846 and fittings as per ASTM- D2846 - SDR 11 Above 50mm : cPVC SCH 40, ASTM F441 with fittings cPVC SCH 80 ASTM F-439 Composite Pex for concealed drops as applicable

2.1 CPVC/uPVC/ Composite Pex piping

A. CPVC Piping:

Chlorinated Polyvinyl Chloride pipes (CPVC) up to 50mm dia SDR.11, CTS, as per IS 15778/D2846, and 50mm dia above CPVC schedule 40 ASTM F441,IPS. Fittings up to 50mm dia SDR.11 ASTM D2846, and Fittings above 50mm dia shall be SCH 80 ASTM F-439 . Where connection with metal is to be made in such case the fittings and specials such as tees, elbows, couplers, bends, enlargers etc, shall have brass threaded (male/ female), brass coupling, Brass FPT, Brass male adaptor etc confirming to ASTM D2846.
The piping works shall be supported with proper metal/CPVC clamps, Tee holders, elbow holders and supports etc., Include necessary drilling holes, chasing walls and making the same good in cement mortar 1:1 restore the same original condition neatly as directed by the Engineer in-charge.

Joints to be made with CPVC solvent cement up to 50mm dia as per ASTM F-493 and above 50mm dia primer P-70, and solvent confirming to ASTM F-493 / CPVC 724.

All exposed pipes to be painted with one coat of desired shade of enamel paint as per architect/client representative requirement.

All termination points for installation of faucets shall have brass termination fittings.

CPVC ASTM D2846, SDR 11 Plastic Pipe							
Nominal Size		**Outside Diameter, in. (mm)**		**Wall Thickness, in. (mm)**		**Pressure Rating. PSI (Kg/Cm^2)**	
(in.)	**(mm)**	**Average**	**Tolerance**	**Minimum**	**Tolerance**	**(23℃)**	**82℃**
½	(15)	0.625 (15.9)	±0.003 (±0.08)	0.068(1.73)	+0.020 (+0.51)	(28.1)	(7.0)
¾	(20)	0.875 (22.2)	±0.003 (±0.08)	0.080(2.03)	+0.020 (+0.51)	(28.1)	(7.0)
1	(25)	1.125 (28.6)	±0.003 (±0.08)	0.102(2.59)	+0.020 (+0.51)	(28.1)	(7.0)
1 ¼	(32)	1.375 (34.9)	±0.003 (±0.08)	0.125(3.18)	+0.020 (+0.51)	(28.1)	(7.0)
1 ½	(40)	1.625 (41.3)	±0.004 (±0.10)	0.148(3.76)	+0.020 (+0.51)	(28.1)	(7.0)
2	(50)	2.125 (54.0)	±0.004 (±0.10)	0.193(4.90)	+0.023 (+0.58)	(28.1)	(7.0)

Outside Diameters and Wall Thickness for CPVC SCHEDULE 40 (AS PER ASTM F 441)				
Nom (in.)	**Size (mm)**	**Average OD (mm)**	**Min. Wall Thick**	**Max. work Pre. At 23℃ (kg/cm^2)**
2 ½"	65	73.02	5.16	21.09
3"	80	88.90	5.49	18.28
4"	100	114.30	6.02	15.47
6"	150	168.28	7.11	12.66
8"	200	219.08	8.18	11.25
10"	250	273.05	9.27	9.84
12"	300	323.55	10.31	9.14

B. uPVC Piping (Water Supply – Non Exposed):

Un plasticized polyvinyl chloride water supply pipes schedule- 40 / 80 ASTM D1785 at a working pressure not less than 600 PSI for 15 mm to 180 PSI for 150 mm at 23 deg C,. The pipes shall be jointed using solvent welded SCH 80 uPVC fittings i.e. Tees, Elbows, Couplers, Unions, Reducers, brushings etc confirming to ASTM D-2467. The transition fittings connection between uPVC & metal pipe/GI shall be Brass Adaptors (both Male & Female threaded), brass tee, brass elbow etc conforming to ASTM D- 2467 . The solvent joint shall be done with solvent cement conforming to ASTM D-2564. The piping works shall be supported with clamps, hangers, anchor fasteners, structural steel supports as required / directed at site including cutting chases and fitting the same with cement concrete / cement mortar as required. All termination points for installation of faucets shall have brass termination fittings. Installation shall be to the satisfaction of Project Manager /Consultant / manufacturer of pipes & fittings.

C. uPVC Piping "UV treated" (Water Supply – Exposed):

Un plasticized polyvinyl chloride "UV treated" water supply pipes schedule- 40 / 80 ASTM D1785 at a working pressure not less than 600 PSI for 15 mm to 180 PSI for 150 mm at 23 deg C,. The pipes shall be jointed using solvent welded SCH 80 uPVC fittings i.e. Tees, Elbows, Couplers, Unions, Reducers, brushings etc confirming to ASTM D-2467. The transition fittings connection between uPVC & metal pipe/GI shall be Brass Adaptors (both Male & Female threaded), brass tee, brass elbow etc conforming to ASTM D- 2467 . The solvent joint shall be done with solvent cement conforming to ASTM D-2564. The piping works shall be supported with clamps, hangers, anchor fasteners, structural steel supports as required / directed at site including cutting chases and fitting the same with cement concrete / cement mortar as required. All termination points for installation of faucets shall have brass termination fittings. Installation shall be to the satisfaction of Project Manager /Consultant / manufacturer of pipes & fittings.
All exposed UPVC pipes to be coated with 2 coats of UV resistant latex.

D. Composite Pipes (PEX-AL-PEX) and Fittings

Composite pipes shall be of multi layer PEX-AL- PEX combination with layer of adhesive in between the two layers in coils. Composite pipes shall conform to ASTM F 1282-95 consisting of an aluminium support pipe, the inner lining of which is of white cross linked polyethylene and the outer layer of black cross linked polyethylene accordance to DIN 16892/93 and Composite pipes shall withstand pressure up to 8 bar. Thermal conductivity shall be 0.43 watt/ (m deg K).Apartment piping shall be laid and clamped in dry wall chase.

Fittings:

Corresponding fittings like Tee's, Elbows, Sockets, Reducers with two layered, inner layer of hot water resistant PPSU and outer layer of reinforced glass fiber PA-Plastic for Hot, Cold and flush water application, and the end fittings like adaptors (both male female) made of PPSU according to DIN EN 1982. Further all termination points should be PPSU fittings only for connection to the faucets.

E. Joining Pipes & Fittings

I. **Cutting:** Pipes shall be cut either with a wheel type plastic pipe cutting or hacksaw blade and care shall be taken to make a square cut which provides optimal bonding area within a joint.

II. **De burring / Bevelling:** Burrs and fittings should be removed from the outside and inside of pipe with a pocket knife, debarking tool or file otherwise burrs and fittings may prevent proper contact between pipe and fittings during assembly.

III. **Fitting preparation:** A clean dry rag/cloth should be used to wipe dirt and moisture from the fitting sockets and tubing end. The tubing should make contact with the socket wall 1/3 or 2/3 of the way into the fitting socket.

IV. **Solvent Cement Application:**

a) CPVC : Joints to be made with CPVC solvent cement up to 50mm dia as per ASTM-F-493 and above 50mm dia primer P-70, and solvent confirming to ASTM F-493 & CPVC 724.

Only CPVC solvent cement confirming to ASTM-F493 should be used for joining pipe with fittings. An even coat of solvent cement should be applied on the pipe end and a thin coat inside the fitting socket, otherwise too much of cement solvent can cause clogged water ways. CPVC cement solvent have a minimum shelf life of 1 year. Aged cement solvent will often change colour or being to thicken and become gelatinous or jelly like and when this happens, the cement should not be used. The cement solvent should be used within 30 days after opening the company's seal and tightly close the seal after using in order to avoid its freezing. The freezed cement solvent should be discarded immediately and fresh one should be used. The CPVC solvent cement usage should be adhered to as given in table below

Diameter of pipe in inch (flow guard)	**½"**	**¾"**	**1"**	**¼"**	**1½"**	**2"**
Approx. nos. of joints which can be mode per litre of solvent cement.	200 Nos	180 Nos	150 Nos	130 Nos	100 Nos	70 Nos

b) uPVC: The solvent joint shall be done with solvent cement conforming to ASTM D-2564. Insert the pipe into the fitting and check to that the interface occur about 1/3rd to 2/3rd of the socket depth. Application of solvent cement – Apply cement lightly but uniformly to inside of

socket and outside of pipe end with suitable applicator. Immediately after applying the last coat of cement to the pipe and while the cement is still fluid or wet, forcefully bottom the male end of the pipe in the socket, giving pipe or fitting ¼ turn (but not after pipe is bottomed) to distribute the cement evenly. Remove excess cement from the end of the fitting socket. The joint must not be disturbed immediately after cementing so that the joint can be properly cured.

V. Assembly: After applying the solvent cement on both pipe and fitting socket, pipe should be inserted into the fitting socket within 30 seconds, and rotating the pipe ¼ to ½ turn while inserting so as to ensure even distribution of solvent cement with the joint. The assembled system should be held for 10 seconds (approximately) in order to allow the joint to set up.

VI. An even bead of cement should be evident around the joint and if this bead is not continues remake the joint to avoid potential leaks.

F. Set & Cure times:

Solvent cement set times depend on pipe sizes and temperature and humidity. Solvent cement set and cure times shall be strictly adhered to as per the below mentioned table.

Ambient Temperature during Curing period	Pipe Size	
	½ " - 1" "	1.¼" - 2"
Above 15 deg. C	1 Hr	2 Hrs
4-15 deg.C	2 Hrs	4 Hrs
Below 4 deg C	4 Hrs	8 Hrs

Special care shall be exercised when assembling systems in extremely low temperature (below 4℃) or extremely high temperature (above 45℃) In extremely hot temperatures, make sure that both surfaces to be joined are still wet with cement solvent when putting them together.

G. Support spacing:

To ensure satisfactory operation of system pipe support shall be installed as follows:

All pipes shall be supported with approved hangers at intervals as shown in below tables. Pipe shall be supported at all branch ends and change of directions apart from straight lines. Concentrated loads should be supported directly/support the pipe immediately adjacent to the load. Allowance must be provided for temperature fluctuations. Hangers should not restrict the pipe movement to allow pipe contraction/expansion.

SCHEDULE - 40 /CPVC

Recommended Support spacing (in feet)

Nom. Pipe Size		Temperature °C			
(In)	(mm)	23	38	49	60
½	15	4	4	2 ½	2 ½
3/4 to 1"	20 - 25	5	4 ½	4	2 ½
1 1/4 to 2"	32 - 50	5	5	3	3
2 ½	65	7 ½	7	7	6 ½
3	80	8	7	7	7
4	100	8 ½	7 ½	7 ½	7
6	150	9 ½	8	8	7 ½
8	200	9 ½	8	8	7 ½

SCHEDULE - 80

Recommended Support spacing (in feet)

Nom. Pipe Size		Temperature °C			
(In)	(mm)	23	38	49	60
½	15	4 ½	4 ½	3	2 ½
3/4 to 1"	20 - 25	5 ½	5 ½	3½	3
1 1/4 to 2"	32 - 50	6	5	3½	3½
2 ½	65	8	7 ½	7 ½	6 ½
3	80	8	8	7 ½	7
4	100	9	9	8 ½	7 ½
6	150	10	9 ½	9	8

H. Testing

Once an installation is completed and cored as per above mentioned recommendations, the system should be hydrostatically pressure tested at 1.5 times working pressure or 150 psi(10 Bar) whichever is higher for one hour. During pressure testing, the system should be fitted with water and if a leak is found, the joint should be cut out and replacing the same with new one by using couplers.

I. PIPE PROTECTION (PIPES BURIED IN TRENCHES / GROUND / EARTH)

All buried pipes shall be cleaned with zinc chromate primer and bitumen paint, wrapped with three layers of fiber glass tissue, each layer laid in bitumen and placed on concrete blocks with PUF saddles dipped in bitumen at every 2 meters. The pipes where laid under floor shall be encased with 100 mm thick good quality, river sand all around in addition to protective coating as described above. Alternatively pypcoat / coatek insulation for protection of pipe would also be acceptable as per final approval of project engineer / consultant.

2.2 GI PIPES

The pipes shall be Electro resistance weld (ERW) or Hot finished welded (HFW) conforming to IS:1239 G.I Class "B" up to pipe sizes 125mm (150 mm pipe shall be class "C"for building height up to 70 m) and Class "C" for building height 70 m to 100 m " for pipe sizes up to 150mm.

Pipes sizes above 150mm, Galvanised Steel pipes shall comply to IS:3589 with minimum thickness of 6mm

All piping to be Cut to required lengths including all necessary fittings conforming to IS:1879 (Part 1 to 10) and specials such as bends, tees, unions, reducers, flanges & plugs etc. fixing in R.C.C. Work supported by galvanised clamps, hangers etc, as per specification. And GI pipe sleeves of specified diameter corresponding to the pipe size shall be provided wherever the pipes are crossing the fire rated walls/floors slab and sealing the sleeves with glass wool in between and fire sealant compound on either end, all as per consultant requirement. The Zinc coating shall be uniform, adherent, reasonably smooth and free from imperfections such as flux, ash and drops inclusions, bare patches, black spots, pimples, lumpiness, runs, rust stains, bulky white deposits and blisters.

All fittings shall be malleable iron galvanized fittings of approved make. The details of pipes and sockets regarding nominal bore, thickness and weight in kg/m shall be as per IS:1239. Threaded Malleable Iron galvanising fittings confirming IS-1879-2000 shall be used for pipes up to 40mm diameter and for 50mm & above diameter pipes welded joints shall be used.

Portable Water piping shall be supplied with internal food grade epoxy coating (2 coats) of minimum thickness of 300 microns.

The Galvanising shall conform to IS:4736, the zinc coating shall be uniform, adherent reasonably smooth and free from such imperfections as flux, ash and drop inclusions, bare patches, black spots, pimples, lumpiness, runs, rust strains, bulky white deposits and blisters. The pipes and sockets shall be cleanly finished, well galvanised in and out and free from cracks, surface flaws laminations and other defects. All screw threads shall be clean and well cut. The ends shall be cut cleanly and square with the axis of the pipe. Each pipe shall be hydraulically tested at manufacturer's work to withstand a test of Pressure of 5 Mpa.

a) G.I Malleable Iron Screwed Fittings :

G.I Malleable iron fittings shall conform to Indian Standard-IS 1879 and British Standard-1256.Wrought steel fittings, shall conform to Indian Standard-1239, Part II. Threads to these fitting conform to Indian Standard-554. Each fitting after being screwed shall withstand without any sign of leakage an internal pressure of 5 MPa.

Malleable iron screwed fittings shall be made with screwed joints. The fittings shall be furnished galvanized. The galvanized malleable iron screwed fittings shall be in the form of sockets, elbows, tees, crosses and reducers etc. The fittings ratings shall be same as pipe class

b) Forged Steel Screwed Fittings : Forged Steel screwed fittings are made in accordance with ASA Standard B-16.11. Materials for carbon steel fittings conform to ASTM Specification. All fittings to be galvanised.

c) Dimensions And working pressure of (Class "B", MDEIUM) (IS 1239)

N.B mm	Outside Dia.		Thickness mm	Woking pressure $Kg.cm^2$
	Max mm	Min mm		
15	21.8	21.0	2.65	21.09
20	27.3	26.5	2.65	21.09
25	34.2	33.3	3.25	21.09
32	42.9	42.0	3.45	17.58
40	48.8	47.9	3.25	17.58
50	60.8	59.7	3.65	14.06
65	76.6	75.3	3.65	14.06
80	89.9	88.0	4.05	14.06
100	115.0	113.10	4.50	12.02
125	140.8	138.50	4.85	12.02
150	166.5	163.9	4.85	9.98

d) Dimensions And working pressure (Class "C", HEAVY) (IS 1239)

N.B mm	Outside dia		Thickness mm	Woking pressure $Kg.cm^2$
	Max mm	Min mm		
15	21.8	21.0	3.25	24.61
20	27.3	26.5	3.25	24.61
25	34.2	33.3	4.05	24.61
32	42.9	42.0	4.05	21.09
40	48.8	47.9	4.05	21.09
50	60.8	59.7	4.50	17.58
65	76.6	75.3	4.50	17.58
80	89.9	88.0	4.85	17.58
100	115.0	113.10	5.4	16.03
125	140.8	138.50	5.4	14.79
150	166.5	163.9	5.4	12.02

e) Laying And Jointing Of GI Pipes

Tender drawings indicate schematically the size and location of pipes. The Contractor, on the award of the work, shall prepare detailed working drawings, showing the cross-sections, longitudinal sections, details of fittings, locations of isolating and control valves, drain and air valves, and all pipe supports. He must keep in view the specific openings in buildings and other structure through which pipes are designed to pass.

Pipe work and fittings shall be supported by hangers or brackets so as to permit free expansion and contraction. All accessories and ancillaries of support system such as brackets, saddles, clamps, hangers etc. shall be hot dip galvanized after fabrication. Further to permit free movement of common piping, support shall be from a common hanger bar, fabricated from galvanised steel sections.

Insulated piping shall be supported in such a manner as not to put undue pressure on the insulation. 14 gauge metal sheet shall be provided between the insulation and the clamp, saddle or roller, extending at least 15 cm. on both sides of the clamps, saddles or roller.

The contractor shall make sure that the clamps, brackets, saddles and hangers provided for pipe supports are adequate or as specified / approved by Consultants. Piping layout shall take due care for expansion and contraction in pipes and include expansion joints where required

Automatic air valves shall be provided at all high points in the piping system for venting. All valves shall be of 15mm pipe size and shall be associated with an equal size isolation ball valve. Automatic air valves shall also be provided on hot water risers.

Discharge from the air valves shall be piped through a galvanized steel pipe to the nearest drain or sump. All pipes shall be pitched towards drain points.

The galvanised pipes and fittings shall run in wall chase or ceiling or as specified. The fixing shall be done by means of standard pattern holder bat clamps keeping the pipes about 1.5 cm clear of the wall where to be laid on surface. Where it is specified to conceal the pipes, chasing may be adopted for pipes fixed in the shafts, ducts etc. there should be sufficient space to work on the pipes with the usual tools. Pipe sleeves shall be fixed at a place the pipe is passing through a wall or floor for reception of the pipe and allow freedom for expansion and contraction and other movements. In case of pipe is embedded in walls or floors it shall be painted with anticorrosive bitumastic paints of approved quality. Under the floors the pipes shall be laid in layer of sand filling and back filing.

Galvanised iron pipes up to 50mm shall be jointed with threaded and socket joints, using threaded fittings & above 50 mm diameter pipes welded joints shall be used. Care shall be taken to remove any burr from the end of the pipes after threading. Teflon tape, White lead or an equivalent jointing compound of proprietary make shall be used, according to the manufacturer's instructions, with a grommet of a few strands of fine yarn while tightening. Compounds containing red lead shall not be used because of the danger of contamination of water. Any threads exposed after jointing shall be painted with bituminous paint to prevent corrosion.

All underground buried pipes shall be initially brushed to remove all foreign matter and apply the primer over the pipe. Primer shall be allowed to dry until the solvent evaporates and surface becomes tacky. Tape(Pypkote / Coatek wrapping) 4mm thick and 150/250mm wide shall then be wound in a spiral fashion and bonded completely to pipe by thermo fusion process. Overlap shall be maintained at 15mm. Wrapping Pypkote / Coatek apply shall be as follows:

1. Surface Preparation - The pipe surface shall be cleaned by a wire brush.

2. Application of Primer - Primer is to be applied on pipes immediately after cleaning. This is to prevent any further accumulation of rust on the pipe. This is a cold applied primer and is applied by brush.

3. Application of Pypkote / Coatek 4 mm Tape - After the primer is applied on the pipe, it is allowed to dry for about 30 min. till it becomes touch dry. Before adhering the tape to the pipe, it is advisable to gently heat the primer coated pipe by a run of LPG torch. Remove the bottom polyethylene from the tape & then heat bottom surface of the tape by LPG torch or any heat source & start wrapping the tape to the pipe by heating the primer coated pipe & by removing the bottom polyethylene from the tape before wrapping better adhesion between the tape & pipe is obtained. Overlaps are maintained with a minimum of 15 mm.

4. Tape coating of weld joints - The tape is applied over the weld joints after the necessary welding & testing methods of the joints is completed. The procedure for application of tape shall be the same as bare pipe procedure. Overlaps on each side of the weld joints shall be 50 mm.

5. A final coat of White wash with water based cement paint is done immediately over the entire coated pipe

2.3 Hot water piping insulation

Insulation material for Pipe insulation shall be Closed Cell Elastomeric Nitrile Rubber or closed cell cross linked polyethylene foam. Thermal conductivity of elastomeric nitrile rubber shall not exceed 0.038 W/moK or 0.0313 Kcal / Mhr oC or 0.212 BTU / (Hr-ft2-oF/inch) at an average temperature of 40^{o}C. The product shall have temperature range of –40 ^{o}C to 105^{o}C. Density of material shall not be less than 0.06 gm/cm3. The insulation shall have fire performance such that it passes minimum CLASS 1 as per BS476 part 7 for surface spread of flame. Water vapour permeability shall not exceed 0.024 per inch (3 x 10-14 Kgs / m.sec.Pa). The material shall have approval from the consultant.

Thickness of the insulation shall be as specified for the individual application. Each lot of insulation material delivered at site shall be accompanied with manufacturer test certificate for thermal conductivity values. Samples of insulation material from each lot delivered at site may be selected by Owner's site representative and gotten tested for thermal conductivity and density at Contractor's cost All joints shall be sealed properly with adhesive, which shall provide similar vapour barrier as the original insulating material.

All hot water piping shall be insulated in the manner specified herein. Before applying insulation, all pipe shall be brushed and cleaned. Thermal insulation shall be applied as follows or as specified in drawings or schedule of quantity:

Pipe size (mm)	Thickness of Nitrile rubber insulation
15 mm to 25 mm	9 mm
32 mm to 50 mm	13 mm
65 mm and above	19 mm

2.4 Insulation for pipes

Insulating material in tube form shall be sleeved on the pipes. On existing piping, slit opened tube from insulating material shall be placed over the pipe and adhesive (as recommended by the manufacturer) shall be applied as suggested by the manufacturer. Adhesive must be allowed to tack dry and then press surface firmly together starting from butt end and working towards centre.

Wherever flat sheets shall be used it shall be cut out in correct dimension. All longitudinal and transverse joints shall be sealed as per manufacturer recommendations. The insulation shall be continuous over the entire run of piping, fittings and valves. All valves, fittings, joints, strainers etc. in hot water piping shall be insulated to the same thickness as specified for the main run of piping and application shall be same as above. Valves bonnet, yokes and spindles shall be insulated in such a manner as not to cause damage to insulation when the valve is used or serviced.

All insulation work shall be carried out by skilled workmen specially trained in this kind of work. All insulated pipes shall be labelled (HWS / HWR / HWRR) and provided with 300 mm wide band of paint along circumference at every 1200 mm for colour coding. Direction of fluid shall also be marked. All painting shall be as per relevant BIS codes.

2.5 Flexible Pre-Insulate Pipe System (buried external piping)

Providing and fixing Pre-insulated (pre-fabricated) pipe systems in accordance with manufacture “Quality Assurance” or another equivalent external monitoring system. It should allow a radius of curvature of 0.40 to 1.25 meter up to DN 100, from DN 100 to DN 200 a radius of 16 to 20 meter. It should be corrosion-resistant and maintenance-free; shutdown (outside the season) can be performed without special measures. No compensators or compensation tube bends should be used during laying as the pipe system should itself compensates for linear expansion on its own. System should consist exclusively of the components belonging to a system.

The pre-fabricated thermal insulation consists of flexible, closed-cell flexible polyolefin foam that is bonded to the casing pipe, having density of 30 – 40 kg/ m3, capable of operating for the temperature range of – 80 to + 95oC, the thermal conductivity: of the pre-fabricated (pre-insulated) system should be 0.301 W/mK at 50^{o}C. The casing pipe should be of HDPE and should be water tight while being bonded with insulation.

2.6 Protective Coating Over Insulation

To provide mechanical strength and protection from damage all exposed pipe insulated with nitrile rubber shall be covered with fibreglass fabric. The fibreglass fabric shall be applied with one coat of fire proof epoxy or acrylic compound (resin & hardner). The coat shall be allowed to cure to non stick state. Subsequently second coat of compound shall be applied to give a tough and smooth finish to the insulated surface.

2.7 Measurement of Insulation

Unless otherwise specified measurement for pipe insulation for the project shall be on the basis of centre line measurements described herewith

Pipe Insulation shall be measured in units of length along the centre line of the installed pipe, strictly on the same basis as the piping measurements. The linear measurements shall be taken before the application of the insulation. It may be noted that for piping measurement, all valves, orifice plates and strainers shall not be separately measurable by their number and size. It is to be clearly understood that for the insulation measurements, all these accessories including valves, orifice plates and strainers etc. shall be considered strictly by linear measurements along the centre line of pipes and no special rate shall be applicable for insulation of any accessories, fixtures or fittings whatsoever.

2.8 Hangers and Supports

Site fabricated products will not be allowed. All supports to be factory fabricated and galvanised

Service	Hanger Type	Maximum Pipe Size
All PVC/CPVC	Full Clamp(3 mm to 5 mm) with Insulation Shield	200mm
All Other Pipes	Clevis (3 mm to 5mm)	200mm
All Other Pipes	Trapeze (6 mm thick)	200mm
All Other Pipes	Wall Bracket (6 mm thick)	125mm
All Other Pipes	Wall Bracket (10 mm thick)	150mm to 300mm

Installation of piping

Provide hanger rod sizes in accordance with the following schedule:

Pipe Size	Rod Size
25mm and smaller	8 mm
32mm to 50mm	10mm
65mm to 80mm	10mm
100mm to 125mm	15mm
150mm	15mm
200mm to 300mm	20mm

Provide hangers in accordance with the following schedule:

Hanger Spacing Schedule		
Piping Material	**Pipe Size**	**Maximum Hanger Spacing**
uPVC/CPVC	Refer corresponding section	
GI & other metal pipes	50mm & less	2000mm
GI & other metal pipes	65mm & 100	2500mm
GI & other metal pipes	100mm & 150	3500mm
GI & other metal pipes	200mm & 300	5000mm

I. Provide hangers at each change in direction on both sides of each valve and on both sides of pipe fittings.

II. For flat slab construction only, support hangers from concrete inserts. Furnish, locate and set such inserts and make sure that such inserts are in place when the concrete is poured. Construct inserts of malleable iron or pressed steel with space for rods of all sizes. Install all inserts for pipes 80mm and larger in size with a reinforcing rod 15mm in diameter run through a slot in the insert specifically provided for this purpose.

III. For flat slab construction only, if any pipe is to be hung in a space where no inserts have been provided, drill holes in the slab (subject to the Engineer prior approval) and provide rods and hanger attached to an approved fishplate or install double expansion shields connected by a 50mm x 50mm x 6 mm angle, from which the hanger rod is to be suspended. For pipe size 50mm and under, use single shields but the hanger spacing defined herein before to be reduced to 1.5m. The carrying capacity and size of each shield to be calculated on the basis of the spacing indicated above but the minimum size to be 10mm. Install additional shields of the same size so that the number of hangers are of adequate size to support the loads which they carry. Shields may be used in flat concrete slabs only.

IV. Regardless of the type of construction (i.e., concrete, concrete-deck-steel or other variations) take particular care to support all main lines and all large and heavy pipes in an approved manner, including the furnishing and installation of supplementary steel, if required. Supplementary steel sections are to be mill-rolled. Submit shop drawings, indicating support methods, point loadings to the building structure and hanger locations for review sufficiently in advance of concrete pouring schedules to permit evaluation, critique and any necessary changes to handling and support methods.

V. Set all inserts for all pipes in ample time to allow concrete work to be performed on scheduled time.

VI. Hangers may be directly attached to steel beams of building construction, where they occur, if approved by Engineer. Smaller pipes may be suspended from crosspieces of pipe or steel angles, which in turn, are to be securely fastened to building beams. The intention is to provide supports which, in each case, will be amply strong and rigid for the load, but which will not weaken or unduly stress the building construction.

VII. Provide approved roller support, floor stands, wall brackets, etc., for all lines running near the floor or near walls, which can be properly supported or suspended by the floors or walls. Pipelines near walls may also be hung by hangers carried from approved wall brackets at a level higher than the pipe.

VIII. Do not hang piping from other piping. Support of hangers by means of vertical expansion bolts is not permitted.

IX. Anchor piping as required to localize expansion or to prevent undue strain on piping and branches. Anchors to be entirely separate from hangers. All anchor designs to be submitted flex bellows flanged or screw type for approval and to include piping reactions which respective anchors are capable of supporting. Provide all indicated or required expansion loops.

X. Hangers used for cold piping will support the pipe without piercing the insulation. Use insulation shields to protect the insulation on cold pipes. Weld insulation protection saddles to insulated hot pipes, or any piping subject to axial movement, at roller supports. Space between pipe and saddle to be filled with insulation.

XI. For piping 100mm and larger, support the elbows of the piping adjacent to the pumps with steel base elbow supports from the inertia base which pump is on to prevent loading heavy weights of piping on pump casing. Where inertia base is not provided, base elbows to be supported on floor with 25mm neoprene pad.

XII. All pipes supports shall be of such design and type to allow for the removal of any pipe section without the necessity of disconnecting other adjacent pipes.

XIII. In all plant and pump rooms discharge pipe work from pumps, and all pipe work where vibration could be transmitted to the building structure, shall be supported with brackets having a tough rubber lining in contact between the bracket and the pipe shall have anti-vibration hangers/supports.

XIV. Special attention shall be paid to that adequate pipe anchors shall be provided at the ends or turning points of uPVC/CPVC pipes to prevent fracture of the pipe resulted from water hammer. Such anchor points shall be fixed in a manner that the inertia in the flow will be directly transmitted onto the anchors thus releasing the uPVC pipes from being under stress.

XV. Where pipes pass through walls, floors, etc., the Contractor shall provide pipe sleeves. Sleeves for uPVC/CPVC pipes & copper pipes shall be galvanized steel. For pipes, where sleeves are fitted through floors/wall they shall extend to at least 20mm clear stud out from the finished floor level.

XVI. The space between pipe sleeves and the pipe or insulation shall be completely backfilled with materials having the same fire resistant rating as the walls and floors by the Contractor. Should multi-services or more than one single pipe be laid through box-out, the space between the individual pipe sleeves shall be sealed off. The space between the pipe sleeves and the service pipes shall be back-filled.

XVII. Sleeves shall be of sufficient size to allow free movement of pipes and furthermore where pipes are insulated the sleeves shall be oversized to allow the insulation to be carried through the sleeves. The Contractor's attention is drawn to the vertical pipe ducts at all floor levels. Where pipes pass through floors, sleeves shall be provided. The Contractor shall supply sleeves for setting in walls, floors, etc., and in the shuttering before concrete is poured.

XVIII. Details of pipes through walls and floors shall be approval by the Engineer before installation.

XIX. Where pipes pass through flat roofs covered with roofing material: -

a. Cast or build in galvanized mild steel sleeve with 2 to 12mm clearance projecting 150mm above roof finish.

b. Caulk space and point both ends with approved sealant.

c. Cover tops of sleeves with lead collars as per roofing Specification.

2.9 PAINTING:

Before Installing all pipes to be painted with one coat of paint. After installing pipes to be painted with two coats of Synthetic enamel paint of approved shade Including painting of legends with direction arrow as per the approval of the Architects / Consultants.

Used paints and coatings that comply with the following limits for VOC content and the following chemical restrictions:

Non-Flat Paints and Coatings: VOC not more than 150 g/L.

Anti-Corrosive Coatings VOC not more than 250 g/L.

Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).

Paints and coatings shall not contain any of the following:

Acrolien
Acrylontrile
Antimony
Benzene
Buty benzyl phthalate
Cadmium
Di (2-ethylheyl) phthalate
Di-n-butyl phthalate
Di-n-octy phthalate
1,2-dichlorobenzene
Diethy phthalate
Dimenthyl phthalate
Ethyl benzene

Water supply pipes in exposed, in shafts shall be painted with two or more coats of ready mix ow-VOC oil paint to give an even shade before painting all dust and extraneous matter shall be removed.

Paint shall be of approved quality and shade. Where directed by the Owner's site representative pipes shall be painted in accordance with approved pipe colour code.

Pipe in chase shall be painted with two coats of bitumen paint, covered with polythene tape and a final coat of bitumen paint. Exposed pipes shall be painted with synthetic enamel paint after removing dust and extraneous matter.

Water supply pipes below ground and covered in cement concrete shall not be painted.

3. SPECIFICATIONS FOR IRRIGATION LINE WORKS

A. uPVC Pipe

The work consists of Supplying, Laying, Jointing, Testing and Commissioning of uPVC pipes including fittings and specials as specified and directed by the ENGINEER-IN-CHARGE for the purpose of irrigation in proposed site. Providing and fixing approved make uPVC pipe Agriculture quality) quickfit class 3, IS 4985, 6 kgs/cm2 pipes fittings, solvent, welding as per manufacturers recommendation, including all testing as specified etc., complete. The alignment of pipeline can also be changed as per the site condition and as per direction of ENGINEER-IN-CHARGE.

B. Couplers & Hose pipe

Quick Coupler Valve (QCV)

Quick coupler valve shall be used at every 30 meter interval in the irrigation pipe network.

The QCV shall have a thermoplastic locking cover. The cover shall be able to open with suitable locking key. The valve body construction shall be one/two piece type. The valve body & coupler key shall be made from cast red brass. The seat disc plunger shall be spring loaded to maintain the valve in closed position at zero inlet pressure. The QCV shall be able withstand 10 bar pressure.

i) Materials of Construction

a. Body – Heavy Duty Brass

b. Spring- Stainless Steel

c. Cover- Thermoplastic rubber (Yellow Colour)

ii) Design parameters

a.	Size	(mm)	:	As per drawing
b.	Rating	(bar)	:	10

iii) List of Approved Makes

Coupler	Rainbird
	Hunter
	Jain Irrigation

C. Garden Hose

The garden hose shall be superior quality flexible PVC hose with polyester yarn reinforcement which shall give the extra strength & resistance in twisting and stretching. The pipe shall have high gloss finish and good visibility. It shall have good cold and warm resistance. The burst pressure shall be 35 bars. The hose shall be supplied with the hose reel.

D. Ball Valves

Valves shall be ball pattern of the square head type with GM steel ball conforming to IS 1703. Valves of sizes up to 50 mm (2 inches) in diameter shall be bronze with threaded ends and for valves of sizes larger than 50 mm (2 inches) in diameter shall be with flange end.

CPVC Valves of sizes up to 50 mm (2 inches) in diameter shall be with union ends and for valves of sizes larger than 50 mm (2 inches) in diameter shall be with flange end

E. LLDPE Pipe

LLDPE pipes – Netafim / Jain / Rain Bird make - manufactured as per IS 13488-1348 or international standard having wall thickness of 0.9mm & above with any special incl. Factory fabricated standard fittings. In case of Inline Drip Laterals, pressure compensating drippers must be used with it.

F. DRIPPER

Dripper: Netafim / NaanDan / Plastro make - Pressure compensating discharge 2 to 8 LPH including all fittings at 1.00 to 1.5 Kg/cm2 pressures.

G. PVC Moulded Valves

PVC Molded – GF/FIP/Astore/Plasson Make PVC Ball valve true union type, 'solvent welded can take pressure of 10kg/cm2 above.

H. Valve Boxes

Rain Bird / Toro/ Hunter Make Heavy Duty Plastic Valve Boxes of suitable sizes minimum 12" should be used to cover the System operation valves with valve chamber

I. Disc Filter

Manual disc filter with glass reinforced Nylon body, UV protected, Suitable for installtion in angular or globe configuration. O ring shall be provided between vover & body. Filter shall have Pre moulded threded holes provision for pressure guage connection. The system shall have protection from clogging. Filtration with 40 mm BV with suitable valve chamber size. Filtration grade shall be suitable for drip irrigation

4. WATER TREATMENT SYSTEM & ACCESSORIES

A) GENERAL

This section of the contract involves the design, supply, installation, testing and commissioning of the complete Water Treatment plant for domestic water.

All installation work shall comply with the latest rules and regulations. The work embraced by this specifications covers the design, submission to authorities, supply, delivery on site, installation, testing, commissioning and maintenance of the Water treatment system installation of the building.

The scope of work shall include the following (list is indicative and not exhaustive) :

- Complete Raw Water Treatment System. The Contractor shall be responsible for carrying out water analysis for the raw water from bore well / tanker supply and design all system components/equipment so as to achieve the potable water quality as per specified Standards SP:35 (S&T 1987) & IS 10500, CPHEEO.

- The Raw Water Treatment System as a minimum shall consist of feed pumps, filters with back wash provisions with all accessories complete with all controls, softener, U/V Treatment System, PH automatic control and monitoring system, electrical panels, cabling, etc.

- All the pipe work between the raw water tanks, treated water tanks and all the interconnecting pipe work amongst the Water Treatment pumps and other equipment.

- Electrical equipment and installation work including the necessary wiring etc. in Control panel.

- Painting and labelling of pipe work and equipment;

- Provision of all hold down bolts, spigots struts and the like required to be built in during construction;

- Provision of dry contacts to BMS indicating the status of the pumps and pressure vessel in form of hardware interfacing panels inside each control panels of all pumps as applicable.

- Provision of all level switches, flow switches and other sensing devices for status indication.

- All interfacing work with other trades.

- Testing and commissioning and balancing of the complete Water Treatment system;

- Provision of twelve (12) months maintenance and breakdown services;

- Provisions of operating instructions and maintenance manuals;

- Provision of spare parts;

- Training of the employer's staff for proper operation of the entire systems;

- Liaison with Local Authorities to obtain all necessary certificates and approvals, including the completion of all submission drawings, forms and payment of any fees and charges. All the costs for all the tests required by Local Authorities shall be included. To attend to any Authorities inspection regardless of whether this inspection is carried out after the defect liability period;

- Provisions of the necessary installation which include pumping works, pipe work within the pumping unit up to suction and discharge manifolds, conduit and control wiring, etc. to form a workable system required;

- All other works and systems as specified in the Contract document and or shown on the drawings.

- All cutting, patching, framing up, furring in, chasing and making good associated with the building construction for the passage of pipes, conduits and the like including providing GI pipes sleeves of required size corresponding to pipe dia, wherever pipes crossing fire rated walls and floors and sealing with glass wool in between and fire sealant compound on either end. Details on shop drawings shall also be provided.

Equipment offered for supply and installation shall include the following:

All minor items and incidental work, equipment accessories and materials may not be specifically mentioned but are required for the proper completion of the installations in accordance with the true intent and meaning of this Specification.

All necessary safety devices for the protection of personnel against injury and the protection of plant and equipment against damage including relief valves, belt guards, fan inlet and/or discharge guards, safety railing, effective earthing of electrical components, electrical interlocks, warning lights and alarms.

Readily accessible, dust-proof lubricating facilities on all moving parts and equipment including provision for cleaning all lubricating lines and bearings and charging same with the correct lubricants after installation but prior to testing and commissioning.

Clearly visible and robust manufacturer's name-plates permanently fitted each and every item of equipment and showing the manufacturer's name, type and/or model number, serial number, and all essential operating data such as speed, capacity, voltage, current draw, etc.

The Contractor also shall allow provision for the inspection of all plant and equipment by the manufacturer or his licensed representative, at least twice during the course of the installation.

B) Filtration

Scope

The scope of this section comprises the supply, installation and commissioning of FRP composite vessel filter.

FRP Composite Vessel Filter

The filter shall be constructed of FRP material with inner shell of integrated polyethylene, polypropylene and other material as per manufacturer's standard.

The inter distribution system and the under bed draw off system shall be of Hub & Lateral type of polypropylene material. The filter shall be provide with manhole cover, hand hole, flanged outlet for piping / valve connection and adequate tripod with skid self supporting structure for making the installation completed. The filter shall also be provided with vacuums breaking connection / accessories to avoid any collapse of internal lining. All filters shall be provided with lifting lugs. The filter bed depth shall be 1500 mm.

Face Piping

Each filter shall be provided with interconnecting face piping comprising of inlet, outlet, and backwash complete with valves.

Accessories

Each filter shall be provided with following accessories :-

a. Air release valve with connecting piping.

b. 100 mm dia dial bourden type gunmetal pressure gauges with brass isolation ball valve and connection piping on inlet and outlet.

c. Sampling valves (ball valves) on raw water inlet and filtered water outlet.

d. Individual drain connection with brass full way ball valve for each filter.

Filter Media

The filter media shall comprise of gravel / silica of various grade in varying thickness. The cut-section of the filter along with filter media detail shall be subject to approval by the Consultant.

Test Kits

Provide one test kit with initial requirement of reagent:

a) PH meter (electronic)

b) Turbidity meter

Detail of equipment with technical literature shall be supplied with the tender.

Piping

The pipes and fittings in the domestic Water Treatment plant room shall be GI class `C' (heavy class) conforming to IS: 1239 (Part-I) for pipes and IS:1879 (Part 1 to 10) for malleable cast iron fittings.

C) Pumps

Pumps shall be vertical, centrifugal, multistage directly coupled to motor. Provision of pump with pump head & base of cast iron and other parts in SS 304 ,including impeller. Impeller shall be hydraulically balanced and keyed to shaft. Pump shall be mounted on a concrete foundation, projecting at least 15 CM above finished floor level. The pumps base shall be set on a vibration elimination pad. The pump shall be lubricated in strict accordance with the manufacturer's instructions and shall be factory aligned prior to shipment. All motors and bases shall be painted with approved finish shop coat of paint. The pump shall be selected for the lowest operating noise

level and shall be complete with flexible connections, valves, and pressure gauges. The pumps shall include cost of foundation channel complete.

D) Alum / Soda Ash Dosers

All dossers shall be of the electronic metering plunger type confirming to the requirements specified in the Bill of Quantities. They shall be complete with low level switch, low level alarm, tank and interconnecting piping.

E) UV Unit

UV unit shall be complete with reactor, cabinet housing, cabinet cooling, treatment chamber, electrical panel, temperature safety control, lamp out alert, UV radiometer along with UV monitoring system and UV monitoring readout panel. The UV Dosage should be > 30,000 uW – Sec / sq.cm. The lamps should be selected based upon the flow requirement of respective unit.

F) Surflow Nozzles

Nozzles shall be constructed of unalterable UV resistant ABS plastic & shall be designed for low noise and smooth flow at desired rate. The nozzle shall be suitable for three adjustable set positions and shall be connected through ferrule / saddle connection to CILA pipe equidistant positioned on the swimming pool floor.

G) Suction Sweeper

Suction sweeper shall consists of centrifugal pump directly coupled through flexible coupling to 400/440 volts, 3 phase 50 cycles motor and both units mounted on a trolley complete with suitable starter, 30 meters (appx.) of cable terminating with a three pin plug with 600 mm wide suction sweeper head with wheels, spring loaded brush and towing rope, 20 meters length of internally armoured hose with necessary coupling and floats. Contractor to submit the technical detail and catalogue of the suction sweeper model along with the bid for the review & approval of the Owner /Consultant.

H) Water Quality

The domestic water treatment basis of design is as per raw water analysis.. Contractor shall get the raw water analysis done at his own expense (in accordance to IS:10500 prior to submission of the water treatment scheme.

The contractor shall ensure domestic water of potable water standard after the treatment system. The acceptable standard of potable water shall be in accordance to SP:35 S & T : 1987 , CPHEEO as per acceptable limits.

The technical tolerances for water for swimming pool shall be as follows:

S.No.	Characteristic	Tolerance
i.	PH value	7.5 to 8.5
ii.	Total alkalinity (as Ca COs), mg/1, Max	20 to 200
iii.	Aluminium (as A1), mg/1, Max	0.1
iv.	Total residual chlorine, mg/1 a. At inlet, Max b. At outlet, Min	 0.5 0.2

v.	Oxygen absorbed in 4 hours at 27 deg. C mg/1, Max	1.0
vi.	Chloride (as CI), mg/1, Max	200
vii.	Iron, mg/1, Maxx	0.1
viii.	Heavy metals (as pb), mg / 1, Max	0.1
ix.	Colour, Hazen units, Max	5
x.	Turbidity, NTU, Max	10
xi.	Odour	Odourless
xii.	Taste	Palatable

I) Float less Type Level Switch In Water Tanks

The Contractor shall supply and install float less type switch probes in the water tanks as indicated below and shown on the drawings.

Raw Water Tanks

- High level alarm (over-flow);
- Low level alarm;
- Low level cut-out for raw water pumps;
- Earthing probe.

Treated Water Tank

- High level alarm (over-flow);

  Low level alarm;

  Low water level cut-out for the pumps;
- Earthing probe.

Each probe shall be of the correct length for the particular application and tank location. Electrodes shall be of polished stainless steel 20 mm OD. Electrode holders shall be weatherproof in all respect.

The earthing probes shall be connected and wired to the building earth systems of the building.

The level switch set shall operate with a stepped down voltage at 24V maximum. Stepped down transformers shall be provided for each set of control probes and shall be installed inside centralised control cubicles inside pump room.

J) Control Of Duty / Standby Pumps

Operation of the duty and standby pumps shall be carried out by the following method:

a Automatically by means of pressure sensor (i.e. pressure switches);

b Manually by means of a local start/stop push buttons on pump local motor control panel and emergency stop switch.

The pressure switch shall be installed next to the manual release valve. When the level drops to the pre-determined level, a signal will be sent to the pump local motor control panel to start the pump.

Automatic controls shall be operated by electronic, float less type level switches.

K) Pump Indicator

The following audible and visible indication shall be provided at the pump local control panels as applicable:

a Red "overflow level" indicator with buzzer for the associated water tanks;

b Amber "extra high water level" indicator for the associated water tank;

c Amber "high water level" indicator;

d Amber "low water level" indicator;

e Red "pump trip" indicator for each pump;

f Green "pump on" indicator for each pump;

g "Pump electrical supply healthy" indicator for each pump;

h Amber "remote/local" status indicator.

L) UV Unit

UV unit shall be complete with reactor, cabinet housing, cabinet cooling, treatment chamber, electrical panel, temperature safety control, lamp out alert, UV radiometer along with UV monitoring system and UV monitoring readout panel. The UV Dosage should be > 30,000 uW – Sec / sq.cm. The lamps should be selected based upon the flow requirement of respective unit.

M) Chemical & Bacteriological / Microbiological Test Parameter Of Raw Meter Water

The above mentioned parameters shall be tested in accordance to : IS : 10500 – 1991, Amendment No : 2-2003

The Chemical and Physical Parameter (30 Parameter) shall be as follows :

Colour, Odour, Turbidity

Total Hardness, pH, Total Iron, Chloride, Dissolved Solids, Calcium, Magnesium, Copper, Hexavalent Chromium, Manganese, Sulphate, Nitrate, Fluoride, mercury, Cadmium, Selenium, Arsenic, Cyanide, Lead, Zinc, Aluminium, Boron, Phenolic Compounds, Detergents, Mineral Oil, Alkalinity, Silica.

Note : It is desired to also obtain probable composition of Total Solids if the TDS parameter exceeds 1000 ppm.

The bacteriological / Microbiological Test Parameter shall be as follows :-

MPN Coliform Organism, Cloiform Bacteria, E. Coli (Typical Faecal Organism).

The above tests shall be carried out by the contractor prior to submitting the technical submittal of the water treatment plant equipment. Contractor shall also submit the test report of raw water & treated water after the commissioning of the plant. The cost of the tests (one pre equipment & two post equipment installation / commissioning) is deemed to be included in the quote.

5. DRAINAGE WORKS (INTERNAL)

SCOPE

The scope of this section comprises the supply, installation, testing and commissioning of internal drainage services.

Work under this section shall consist of furnishing all labour, materials, equipments and appliances necessary and required to completely install all soil, waste, vent and rainwater pipes etc and fittings as required by the drawings, and given in the schedule of quantities.

BASIC PIPING SYSTEM

Soil, waste and vent pipes in shafts, ducts and in concealed areas i.e. false ceilings etc. shall consist of uPVC pipes & fittings as called for. In general wastes and vents smaller than and up to 50mm dia shall be of heavy class PVC pipes as specified.

The soil pipes shall be circular with a minimum diameter of 110mm. Pipes shall be fixed by means of stout GI clamps in two sections, bolted together, built into the walls, wedged and neatly jointed as directed and approved by the Owner's site representative / Architect. All bends, branches, swan neck and other parts shall conform to the requirement and standards as described for the pipes. Pipes shall be rested against the walls on suitable wooden cradles. Local authority regulations applicable to the installations shall be strictly followed.

Where indicated, the soil pipes shall be continued upwards without any diminution in its diameter, without any bend or angle to the height shown in the drawings. Soil pipes shall be painted as provided under `painting'. The soil pipes shall be covered on top with uPVC terminal outlets as directed and approved. All vertical soil pipes shall be firmly fixed to the walls with properly fixed clamps, and shall as far as possible be kept 50mm clear of wall. Waste pipes and fittings shall be of uPVC pipes.

Every waste pipe shall discharge above the grating of properly trapped gully. The contractor will ensure that this requirement is adequately met with. Wherever floor traps are provided, it shall be ensured that at least one wash is connected to such floor traps to avoid drying of water seal in the trap. Anti-syphon vent pipes/relief vent pipes to provided for satisfactory working of system. The pipes shall be of the diameter shown on the drawings.

All traps on branch soil and waste pipes shall also be ventilated at a point not less than 75mm or more than 300mm from their highest part and on the side nearest to the soil pipe or waste pipes.

Access doors for fittings and clean outs shall be so located that they are easily accessible for repair and maintenance. Any access panel required in the civil structure, false ceiling or marble cladding etc. shall be clearly reported to the Owner in the form of shop drawings so that other agencies are instructed to provide the same.

All the fittings used for connections between soil, waste and ventilation pipes and branch pipes shall be made by using pipe fittings with inspection doors for cleaning. The doors shall be provided with 3mm thick rubber insertion packing and when closed and bolted shall be air and water tight.

Where soil, waste and ventilating pipes are accommodated in shafts ducts, adequate access to cleaning eyes shall be provided.

Vent Pipe Terminations

a) Vent system conforming to IS : 13592 -Type as per building height comprising uPVC pipes and uPVC fittings (moulded as well as fabricated) like bends, tees, Y-tees, crosses, boss connections, access pieces, saddle pieces, cleanouts, adaptors for connections to other materials, plugs, reducers, cowls, offsets and other specials. Jointing shall be done with push fit rubber ring jointing technique in general. Solvent cement joints may be provided for fittings and specials which are not manufactured with push fit rubber joints. Pipes may be laid/ fixed in pipe ducts, sunken floors, under slung from ceiling. The pipes laid in sunken floor shall be encased with 75 mm thick cement concrete (1:2:4) all around. Pipes fixed on MS structural supports shall be fixed with U-clamps made from 10 mm dia MS bar complete with necessary threading nuts and washers (MS Structural Work to be included in the rate). The installation shall be complete in all respects including cutting chases / holes in walls, slabs and making good the same as per specifications

b) Providing GI pipe sleeves of suitable higher size wherever pipes crossing a fire rated wall / floor slab and sealing of space around pipe and pipe sleeve with glass wool in between and fire proof sealant at either end to the satisfaction of the Project Manager /Consultants and making good the same after pipes have been duly laid and testing.

c) Ventilating pipes terminating to atmosphere shall pass through the roof level with a proprietary roof vent connector and purpose made weathering slate to suit the roofing material.

d) Ventilating pipes terminating to atmosphere, shall terminate with a vent cowl, balloon guard or ridge tile termination, 900mm vertically and/or 3000mm horizontally from the nearest opening into the building or fresh air intake, in accordance with the Building Regulations and BS EN 12056-2.

PIPES HANGERS, SUPPORTS, CLAMPS ETC.

All vertical pipes shall be fixed by galvanized clamps (3mm to 5mm) and galvanized angle brackets (3mm to 5mm) truly vertical. Branch pipes shall be connected to the stack at the same angle as that of the fittings. No collars shall be used on vertical stacks. Each stack shall be terminated at top with a cowl (terminal guard).

Horizontal pipes running along ceiling shall be fixed on galvanized structural adjustable clamps of special design shown on the drawings or as directed. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully reset on them.

Contractor shall provide all sleeves, openings, hangers, inserts during the construction. He shall provide all necessary information to the building contractor for making such provisions in the structure as necessary. All damages shall be made good to restore the surfaces.

All pipes clamps, supports and hangers shall be galvanized. Factory made prefabricated clamps shall be preferred. Contractor may fabricate the clamps of special nature and galvanize them after fabrication but before installation. All nuts, bolts, washers and other fasteners shall be factory galvanized..

When required to be fixed on RCC columns, walls or beam they shall be fixed with approved type of galvanized expansion anchor fasteners (Dash fasteners) of approved design and size according to load. Structural clamps e.g.. Trapeze or cluster hangers shall be fabricated by electro-welding from MS structural members e.g. rods, angles, channels flats as per contractors shop drawings shall be galvanized after fabrication. All nuts, bolts and washers shall be galvanized.

Galvanized slotted angle/channel of approved sizes supports on walls shall be provided wherever shown on shop drawings. Angles/channels shall be fixed to brick walls with bolts embedded in cement concrete blocks and to RCC walls with anchor fasteners mentioned above. The spacing of support bolts on support members fixed horizontally shall not exceed 1 m.

Drainage Pipe material shall be as follows:

Building height (< 30 m)

Service	Down take	Toilet Internal	Stilt/building external
Soil	uPVC, SWR Type-B, IS 13592 Fittings IS 14735 Refer Note :2	Buried: uPVC, up to 65mm - SWR, IS 4985, class-3 with fittings IS 7834 Buried: Above 65 mm -IS 13592, Type-B with Fittings IS 14735 Exposed: Low noise ,Refer Note:1	Buried: Solid wall/Foam core brown pipes as per IS 15328, SDR 34 , SN 8 Exposed: CI LA class , IS 1536
Waste	uPVC, SWR Type-B, IS 13592 Fittings IS 14735 Refer Note :2	uPVC, up to 65mm - SWR, IS 4985, class-3 with fittings IS 7834 Above 65 mm - IS 13592, Type-B with Fittings IS 14735	Buried: Solid wall/Foam core brown pies as per IS 15328, SDR 34 , SN 8 Exposed: CI LA class , IS 1536
Vent	uPVC,Type-A, IS 13592 Fittings IS 14735	uPVC, SWR, Type-A, IS 13592 Fittings: IS 14735	uPVC, SWR, Type-A, IS 13592 encased Fittings: IS 14735
Rainwater	uPVC, Type-B, IS 13592 Fittings IS 14735 Refer Note :2	uPVC, up to 65mm - SWR, IS 4985, class-3 with fittings IS 7834 Above 65 mm - IS 13592, Type-B with Fittings IS 14735	Buried: HDPE Double wall corrugated SN 8 brown as per ISO 21138-3 Exposed: CI LA class , IS 1536
Note:1	Under slung soil pipes to be Low noise PP Pipes (Silent poly-propylene), for noise rating refer specifications.		
Note:2	Velocity breakers to be provided as applicable		

Drainage Building height (above 30 m to below 70 m)

Service	Down take	Toilet Internal	Stilt/building external
Soil	uPVC, IS 4985, class-3 Fittings as per IS 7834 Refer Note :2	Buried: uPVC, up to 65mm - SWR, IS 4985, class-3 with fittings IS 7834 Buried: Above 65 mm -IS 13592, Type-B with Fittings IS 14735 Exposed: Low noise ,Refer Note:1	Buried: Solid wall/Foam core brown pipes as per IS 15328, SDR 34 , SN 8 Exposed: CI LA class , IS 1536
Waste	uPVC, IS 4985, class-3 Fittings as per IS 7834 Refer Note :2	uPVC, up to 65mm - SWR, IS 4985, class-3 with fittings IS 7834 Above 65 mm - IS 13592, Type-B with fittings IS 14735	Buried: Solid wall/Foam core brown pies as per IS 15328, SDR 34 , SN 8 Exposed: CI LA class , IS 1536
Vent	uPVC, SWR, Type-A, IS 13592 Fittings: IS 14735	uPVC, SWR, Type-A, IS 13592 Fittings: IS 14735	uPVC, SWR, Type-A, IS 13592 encased Fittings: IS 14735
Rainwater	uPVC, IS 4985, class-3 Fittings as per IS 7834 Refer Note :2	uPVC, up to 65mm - SWR, IS 4985, class-3 with fittings IS 7834 Above 65 mm - IS 13592, Type-B with fittings IS 14735	Buried: HDPE Double wall corrugated SN 8 brown as per ISO 21138-3 Exposed: CI LA class , IS 1536
Note:1	Under slung soil pipes to be Low noise PP Pipes (Silent poly-propylene), for noise rating refer specifications.		
Note:2	Velocity breakers to be provided as applicable		

Drainage Building height (above 70 m to below 100 m)			
Service	**Downtake**	**Internal**	**Stilt/building external**
Soil	uPVC, IS 4985, class-3 Fittings as per IS 7834 Refer Note :2	Buried: uPVC, up to 65mm - SWR, IS 4985, class-3 with fittings IS 7834 Buried: Above 65 mm -IS 13592, Type-B with Fittings IS 14735 Exposed: Low noise ,Refer Note:1	Buried: Solid wall/Foam core brown pipes as per IS 15328, SDR 34 , SN 8 Exposed: CI LA class , IS 1536
Waste	uPVC, IS 4985, class-3 Fittings as per IS 7834 Refer Note :2	uPVC, up to 65mm - SWR, IS 4985, class-3 with fittings IS 7834 Above 65 mm - IS 13592, Type-B with fittings IS 14735	Buried: Solid wall/Foam core brown pies as per IS 15328, SDR 34 , SN 8 Exposed: CI LA class , IS 1536
Vent	uPVC, SWR, Type-A, IS 13592 Fittings: IS 14735	uPVC, SWR, Type-A, IS 13592 Fittings: IS 14735	uPVC, SWR, Type-A, IS 13592 encased Fittings: IS 14735
Rainwater	uPVC, IS 4985, class-3 Fittings as per IS 7834 Refer Note :2	uPVC, up to 65mm - SWR, IS 4985, class-3 with fittings IS 7834 Above 65 mm - IS 13592, Type-B with fittings IS 14735	Buried: HDPE Double wall corrugated SN 8 brown as per ISO 21138-3 Exposed: CI LA class , IS 1536
Note 1	Under slung soil pipes to be Low noise PP Pipes (Silent poly-propylene), for noise rating refer specifications.		
Note 2	Velocity breakers to be provided as applicable		

5.1 uPVC PIPES

A) uPVC SWR

uPVC Soil, Waste, RWP & Vent system conforming to IS : 13592 - Type B up to 30 m height and uPVC Class-3 as per IS 4985 for building above 30m and up to 100m, comprising uPVC pipes and uPVC fittings IS 14735 (moulded as well as fabricated) like bends, tees, Y-tees, crosses, boss connections, access pieces, saddle pieces, cleanouts, adaptors for connections to other materials, plugs, reducers, cowls, offsets and other specials. Jointing shall be done with push fit rubber ring jointing technique in general. Solvent cement joints may be provided for fittings and specials which are not manufactured with push fit rubber joints. Pipes may be laid/ fixed in pipe ducts, sunken floors, under slung from ceiling. The pipes laid in sunken floor shall be encased with 75 mm thick cement concrete (1:2:4) all around. Pipes fixed on MS structural supports shall be fixed with U-clamps made from 10 mm dia MS bar complete with necessary threading nuts and washers (MS Structural Work to be included in the rate). The installation shall be complete in all respects including cutting chases / holes in walls, slabs and making good the same as per specifications.

Providing GI pipe sleeves of suitable higher size wherever pipes crossing a fire rated wall / floor slab and sealing of space around pipe and pipe sleeve with glass wool in between and fire proof sealent at either end to the satisfaction of the Project Manager / Consultants and making good the same after pipes have been duly laid and testing.

Seal ring fittings shall be used where necessary to accommodate thermal movement . The rubber seals for seal ring joints shall be of section that gives more than one point of contact with the pipe and shall be to the material requirements of BS 7874, BS EN 681-1, BS EN 681-2. Horizontal and vertical pipe work

shall include allowance for thermal expansion in accordance with the manufacturer's recommendations. All expansion units shall be anchored.

Access shall be provided by means of an integrally moulded door in an access fitting with an externally fitted rubber seal and secured with two galvanised bolts and nuts, or alternatively by a two-piece clamp type door fitted into the pipe run. Access shall be installed on all vertical foul drainage pipes at the specified height above each finished floor level, to centre line of the access door and horizontally in accordance with the Building Regulations and BS EN 12056-2.

B) uPVC Pipes (Internal toilet)

Providing & fixing uPVC soil and waste pipe work comprising uPVC pipe conforming to IS :4985-2000 up to pipe sizes 65 mm and IS : 13592 - Type B for sizes above 65 mm of required class as specified including fittings (moulded as well as fabricated) like elbows, bends, reducers, threaded tail pieces, caps and other specials. Chasing, cutting and making good the walls, complete in all respects including testing of complete installation. All under slung soil pipes to be low noise PP Pipes (Silent poly-propylene).

Pipes may be laid/ fixed in sunken floors, under slung from ceiling. The pipes laid in sunken floor shall be encased with 75 mm thick cement concrete (1:2:4) all around. Pipes fixed on MS structural supports shall be fixed with U-clamps made from 10 mm dia MS bar complete with necessary threading nuts and washers (MS Structural Work to be included in the rate). The installation shall be complete in all respects including cutting chases / holes in walls, slabs and making good the same as per specifications.

Providing GI pipe sleeves of suitable higher size wherever pipes crossing a fire rated wall / floor slab and sealing of space around pipe and pipe sleeve with glass wool in between and fire proof sealant at either end to the satisfaction of the Project Manager / Consultants and making good the same after pipes have been duly laid and testing.

C) uPVC PIPES AND FITTINGS

The pipes shall be round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth, clean, and free from grooving and other defects. The ends shall be cleanly cut and square with the axis of the pipe. The pipes shall be designed by external diameter.

Fittings shall be of the same make as that of pipes, injection moulded and shall conform to Indian Standard.

D) Laying , Jointing

The pipes shall be laid in uniform slope and proper levels. All vertical pipes shall be truly vertical fixed by means of stout clamps in two sections, bolted together, built into the walls, wedged and neatly jointed. The branch pipes shall be connected to the stack at the same angle as that of fittings. All connections between soil, waste and ventilating pipes and branch pipes shall be made by using pipe fittings with inspection doors for cleaning. Pipes shall be fixed in a manner as to provide easy accessibility for repair and maintenance and shall not cause obstruction in shafts. Where the horizontal run off the pipe is long or where the pipes cross over building expansion joints etc. suitable allowance shall be provided for any movements in the pipes by means of expansion joint etc. such that any such movement does not damage the installation in any way.

Provision shall be made for the effect of thermal movement by not gripping or disturbing the pipe at supports between the anchors for suspended pipes. The supports shall allow the repeated movements to take place without abrasion.

Jointing for uPVC pipes shall be made by means of solvent cement for horizontal lines and 'O' rubber ring for vertical line. The type of joint shall be used as per site conditions / direction of the Owner's site representative. Where uPVC pipes are to be used for rain water pipes, the pipe shall be finished with GI adopter for insertion in the RCC slab for a water proof joint complete as directed by Owner's site representative.

uPVC pipes require supports at close intervals. Recommended support spacing for un plasticised PVC pipes is 1400 mm for pipes 50 mm dia and above. Pipes shall be aligned properly before fixing them on the wooden plugs with G.I clamps. Even if the wooden plugs are fixed using a plumb line, pipe shall also be checked for its alignment before clamping, piping shall be properly supported on, or suspended from clamps, hangers as specified and as required. The Contractor shall adequately design all the brackets, saddles, anchors, clamps and hangers and be responsible for their structural sufficiency. Pipe supports shall be primer coated with rust preventive paint.

E) Repairs

While temporary or emergency repairs may be made to the damaged pipes, permanent repairs shall be made by replacement of the damaged section. If any split or chip out occur in the wall of the pipe, a short piece of pipe of sufficient length to cover the damaged portion of the pipe is cut. The sleeve is cut longitudinally and heated sufficiently to soften it so that it may be slipped over the damaged hard pipe.

5.2 PP Pipes (Silent poly-propylene):

All hangers, clamps, brackets, anchor/fixed support, guides, rollers etc. shall be of galvanized iron unless specified otherwise and then supply and installation of the same shall also be included for rates under this head. Welding of any kind on the galvanized support / hanger shall not be permitted.

All Silent Poly propylene shall be support with rubber lined clamps.
Pipes shall be as follows

I. Supply, installation , testing commissioning of Low noise (26 db) type Polypropylene pipes with push fit joints, The Pipe & fittings shall be Mineral Reinforced with material density not less than 0.95 kg/cm3 , the door access fittings (elbow, tee) & P- Traps shall also be with the same material with density not less than 0.95 Kg/cm3 & also making proper connections to equipments including all necessary fittings and specials such as bends, tees, reducers, nuts, bolts, gasket, plug, supports and plugs etc. Fixing at wall/ ceiling level supported by clamps, fire collars, expansion joints branches, Roding Eye, thrust blocks, velocity breakers, hangers etc. as per the specification, drawings and schematics. For above 200 mm Dia. use HDPE pipe as specified. G.I. pipe sleeve of suitable higher size shall be provided wherever the pipes are crossing the walls/floors and cutting holes and chases in brick, R.C.C work and making good the same to original conditions complete in all respects.

II. Supply, installation , testing commissioning of Low noise (20 db) type Polypropylene pipes with as per DIN 4102 push fit joints, The Pipe & fittings shall be Mineral Reinforced with material density not less than 1.9 kg/cm^3 , the door access fittings (elbow, tee) & P- Traps shall also be with the same material with density not less than 1.9 Kg/cm^3 & also making proper connections to equipments including all necessary fittings and specials such as bends, tees, reducers, nuts, bolts, gasket, plug, supports and plugs etc. Fixing at wall/ ceiling level supported by clamps, fire collars, expansion joints branches, Roding Eye, thrust blocks, velocity breakers, hangers etc. as per the specification, drawings and schematics. For above 200 mm Dia. use HDPE pipe as specified. G.I. pipe sleeve of suitable higher size shall be provided wherever the pipes are crossing the walls/floors and cutting holes and chases in brick, R.C.C work and making good the same to original conditions complete in all respects.

5.3 HDPE pipe (Silent db20)

Mineral wool reinforced HDPE pipe (Silent dB 20) with electro fusion jointing method with additional carbon content to make the pipes suitable for waste and sanitary application & making proper connections to equipments including all necessary fittings. Manufactured as per IS-4984, ISO-4427, DIN8074, ASTM D 3035 and BS-6437 standards in PE-63, PE-80 and PE-100 grades.

Table 15066-1 Physical Property and Pipe Performance Requirements

Property Specification Units Minimum Values

Property	Specification	Units	Minimum Values
Material Designation	PPI/ASTM	---	PE3408
Material Classification	ASTM D1248	---	III C 5 P34
Cell Classification	ASTM D3350	---	345434C
Hardness	ASTM D2240	Shore D	64
Compressive Strength (Yield)	ASTM D695	psi	1,600
Tensile Strength @ Yield (TypeIV Spec.)	ASTM D638 (2%/min)	psi	3,200
Elongation @ Yield	ASTM D638	%, min	8
Tensile Strength @ Break (Type IV Spec.)	ASTM D638	psi	3,500
Elongation @ Break	ASTM D638	%, min	600
Modulus of Elasticity	ASTM D638	psi	110000
ESCR:			
Cond A, B, C: Mold Slab.	ASTM D1693	Fo, Hrs	Fo>5,000
Compressed Ring)	ASTM F1248	F50, Hrs	F50>1,000
Slow Crack Growth	Battelle		Fo>32
Impact strength			
(IZOD) (0.125-inch thick)	ASTM D256	in-lb/in	
	(Method A)	Notch	42
Linear Thermal			
Expansion Coeff	ASTM D696	in/in/℉	
Thermal Conductivity	ASTM C177	BTU, in/ ft2/hrs/℉	
Brittleness Temp	ASTM D746	℉	<-180
Vicat Soft. Temp	ASTM D1525	℉	+257
NSF Listing	Standard 61	---	Listed

1. Nipples and flanged stub ends

Short nipples and stub ends shall be of the same material as the HDPE pipe.

2. Fittings

A. Fittings shall be made from material meeting the same requirements as the pipe. Fittings shall be fabricated by the manufacturer of the pipe.

B. Molded fittings shall be manufactured in accordance with ASTM D3261 and shall be so marked.

C. Mechanical fittings, when used, shall be specifically designed for, or tested and found to be acceptable for use with HDPE pipe.

D. Fittings used to connect with dissimilar pipe materials shall be provided as per Section

15062 "Ductile Iron Pipe and Fittings."

3. Joints

Sections of polyethylene pipe shall be joined into continuous lengths on the job site above ground. The joining method shall be electro fusion method and shall be performed in strict accordance with the pipe manufacturer's recommendations. The electro fusion equipment used in the joining procedures shall be capable of meeting all conditions recommended by the pipe manufacturer.

electro fusion joining shall result in joint weld strength equal to or greater than the tensile strength of the pipe. Extrusion welding or hot gas welding of HDPE shall not be used. Flanges, unions, grooved-couplers, transition fittings, and some mechanical couplers may be used to connect HDPE pipe mechanically without butt-fusion only where shown in the Drawings.

5.4 Cast iron (LA class) pipes and pipe fittings

A GENERAL:

This standard covers the requirements of cast iron LA) pipes (IS : 1536) non pressure above ground pipes and fitting used for discharge of waste water, sewage, rain water and ventilation. These pipes may be manufactured by centrifugally cast (spun) process in metal moulds or sand cast and fittings by sand cast process.

Cast iron class (LA) pipe shall be such that they could be cut, drilled or machined. Pipe centrifugally cast in unlined water cooled moulds shall be heat treated in order to achieve the necessary mechanical properties and to relieve casing stress; provided that the specified mechanical properties are satisfied.

Material

Cast iron pipe shall be centrifugally spun cast iron pipe and conforming to IS:1536-1976

Fittings

Fittings shall be used for cast iron class (LA pipes shall conform to IS:1538-1976).Whenever possible junction from branch pipe shall be made by wyes.

All cast iron water main pipes and fittings shall be manufactured to IS:1536 of tested quality. The pipes and fittings shall either be spigot and socket type or as called for. The pipes and fittings shall be of uniform material throughout and shall be free from all manufacturing defects.

Joints

Cast iron class (LA) pipe used for soil and waste pipes shall be jointed with sealant joints sufficient skein of jute rope shall be caulked to leave minimum space of 25 mm for the Sealant.

Testing :

All cast iron pipes and fitting including joints are tested as under:

Smoke Test : Smoke shall be pumped under a pressure of 25 mm of water for 15 minutes into the pipe at the lowest end from a smoke machine which consists of a bellow and a burner. The material usually burnt is greasy cotton waste or tar paper which gives out a clear pungent smoke, which is easily detectable by sight as well as by smell if there is leakage at any point of drain.

Hydraulic Test : Alternatively the drainage pipes shall be tested hydraulically. Not more than 1.8 m head should usually be applied to any part of the drain. IS-1729 specifies the leakage test pressure of these pipes and fittings as 5 Kg/cm2 without showing any sign of leakage.

5.5 Rainwater works

All open terraces shall be drained by rain water down takes.

Rainwater down takes are separate and independent of the soil and waste system and will discharge into the underground storm water drainage system of the complex.

Rainwater in open courtyards shall be collected in catch basins and connected to the Storm Water Drains.

Any dry weather flow from waste appliances, e.g. waste water sumps shall connected to sewers after traps and not in the storm water drainage systems.

5.6 Balcony / Planter drainage

Wherever required, all balconies, terraces, planters and other frontal landscape areas will be drained by vertical down takes or other type of drainage system shown on the drawings and directed by the Project Manager. All balcony drains shall be connected to storm water net work.

5.7 Rain Water Khurra:

Rain water `Khurras' size 450x450 mm required depth with lead flashing around the pipe with one piece lead sheet of 3 mm thick set on a layer of cold bitumen. Including Heavy duty CI/MS grating as per drawing complete as required.

5.8 Cleaning Eye/ Clean outs

Provide cleanouts at the base of all soil, waste and leader stacks, all changes in direction of horizontal piping, every floor of sanitary, vent and rain water stacks, all branch connections to stacks and every 15m of horizontal pipe runs. Cleanout plugs shall be threaded and provided with key holes for opening. Cleanout plugs shall be fixed to the pipe by a GI socket and lead caulked joint.

uPVC Pipe Cleanouts. Heavy plastic cleanout screw plug in uPVC fitting with sound square nut.

Extend cleanouts to walls and floor with long sweep ells or "wye" and 1/8 bends with plugs and face or deck plates to conform to the architectural finish in the room. Where no definite finish is indicated on drawings provided by other Divisions of this Specification, use stainless steel wall plates and floor plates of nickel bronze.

Floor Clean Out Plug: Clean out plug for soil, waste or rain water pipes laid under floors shall be provided near pipe junctions bends, tees, “Y” and on straight runs at such intervals as required as per site conditions. Cleanout plugs shall terminate flush with the floor level. They shall be threaded and provided with key holes for opening. Cleanout plugs shall be cast brass suitable for the pipe dia. With screwed to a GI socket. The socket shall be drip seal joined/ Lead Caulked to the drain pipes.

Cleanout on Drainage Pipes

Cleanout plugs shall be provided on head of each drain and in between at locations indicated on plans or directed by Owner’s site representative. Cleanout plugs shall be of size matching the full bore of the pipe

but no exceeding 150 mm dia CO plugs on drains of greater diameters shall be 150 mm dia. Fixed with a suitable reducing adapter.

Floor cleanout plugs shall be cast brass.

Cleanouts provided at ceiling level pipe shall be fixed to a CI flanged tail piece. The cleanout doors shall be specially fabricated from light weight galvanized sheets and angles with hinged type doors with fly nuts, gasket etc.

5.9 Traps

a) Floor Traps

Nahni traps or floor traps shall be cast iron/PVC, deep seal with an effective seal of 50mm deep seal. The trap and waste pipes when buried below ground shall be set and encased in cement concrete blocks firmly supported on firm ground or when installed on a sunken RCC structural slab. The blocks shall be in 1:2:4 mix (1 cement : 2 coarse sand : 4 stone aggregate 20 mm nominal size).

Contractor shall provide all necessary shuttering and cantering for the blocks. Size of the block shall be 30 x 30 cms of the required depth.

When multi port floor traps are suspended from ceiling shall be supported from bottom with adequate G.I angle& treaded rods from ceiling.

b) Floor trap inlet

Bath room traps and connection shall ensure free a silent flow of discharging water. Contractor shall provide three inlet sockets to receive the waste pipes. Joint between waste hopper inlet sockets shall be ring joint. Multi port floor trap joints shall be as per manufacture recommendations.

Traps of self cleansing design with three inlet connections including providing PVC adapter with solvent cement joints complete and connection with waste pipes including providing & fixing grating over the trap.

5.10 Floor Trap Grating

Floor and urinal traps shall be provided with 100 – 150 mm square or round stainless steel gratings, with frame and rim of approved design and shape or as specified shown drawings and approved by the Owner's site representative/Architect.

5.11 Backflow preventer

Back flow preventers to be type 2 EN 13564. The back floe preventer to be double back flow stop. The force of flowing waste water pushes open the flap in the flow direction to drain the waste water in the direction of the sewer. If there is back flow, the wastewater backing up from the sewer flows against the normal flow direction and comes into contact with the outer backflow flap. This prevents wastewater from the sewer from flowing back into the building. The second flap is an extra safety feature to ensure that the back flow stop functions even when first flap fails to close properly because of the presence of dirt, etc. The back flow preventer shall have emergency seal. Size shall be as shown in the drawings

5.12 Painting

Used paint and coatings that comply with the following limits for VOC content and the following chemical restrictions:

Non-Flat Paints and Coatings: VOC not more than 150 g/L.

Anti-Corrosive Coatings VOC not more than 250 g/L.

Aromatic Compounds: Paints and coatings shall not contain more than 1.0 percent by weight total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).

Paints and coatings shall not contain any of the following:

Acrolien

Acrylontrile

Antimony

Benzene

Buty benzyl phthalate

Cadmium

Di (2-ethylheyl) phthalate

Di-n-butyl phthalate

Di-n-octy phthalate

1,2-dichlorobenzene

Diethy phthalate

Dimenthyl phthalate

Ethyl benzene

Soil, waste, vent and rain water pipes in exposed location, in shafts shall be painted with two or more coats of ready mix Low – VOC oil paint to give an even shade. Before painting all dust and extraneous matter shall be removed.

Paint shall be of approved quality and shade. Where directed by the Owner's site representative pipes shall be painted in accordance with approved pipe colour code.

Pipe in chase shall be painted with two coats of bitumen paint, covered with polythene tape and a final coat of bitumen paint. Exposed pipes shall be painted with synthetic enamel paint after removing dust and extraneous matter.

C.I. Soil and waste pipes below ground and covered in cement concrete shall not be painted.

5.13 Testing

Testing shall be done in accordance with IS:1172 and IS:5329 except as may be modified herein under.

Entire drainage system shall be tested for water tightness and smoke tightness during and after completion of the installation. No portion of the system shall remain untested. Contractor must have adequate number of expandable rubber bellow plugs, manometers, smoke testing machines, pipe and fitting work tests,

All materials obtained and used on site must have manufacturer's hydraulic test certificate for each batch of materials used on the site.

Before use at site all CI pipes shall be tested by filling up with water for at least 30 minutes. After filling, pipes shall be struck with a hammer and inspected for blow holes and cracks. All defective pipes shall be rejected and removed from the site within 48 hours. Pipes with minor sweating may be accepted at the discretion of the Project Manager.

Soil and waste pipes shall be tested in sections after installation, by filling up the stack with water. All openings and connections shall be suitably plugged as approved by the Project Manager. The total head in the stack shall be 4.5 m to 6.0 m at the highest point of the section under test. The pipes shall be plugged preferably with standard design plugs or with rubber plugs on both sides, the upper end shall, however, be connected to a pipe for filling with water and getting the required head poured at one time. The period of test shall be minimum for 30 minutes or as directed by the Project Manager. If any leakage is visible, the defective part of the work shall be cut out and made good.

On completion of the work the entire installation shall be tested by smoke testing machine. The test shall be conducted after the plumbing fixtures are installed and all traps have water seal or by plugging the outlets with bellow plugs. Apply dense smoke keeping the top of stack open and observe for leakages. Rectify or replace defective sections.

After the installation is fully complete, it should be tested by flushing the toilets, running at least 20% of all taps simultaneously and ensuring that the entire system is self draining, has no leakages, blockages etc. rectify and replace where required.

A test register shall be maintained and all entries shall be signed and dated by the Contractor and the Project Manager or his representative.

All pipes in wall chase or meant to be encased or buried shall be hydro tested before the chase in plastered or the pipe encased or buried.

A test register shall be maintained which shall be signed and dated by contractor and Owner's site representative.

6. CLUSTER & STILT SEWAGE ,STORM WATER DISPOSAL

Scope

The scope of this section comprises the supply, installation, testing and commissioning of external drainage & sewage disposal services. including earth work for excavation, disposal, back filling and compaction etc.

General Scheme

The contractor shall install a drainage system to effectively collect; drain and dispose all soil and waste water from various parts of the buildings, appurtenances and equipment. The piping system shall finally terminate and discharge into the STP. The piping work mainly consists of laying of Solid wall/Foam core brown pipes as per IS 15328 SDR 34 SN 8, HDPE DWC (Double wall corrugated) ,reinforced cement concrete pipes and cast iron pipes as called for on the drawings. The disposal system shall include construction of gully traps, manholes, intercepting chambers, catch basins, soak away pits etc. as indicated on the drawings. The piping system shall be vented suitably at the starting point of all branch drains, main drains, the highest/lowest point of drain and at intervals as shown. All ventilating arrangements shall be unconstructive and concealed. The system shall be tested for its soundness as specified. Wherever the sewerage pipes run above water supply lines, same shall be completely encased in cement concrete 1:2:4 all round with the prior approval of the Project Manager.

General Requirements

All materials shall be new and of quality conforming to specifications and subject to the approval of the Owner's site representative. Wherever particular makes are mentioned, the choice of selection shall remain with the Architect / Consultant / Owner's site representative.

Drainage lines and open drains shall be laid to the required gradients and profiles.

All drainage work shall be done in accordance with the local municipal bye-laws.

Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent authority.

Location of all manholes, etc shall be got confirmed by the Project Manager/Archiect before the actual execution of work at site. As far as possible, no drains or sewers shall be laid in the middle of road unless otherwise specifically shown on the drawings or directed by the Project Manager in writing.

All materials shall be rust proofed; materials in direct or indirect contact shall be compatible to prevent electrolytic or chemical (bimetallic) corrosion.

6.1 Trenching for pipes and drains

General

All the material shall be new of best quality conforming to specifications and subject to the approval of the Architects/consultant. Drainage lines shall be laid to the required gradients and profiles. All drainage work shall be done in accordance with the local municipal by-laws.

Contractor shall obtain necessary approval and permission for the drainage system from the municipal or any other competent authority. Location of all manholes, catch basins etc. shall be finalized and shown in approved shop drawings before the actual execution of work at site.

Alignment & Grade

The sewer and storm water drainage pipes shall be carefully laid to levels and gradients shown in the plans and sections but subject to modifications as shall be ordered by the Architects/consultant from time to time to meet the requirements of the works. Great care shall be taken to prevent sand etc. from entering the pipes. The pipes between two manholes shall be laid truly in straight lines without vertical or horizontal undulations. The body of the pipes shall rest on an even bed in the trench for its length and places shall be excavated to receive collar for the purpose of jointing. No deviations from the lines, depths of cuttings or gradients as called for on the drawings shall be permitted without the written approval of the Architect. All pipes above 90 cm from the finished ground level shall be encased with minimum 100 mm thick square cement concrete box,

Setting out Trenches

The contractor shall set out all trenches, manholes, chambers and such other works to true grades and alignments as called for. He shall provide the necessary instruments for setting out and verification for the same. All trenches shall be laid to true grade and in straight lines and as shown on the drawings. The trenches shall be laid to proper levels by the assistance of boning rods and sight rails which shall be fixed at intervals not exceeding 10 meters or as directed by the Project Manager.

Trench Excavation

The trenches for the pipes shall be excavated with bottoms formed to level and gradients as shown on the drawings or as directed by the Project Manager. In soft and filled in ground, the Project Manager may require the trenches to be excavated to a greater depth than the shown on the drawings and to fill up such additional excavation with concrete (1:4:8) consolidated to bring the excavation to the required levels as shown on the drawings.

All excavations shall be properly protected where necessary by suitable timbering, piling and sheeting as approved by the Project Manager. All timbering and sheeting when withdrawn shall be done gradually to avoid falls. All cavities be adequately filled and consolidated. No blasting shall be allowed without prior approval in writing from the Architect. It shall be carried out under thorough and competent supervision, with the written permission of the appropriate authorities taking full precautions connected with the blasting operations.

Shuttering of Trenches

The Contractor shall at all times support efficiently and effectively the sides of all the trenches and other excavations by suitable timbering, piling and sheeting and they shall be close timbered in loose or sandy strata and below the surface of the sub soil water level.

All timbering, sheeting and piling with their walling and supports shall be of adequate dimensions and strength and fully braced and strutted so that no risk of collapse or subsidence of the walls of the trench shall take place.

The Contractor shall be held responsible and shall be accountable for the sufficiency of all timbering, bracings, sheeting and piling used and also for, all damage to persons and property resulting from improper quality strength placing, maintaining or removing of the same.

Shoring of Buildings

The Contractor shall shore up all buildings, walls and other structures, the stability of which is liable to be endangered by the execution of the work and shall be fully responsible for all damages to persons or property resulting from any accident.

Obstruction Road

The contractor shall not occupy or obstruct by his operation more than one half of the width of any road or street and sufficient space shall then be left for public and private transit. He shall remove the materials excavated and bring them back again when the trench is required to be refilled. The contractor shall obtain the consent of the Project Manager in writing before closing any road to vehicular traffic and the foot walks must be clear at all times.

Protection of Pipes etc.

All pipes, water mains, cables etc. met in the course of excavation shall be carefully protected and supported. Care shall be taken not to disturb the cables, the removal of which shall be arranged by the contractor with the written consent from the Project Manager.

Trench Back Filling

Refilling of the trenches shall not be commenced until the length of pipes therein has been tested and approved. All timbering which may be withdrawn safely shall be removed as filling proceeds. Where the pipes are unprotected by concrete hunching, selected fine material shall be carefully hand-packed around the lower half of the pipes so as to buttress them to the sides of the trench.

The refilling shall then be continued to 150mm over the top of the pipe using selected fine hand packed material, watered and rammed on both sides of the pipes with a wooden hammer. The process of filling and tamping shall proceed evenly in layers not exceeding 150mm thickness, each layer being watered and consolidated so as to maintain an equal pressure on both sides of the pipe line. In gardens and fields the top solid and turf if any, shall be carefully replaced. Back filling shall achieve minimum 95 % of dry density.

Contractor to restore settlement and Damages

The contractor shall at his own costs and expenses, make good promptly during the whole period for the works in hand if any settlement occurs in the surfaces of roads, beams, footpaths, gardens, open spaces etc. in the public or private areas caused by his trenches or by his other excavations and he shall be liable for any accident caused thereby. He shall also, at his own expense and charges, repair (and make good) any damage done to building and other property. If in the opinion of the Project Manager he fails to make good such works with all practicable dispatch, the Project Manager shall be at his liberty to get the work done by other means and the expenses thereof shall be paid by the contractor or deducted from any money that may be or become due to him or recovered from him by any other manner according to the laws of land.

The contractor shall at his own costs and charges provide places for disposal of all surplus materials not required to be used on the works. As each trench is refilled, surplus soil shall be immediately removed, the surface shall be properly restored and roadways and sides shall be left clear.

Removal of Water from Trench etc.

The contractor shall at all times during the progress of work keep the excavations free from water which shall be disposed by him in a manner as will neither cause injury to the public health nor to the public or private property nor to the work completed or in progress nor to the surface of any road or streets, nor cause any interference with the use of the same by the public.

If any excavation is carried out at any point or points to a greater width of the specified cross section of the sewer with its cover, the full width of the trench shall be filled with concrete by the contractor at his own expense and charges to the requirements of the Project Manager.

Removal of Filth

All night soil, filth or any other offensive mater met with during the execution of the works, shall not be deposited on the surface of any street or where it is likely to be a nuisance or passed into any sewer or drain but shall be immediately, after it is taken out of any trench, sewer or cess pool, put into the carts and removed to a suitable place to be provided by the Contractor

6.2 Piping material

6.2.1 Reinforced Cement Concrete (RCC) Pipes

scope

This Specification covers the requirements for manufacturing, testing, supplying, lowering, laying, jointing, testing at work sites and commissioning of Reinforced Cement Concrete (RCC) pipes, of non-pressure used as branch sewers, lateral sewers, gravity mains for conveyance of domestic sewage & storm water.

Applicable Codes & Standards

The manufacturing, testing, supplying, jointing and testing at work sites of RCC pipes shall comply with all currently applicable statutes, regulations, standards and codes. In particular, the following standards, unless otherwise specified herein, shall be referred. In all cases, the latest revision of the Codes shall be referred to. If requirements of this Specification conflict with the requirements of the Codes and standards, this Specification shall govern.

Materials

IS: 458	Specification for Concrete Pipes (with and without Reinforcement).
IS: 3597	Method of Tests for Concrete Pipes.
IS: 5382	Specification for Rubber Sealing Rings for Gas Mains, Water Mains and Sewers.
IS: 432 Part I & II	Specification for mild steel and medium (tensile steel bars and hard drawn steel) wires for concrete reinforcement.
IS: 516	Method for test for strength of concrete.

Code of practice

IS: 456	Code of Practice for Plain and Reinforced Concrete.
IS: 783	Code of Practice for Laying of Concrete Pipes.

Design

Design of RCC pipes, details of reinforcement and the ends of the pipe shall be in accordance with the relevant clauses of IS: 458. The Class of the pipe shall be RCC Type NP-III and RCC Type NP-II as specified on drawings.

Manufacturing

General

i) The method of manufacture shall be such that the form and the dimensions of the finished pipes are accurate within the limits specified in relevant IS: 458. The surfaces and edges of the pipes shall be well defined and true, and their ends shall be square with the longitudinal axis. The ends of the pipes shall be further reinforced by an extra ring of reinforcement to avoid breakage during transportation.

ii) The RCC pipes and rubber rings shall be systematically checked for any manufacturing defects by experienced supervisors so as to maintain a high standard of quality.

iii) engineer-in-charge shall at all reasonable times have free access to the places where the pipes and rubber rings are manufactured for the purpose of examining and testing the pipes and rubber rings and of witnessing the test and manufacturing.

iv) all tests shall be performed by supplier / contractor at his own cost and in presence of engineer-in-charge, if desired. for this, sufficient notice before testing of the pipes shall be given to engineer-in-charge.

v) if the test is found unsatisfactory, engineer-in-charge may reject any or all pipes of that lot. the decision of engineer-in-charge in this matter shall be final and binding on contractor and not subject to any arbitration or appeal.

Materials

for all materials, factory's test result and written guarantee document with necessary analysis data shall be submitted to obtain the approval of the engineer-in-charge before carrying to sites.

Cement

Sulphate Resisting Cement shall be used for the manufacture of RCC pipes and fittings and shall conform to relevant IS codes. The use of pozzolana as an admixture to Portland cement shall not be permitted.

Aggregates

Aggregates used for the manufacture of RCC pipes shall conform to IS: 383. The maximum size of aggregate should be 10mm for pipes of internal diameter 150 to 250mm but should not exceed one third thickness of the pipe or 20mm, whichever is smaller, for pipes of internal diameter above 250mm.

Mixing and Curing Water

Water used for mixing of concrete and curing of pipes shall conform to IS: 456. Water shall be clean, colourless and free from objectionable quantities of organic matter, alkali, acid, salts, or other impurities that might reduce the strength, durability or other desirable qualities of concrete and mortar. CONTRACTOR shall submit water quality report before using it.

Reinforcement

Reinforcement used for the manufacture of the spigot and socket RCC pipes shall be mild steel Grade I or medium tensile steel bars conforming to IS: 432 (Part-1) or hard-drawn steel wire conforming to IS: 432 (part-2). A reinforcement cage for pipes shall be as per relevant requirement of IS: 458.

Concrete

Concrete used for the manufacture of spigot and socket RCC pipes shall conform to IS: 456. The minimum cement content and minimum compressive strength of concrete shall be as per relevant requirements of IS: 458. Compressive strength tests shall be conducted on 15cm cubes in accordance with the relevant requirements of IS: 456 and IS: 516.

Curing

Pipes manufactured in compliance with IS: 458 shall be either water cured or steam cured in accordance with the relevant requirements of IS: 458.

Dimensions and Tolerances

The internal diameter, wall thickness and length of barrel, reinforcement (longitudinal and spiral), type of ends and minimum clear cover to reinforcement and strength test requirements shall be as per the relevant clauses / tables of IS: 458 for different class of pipes.

The tolerances regarding overall length, internal diameter of pipes or socket and barrel wall thickness shall be as per relevant clauses of IS: 458.

Workmanship and finish

a) Pipes shall be straight and free from cracks except that craze cracks may be permitted. The ends of the pipes shall be square with their longitudinal axis so that when placed in a straight l ine in the trench no opening between ends in contact shall exceed 3mm in pipes up to 600mm diameter (inclusive), and 6mm in pipes larger than 600mm diameter.

b) The outside and inside surfaces of the pipes shall be smooth, dense and hard, and shall not be coated with cement wash or other preparation unless otherwise agreed to between ENGINEER-IN- CHARGE and the manufacturer or supplier.

c) The pipes shall be free from defects resulting from imperfect grading of the aggregate, mixing or moulding.

d) The pipes shall be free from local dents or bulges greater than 3.00 mm in depth and extending over a length in any direction greater than twice the thickness of barrel.

e) The deviation from straight in any pipes throughout its effective length, tested by means of a rigid straight edge parallel to the longitudinal axis of the pipe shall not exceed, for all diameters, 3 mm for every meter run.

Testing

All pipes for testing purposes shall be selected at random from the stock of the manufacturer and shall be such as would not otherwise be rejected under the criteria of tolerances asmentioned in IS: 458.

a) During manufacture, tests on concrete shall be carried out as per IS: 456. The manufacturer shall supply, when required to do so by ENGINEER-IN-CHARGE the results of compressive tests of concrete cylinders or cubes made from the concrete used for the pipes. Every pressure pipe shall be tested by the manufacturer for the hydrostatic test pressure.

b) The specimen of pipes for the following tests shall be selected in accordance with Clause 9.1 of IS: 458 and tested in accordance with the methods described in IS: 3597.

i) Hydrostatic test

ii) Three edge bearing test or sand bearing test

iii) Absorption test

iv) Visual Examination

Note: Three edge bearing strength to produce 0.25 mm crack shall be as per IS: 458.

Sampling and inspection

a) In any consignment, all the pipes of same class and size and manufactured under similar conditions of production shall be grouped together to constitute a lot. The conformity of a lot to t he requirements of this Specification shall be ascertained on the basis of tests on pipes selected from it.

b) The number of pipes to be selected from the lot shall be in accordance with column 1 and 2 of Table 9 of IS: 458.

c) Pipes shall be selected at random. In order to ensure randomness, all the pipes in the lot may be arranged in a serial order and starting from any pipe, every "r^{th}" pipe be selected till the requisite number is obtained, "r" being the integral part of N/n where "N" is the lot size and "n" is the sample size.

d) The number of pipes selected for testing shall be in accordance with Table 15 of IS: 458 and tested in accordance with methods described in IS: 3597. These pipes shall be selected from pipes that have satisfied the requirements mentioned in the above clause. All the pipes shall be inspected for dimensional requirements, finish and deviation from straight. A pipe failing to satisfy one or more of these requirements shall be considered as defective.

e) A lot shall be considered as conforming to the requirements of IS: 458 if the following conditions are satisfied.

i) The number of defective pipes (those not satisfying one or more of the requirements for dimensions, finish and deviation from straight) shall not be more than the permissible number given in Column 3 of Table 9 / 15 of IS: 458.

ii) All the pipes tested for various tests as per IS: 3597 shall satisfy corresponding requirements of the tests.

iii) In case the number of pipes not satisfying requirements of any one or more tests, one or two further sample of same size shall be selected and tested for the test or tests in which failure has occurred. All these pipes shall satisfy the corresponding requirements of the test.

All result of tested data must be prepared by CONTRACTOR at site so that the ENGINEER-IN-CHARGE shall make decision of “fail or pass” at once. All cost for the test shall be borne by the CONTRACTOR.

Storage

Each stack of pipes shall contain only pipes of same class and size, with consignment or batch number marked on it with particulars of suppliers wherever possible. Storage shall be done on firm level and clean ground and wedges shall be provided at the bottom layer to keep the stack stable. The stack shall be in pyramid shape or the pipes lay lengthways and crosswise in alternate layers. The pyramid stack shall be made for smaller diameter pipes for conserving space in storing them. The height of the stock shall not exceed 1.5 m.

Rubber rings shall be stored in a clean, cool store away from windows, boiler, electrical equipment and petrol, oils or other chemicals.

Jointing

Jointing of RCC pipes shall be done as per the requirements of following Specifications and as per the relevant IS. The type of joints shall be as socket / spigot type. After jointing extraneous material if any, shall be removed from the inside of the pipe and newly made joints shall be thoroughly cured. In case, rubber sealing rings are used for jointing, these shall conform to IS: 5382. The pipe joint work must be done neatly and keep even slope and level for pipe laying works.

Spigot and Socket Joint (Flexible)

The RCC pipe with the rubber ring accurately positioned on the spigot shall be pushed well home into the socket of the previously laid pipes. The manufacturer’s instructions shall be used, and the manufacturer’s instructions shall be deemed to form a part of these Specifications. The rubber rings shall be lubricated before making the joint and the lubricant shall be soft soap water or an approved lubricant supplied by the manufacturer.

Cleaning of pipes

As soon as a stretch of RCC pipes has been laid complete from manhole to manhole or for a stretch as directed by ENGINEER-IN-CHARGE, CONTRACTOR shall run through the pipes both backwards and forwards a double disc or solid or closed cylinder 75mm less in diameter than the internal diameter of pipes. The open end of an incomplete stretch of pipe line shall be securely closed as may be directed by ENGINEER-IN-CHARGE to prevent entry of mud or slit etc.

If as a result of the removal of any obstruction, ENGINEER-IN-CHARGE considers that damages may have been caused to the pipe lines, he shall be entitled to order the stretch to be tested immediately. Should such test prove unsatisfactory CONTRACTOR shall amend the work and carry out such further tests as are required by ENGINEER-IN-CHARGE.

It shall also be ascertained by CONTRACTOR that each stretch from manhole to manhole or the stretch as directed by ENGINEER-IN-CHARGE is absolutely clear and without any obstruction by means of visual examination of the interior of the pipeline suitably enlightened by projected sunlight or otherwise.

Testing at work site

After laying and jointing of rcc pipes is completed the pipe line shall be tested at work site as per the following specifications and as directed by engineer-in-charge. all equipment for testing at work site

shall be supplied and erected by the contractor and shall be rectified by him / her to the full satisfaction of engineer-in-charge. water used for test shall be removed from pipes and not released to the excavated trenches.

after the joints have been thoroughly jointed and have been checked by engineer-in-charge and before backfilling the trenches, the entire section of the sewer shall be proved by contractor to be water tight by filling in pipes with water at a constant head of 2.5m above the top of the highest pipe in the stretch and heading the water up for the period of one hour. the testing apparatus used for the purpose shall normally be fixed on the upstream end and should be got approved by engineer-in-charge. contractor if required by engineer-in-charge shall dewater the excavated pit and keep it dry during the period of testing. the loss of water over a period of 30 minutes should be measured by adding water from a measuring vessel at regular intervals (not more than 1 minute) and noting the quantity of water required to maintain the original water level. for the approval of this test the average quantity added should not exceed 1 liter / hour / 100 linear meters / 10mm nominal internal diameter. any leakage including excessive sweating which causes a drop in the test water level will be visible and the defective part of the work should be removed and made good.

all of results of test and inspection data must be prepared by contractor at site so that the engineer-in-charge shall make decision of “fail or pass” at once. all cost for the inspection shall be borne by the contractor.

Notes

a) if any damage is caused to the pipeline during the execution of work or while cleaning / testing the pipeline as specified, contractor shall be held responsible for the same and shall replace the damaged pipeline and retest the same at his own cost to the full satisfaction of engineer-in-charge.

b) water for testing of pipeline shall be arranged by contractor at his own cost.

6.2.2 Pipes (Double Wall Corrugated PE pipes)

Scope

This specification covers the requirements for manufacture, supplying, lowering, laying, jointing, testing and commissioning of Double Wall Corrugated (DWC) PE pipes and fittings used for the conveyance of sewage.

Applicable codes

The manufacturing, testing, supplying, jointing and testing at work site of DWC PE pipes and fittings shall comply with all currently applicable statutes, regulations, standards and codes. In particular, the following standards unless otherwise specified herein, shall be referred. In all cases, the latest revision of the codes shall be referred to. If requirements of this specification conflict with the requirements of the codes and standards, this specification shall govern.

Code No.	Title / Specification
ISO:21183-3	Specification for Double Wall Corrugated (DWC) PE pipes and fittings for non pressure underground drainage and sewerage.

IS: 7634 (Part-2)	Code of practice for Laying and Jointing of High Density Polyethylene pipes (HDPE) piping system
IS:5282	Specification for Rubber Sealing Rings for Gas mains, Water mains and sewers
IS: 2530	Method of test for polyethylene moulding materials and polyethylene compounds
IS: 7328	High Density Polyethylene material for moulding and extrusion
IS: 4905	Method for random sampling

Other codes as approved by Engineer but not specifically mentioned here pertaining to the use of DWC Pipes form part of these specifications.

GENERAL

Design

Design of DWC PE pipes including material details and the maximum allowable hydrostatic design stress taking into consideration, the temperature and design life of pipes shall be in accordance with the relevant clauses of ISO: 21138-3.

Grade of Material

The DWC PE pipes and fittings shall be in the range of 160 mm to 1000 mm nominal diameter of class SN8 for conveyance of sewage.

Material Grade, Minimum Required Strength and Maximum Allowable Hydrostatic Design Stress shall conform to the relevant clause of ISO: 21138-3.

MANUFACTURING, WORKMANSHIP & FINISH

General

a) The base material shall be polyethylene (PE) to which are added those additives that are needed to facilitate the manufacture of components conforming to ISO 21138-3.

b) The method of manufacture of DWC PE pipes shall be such that the internal surface of the pipes shall be smooth, clean and free from grooving and other defects. The ends shall be cleanly cut and shall be square with axis of the pipes. External surface of the pipes shall be corrugated.

c) The Engineer shall at all reasonable times have free access to the place where the pipes and fittings are manufactured for the purpose of examining and testing the pipes and fittings and of witnessing the test and manufacturing.

d) All tests specified either in this specification or in the relevant Indian standards shall be performed by the supplier/contractor at his own cost and in presence of the Engineer if he so desires. For this, sufficient notice before testing of the pipes and fittings shall be given to the Engineer.

e) If the test is found unsatisfactory, the Engineer may reject any or all pipes of that lot.

Materials

The material used for the manufacturer of pipes should not constitute toxicity hazard, should not support microbial growth, should not give rise to unpleasant taste or odour, cloudiness or discoloration of water.

Pipe manufacturers shall obtain a certificate to this effect from the manufacturers of raw material by any reputed organization as per the satisfaction of the Engineer.

Material Characteristics of Pipe And Injection Moulded Fittings

When tested in accordance with the test method in Table 3, using the indicated parameters, the material shall have characteristics conforming to requirements given in Table 3 of ISO 21138-3.

Material Characteristics of rotational moulded fittings

When tested in accordance with the test methods specified in Table 4,using the indicated parameters, the material shall have characteristics conforming to the requirements given in Table 4 of 21138-3..

Utilization of Non Virgin Material

For the utilization of non-virgin PE materials, conditions and requirements are given in Annex F of ISO 21138-3 and the PE recyclates shall conform to characterization specified in EN 15344.

Dimensions and Tolerances

a) The outside diameters of pipes, tolerance on the same and ovality of pipes shall be as given in relevant clause of ISO: 21138-3.No negative tolerances are allowed.

b) The minimum & maximum wall thickness of pipe for the given class, namely, SN8 shall be as given in Table 5 of ISO: 21138-3.

c) The length of straight pipe used shall be 6 m or as agreed by Engineer.

Testing

The specimen of pipes for the following tests shall be selected in accordance with relevant clause of IS: 2530 and tests in accordance with the methods described in Table 3 of ISO: 21138-3. Following tests shall be taken in consideration:

i. Hydrostatic test
ii. Density test
iii. Melt- Mass Flow Test
iv. Thermal Stability

Sampling and Inspection

a) Three samples of the same size and same pressure rating selected at random shall be tested for compliance with the requirements of the type test for Internal Pressure Creep Rupture Test.

b) In case, any of the samples fails in the type test, the testing authority, at its discretion, may call for fresh samples not exceeding the original number and subject them to type test again. In case of the sample fails in the repeat tests, the type of pipe shall not be approved.

c) Acceptance tests are carried out on samples selected from a lot for the purpose of acceptance of the lot.

d) A lot having satisfied dimensional and visual requirements shall be tested for hydraulic characteristics, reversion, density, MFR and Carbon Black content / dispersion requirements. The lot shall be considered to have met the requirements of these tests, if none of the samples tested fails.

Workmanship / Appearance

Pipes shall be free from all defect including indentations, delaminating, bubbles, pinholes, cracks, pits, blisters, foreign inclusions that due to their nature degree or extent detrimentally affect the strength and serviceability of the pipe. The pipe shall be as uniform as commercially practicable in colour opacity, density and other physical properties as per relevant ISO 21138-3 or equivalent International Code. The inside surface of each pipe shall be free of scouring, cavities, bulges, dents, ridges and other defects that result in a variation of inside diameter from that obtained on adjacent unaffected portions of the surface. The pipe ends shall be cut clearly and square to the axis of the pipe.

Carting & Handling

During handling, transportation, storage and lowering of pipes & fittings, all sections shall be handled by such means and in such a manner that no distortion or damage is done to the section or to the pipes as a whole. Also, unless waived by the Engineer, method statements shall be submitted by the Contractor for the approval of the Engineer before the handling, transportation and laying of any pipes commences. All pipes shall be handled and stored in compliance with the manufacturer's recommendations. Pipes and fittings /specials shall be transported from the factory to the central pipe store and unloaded there before being transported to Site. At every point of loading or unloading, all pipes and fittings shall be lifted using approved lifting tackle. Unloading by rolling down any form of inclined ramp will not be permitted. Pliable straps or slings shall be used to lift pipes. Rope, wire rope, hooks or chains shall not be allowed to come into contract with any pipe surface. All pipes shall be thoroughly inspected on arrival on site and immediately prior to installation. Any damage to the pipes shall be notified to the Engineer for a decision as to the acceptability of the pipes, with or without repairs or remedial work. The final judgement will be taken by the Engineer based on his judgement of the suitability of the items for the purpose intended.

The following procedures should be followed so as to eliminate potential damage to pipes & fittings and to maintain maximum safety during unloading, lifting and lowering of pipes:

a) Pipes must not be stored or transported where they are exposed to heat sources likely to exceed 60^{o}C.

b) Pipes shall be stored such that they are not in contact with direct sunlight, lubricating or hydraulic oils, petrol, solvents and other aggressive materials.

c) Scores or scratches to a depth of greater than 10% or more of wall thickness are not permissible; any pipes having such defects should be strictly rejected.

d) PE pipes should not be subjected to rough handling during loading and unloading operations. Rollers shall be used to move, drag the pipes across any surface.

e) Only polyester webbing slings should be used to lift heavy PE (>315mm) pipes by crane. Under no circumstances, chains, wire ropes and hooks be used on PE pipes.

f) Pipes shall not be dropped to avoid impact or bump. If any time during handling or during installation, any damage, such as gouge, crack or fracture occurs, the pipe shall be repaired if so permitted by the competent authority before installation.

g) Straight lengths should be stored on horizontal racks giving continuous support to prevent the pipe taking on a permanent set.

h) Pipes manufactured at factory are to be carried to the site of work directly or stacked suitably and neatly along the alignment/road side/elsewhere near by the work site or as directed by the Engineer.

i) Damages during transit, handling, storage will be to the Contractor's account and replacement for such pipes has to be made by the Contractor without any extra cost as directed by the Engineer.

Storage

a) Polyethylene pipes may be stored either under cover or in the open. It is suitably protected from ageing due to sunlight by the addition of the appropriate quantity and type of carbon black. .

b) Straight lengths should be stored on horizontal racks giving continuous support to prevent the pipe taking on a permanent set.

c) Storage of pipes in heated areas exceeding 30 deg centigrade should be avoided.

LAYING AND JOINTING OF PIPES

Laying

For lowering and laying of pipes, the following points shall be considered:

a) Each pipe shall be thoroughly checked for any damages before laying and only the pipes which are approved by the Engineer shall be laid. Pipes shall be laid at required gradient as per drawing.

b) While installing the pipes in trenches, the bed of the trench should be level and free from sharp edged stones. While laying in rocky areas suitable bed of sand should be provided. The fill to about 10 to 15 cm above the pipe should be fine sand or screened excavated material. Where hard rock is met with, 20cm thick sand bed as approved by the engineer may be provided

c) PE pipe is lighter than water. Hence care should be taken for normal installations where there could be a possibility of flooding of the trench thus the trench shall be kept free of water till the jointing has been properly done

d) When flooded, some soils may lose cohesiveness, which may allow the PE pipe to float out of the ground. Several design checks are necessary to see if groundwater flotation may be a concern. Obviously, if the pipeline typically runs full or nearly full of liquid, or if groundwater is always below the pipe, flotation may not be a significant concern.

e) Pipe embedment backfill shall be stone-free excavated material placed and compacted to the 95% maximum dry density.

Jointing

The jointing method for pipes shall be with coupler and rubber rings. On first valley segment of corrugators pipe (destined to be pushed into the coupler) one elastomeric rubber ring needs to be placed which is pushed into the coupler socket. This provides sufficient gripping lock and leak proof joint.

Similar system is also used for fabricated accessories or moulded fittings required such as Tee , Bends, etc for the purpose of installation of the system related to sewerage. For quality connections, following steps are to be ensured, failing which the performance aspects are to be severely compromised.

- The non-coupler end needs to be thoroughly cleared and shall be free from any foreign material.
- Use a clean rag or brush to lubricate the non coupler end with lubricant.
- Clean and lubricate the coupler end of the pipe to be laid in similar manner.
- Lubricate the exposed gasket in the same manner with pipe lubricant.
- Keep the lubricated non-coupler end free from dirt, backfill material, and foreign matter so that the joint integrity is not compromised.
- Push the coupler into non-coupler and align properly. Always push coupler end into non-coupler end.

For smaller diameter pipes simple manual insertion shall be sufficient. In every methodology, it should be ensured that the coupler end is adequately 'Homed' within non-coupler end to ensure installation and tight joining seal. Therefore prior to insertion always place a 'Homing Mark' on appropriate corrugation of the non-coupler end.

Construction of Backfill Envelope And Backfilling of the Trenches

These pipes and well compacted backfill envelope work together to support soil and traffic load.

In general, material used for construction of backfill envelop around the pipe comprises of the following:

- Initial Backfill
- Side fill
- Top back fill

The material for backfill envelop shall be as per the structural design of flexible buried conduit. It can be the same material that were removed in the course of excavation or it can be fine sand/course sand/gravel depending on the over burden and superimposed load, but it should be the concrete which invariably induces undesired rigidity in the system.

- The remaining portion of backfilling shall be the materials that were removed in the course of excavation. These materials shall consist of clean earth and shall be free from large clod or stone-75mm,ashes,refuse and other injurious materials.
- After completion of laying of pipes, etc, first backfill envelope shall be constructed as per design around pipe. Voids must be eliminated by knifing under and around pipe or by some other technique and compacted with necessary watering, either by hand rammers or compactors to a possible maximum level of proctor density.
- Backfilling shall start only after ensuring the water tightness test of joints for the concerned sewer segments. However partial filling may be done keeping the joints open.
- Precautions shall be taken against floatation as per the specified methodology and the minimum required cover

FITTINGS AND SPECIALS

All DWC PE fittings/ specials shall be fabricated in accordance with ISO-21138-3. All fittings/specials shall be fabricated or injection moulded at factory only. No fabrication or moulding will be allowed at site, unless specifically permitted by the Engineer. Fittings will be butt welded on to the pipes or other fittings by use of heat fusion.

SITE TESTING

After laying and jointing of DWC PE pipes is completed, the pipe line shall be tested. All equipment, material, and labor for testing shall be supplied by the Contractor. Damage during testing shall be contractor's responsibility and shall be rectified by him to the full satisfaction of the Engineer. Water for testing of pipeline shall be arranged by the Contractor at his own cost.

After the joints have been checked by the Engineer and before backfilling of the trenches, the entire section of the sewer shall be proved by the contractor to be watertight. Water used for the test shall be removed from pipes and not discharged to the excavated trenches.

The Contractor shall carry out final testing of the equipment and commissioning of all pipelines to the satisfaction of the Engineer.

6.2.3 uPVC Pipes and Fittings

uPVC Soil, Waste, RWP & Vent system conforming IS 4985 Class-5 comprising uPVC pipe . The pipes shall be round and shall be supplied in straight lengths with socketed ends. The internal and external surfaces of pipes shall be smooth, clean, free from grooving and other defects. The ends shall be cleanly cut and square with the axis of the pipe. The pipes shall be designed by external diameter.

Fittings

Fittings shall be of the same make as that of pipes, injection moulded and shall conform to IS 14735 Indian Standard.

Laying in Trenche

uPVC pipes shall be laid on cement concrete bed of width 300mm over the outside diameter of pipe, and 100 mm thickness. Fine sand shall be carefully filled around the lower half of the pipes so as to buttress them to the sides of the trench.

The filling shall then be continued to 150mm over the top of the pipe using fine sand, watered and rammed on both sides of the pipes. The process of filling and ramming with fine handpicked material shall proceed evenly in layers not exceeding 150mm thickness, each layer being watered and consolidated so as to maintain an equal pressure on both sides of the pipe line. To achieve minimum 95 % dry density

All pipes including joints to be encased with 100 mm concrete if cover less than 90 cm.

6.2.4 uPVC Pipes and Fittings - Under ground

uPVC Brown solid wall/foam core as per Is 15328 SDR 34 , SN8, underground . The pipes shall be round and shall be supplied in straight lengths with socketed ends with click ring/rubber ring joints. The internal and external surfaces of pipes shall be smooth, clean, free from grooving and other defects. The ends shall be cleanly cut and square with the axis of the pipe. The pipes shall be designed by external diameter.

Fittings

Fittings shall be of the same make as that of pipes, injection moulded and shall conform to Indian Standard.

Laying in Trenches

uPVC brown pipes shall be laid on cement concrete bed of width 300mm over the outside diameter of pipe, and 100 mm thickness. Fine sand shall be carefully filled around the lower half of the pipes so as to buttress them to the sides of the trench.

The filling shall then be continued to 150mm over the top of the pipe using fine sand, watered and rammed on both sides of the pipes. The process of filling and ramming with fine handpicked material shall proceed evenly in layers not exceeding 150mm thickness, each layer being watered and consolidated so as to maintain an equal pressure on both sides of the pipe line. To achieve minimum 95 % dry density

All pipes including joints to be encased with 100 mm concrete if cover less than 90 cm.

6.3 Construction of Manhole

Where manholes are to be constructed, the excavation, filling back and ramming, disposal of surplus earth, preparation of bottom and sides etc. shall be carried out as described earlier under trench excavation. Manhole shall be sized and depths as called for in the drawings and standard details.

The walls shall be of brick work of thickness as shown in drawings built in cement mortar 1:5. The joints of brick work shall be raked and plastered internally in cement mortar 1:3 (at least 12 mm thick) and finish with a coat of neat cement, external plaster shall be rough plaster in 1:3, PCC benching & semi circular channels of the same diameter as the pipes shall be provided and finished with neat cement coating.

Above the horizontal diameter, the sides of channel shall be extended vertically to the same level as the crown of the outgoing pipe and the top edge shall be suitably rounded off. The branch channels shall also be similarly constructed with respect to the benching but at their junction with the main channel an appropriate fall suitably rounded off in the direction of flow in the main channel shall be given. All manholes / sumps shall be provided withCast iron steps shall be as per IS: 555. Where the depth of invert of manhole exceeds 800 mm, cast iron steps of approved pattern shall be built in the brick work at the interval of 30 cm vertically and 38 cm horizontally. C.I. steps shall weigh not less than 4.5 kg each and shall be of 150 mm X 375 mm overall dimensions. In case of pipe diameter greater than 600mm box type C.I. steps weighing 19 kg each shall be provided in channel of the manhole as per Drawing. C.I. Steps shall be PVC encapsulated. These rungs shall be set at 30cms interval in two vertical runs at 380mm apart horizontally. The top rung shall be 450mm below the manhole cover. Unless otherwise mentioned, manholes shall be constructed to the requirements of Indian Standard IS:4111 (Part I). All manholes shall be constructed so as to be water tight under test. All angles shall be rounded to a 75mm radius with cement plaster 20mm thick. The benching at the side shall be carried out in such a manner so as to provide no lodgment for any splashing in case of accidental flooding. The covers and frame shall be double seal .

Drop Connection

Drop connection shall be provided between branch sewer and main sewer in the main sewer itself in steep ground when the difference in invert level of two exceeds 60 cms of the required sizes. Drop connections from gully traps to main sewer in rectangular shall be made inside the manholes and shall have CI special types door bend on to top and heel rest bend at bottom connected by a CI pipe. The pipe shall be supported by holder bat clamps at 180 cms intervals with at least one clamp for each drop connection. All joints shall be lead caulked joints 25mm deep.

Drop connections from branch sewer to main sewer shall be made outside the manhole wall with material as shown in the drawing for connection, vertical pipe and bend at the bottoms. The top of the tee shall be finished up to the surface level and provided with frame and cover 30cms x 30cms.

Drop connection made from vertical stacks directly into manholes shall not be considered as drop connections.

6.4 Catch Basins

RCC Catch basins wherever vehicular movement size & gratings as shown in the drawings joining to nearest storm water drain. They will be constructed as per position and number mentioned in layout drawing. The outgoing pipe invert shall be minimum 125mm above the catch basin invert. The invert of the pipe can be suitably adjusted for connection to the adjacent trunk storm water drain. The catch basins shall be measured and paid in per number basis excluding pipe providing and jointing cost.

Designing & Construction of Road Catch Basin Chamber of the sizes as shown in drawings in brick work, wherever there is no vehicular movement, with bricks of class 75 in cement mortar 1 : 5 (1 cement : 5 find sand) necessary foundation concrete(1 : 4 : 8). Inside & outside plastering 12 mm thick with cement mortar 1 : 3 with a floating a coat of neat cement. Including the RCC top slab for fixing the grating including necessary excavation, dewatering, refilling, watering, ramming, removing, the surplus excavated material and making good the same complete as required.

6.5 Gully Trap

Fixing pvc/Stone ware gully trap of the 300mm X 300mm sizes embedded in brick masonry chamber of standard design with first class bricks and trap to be set in cement concrete 1:2:4, both side 12mm thick plastering with floating coat of neat 'cement. Making necessary connections & providing water tight D.I. cover A15/C-250 with frame as per loading. In and out sizes shall be as per drawings. Including necessary excavation, dewatering, refilling, watering, ramming and removing the surplus excavated material and shifting within the site limit as directed by site in charge and making good the same complete as required.

6.6 Inspection Chamber

IC chamber either brick masonry/ RCC as loading and as shown in drawings.

a) Brick Masonry IC

Designing & Constructing brick masonry inspection chamber of the 900mm X 450mm sizes in brickwork of class designation 75 in cement mortar 1:5 work (1 cement:5 fine sand) R.C.C. top slab with 1:2:4 mix (1 cement : 2 coarse sand : 4 graded stone 'aggregate 20mm nominal size) and foundation concrete 1:4:8 mix(1 cement:4 coarse sand graded stone aggregate 40mm nominal :8 size).Inside plastering 12 mm thick with cement motor 1:3 (1 cement : 3 coarse sand) and rough plastering on outside 'floating coat of neat cement on both sides. Including M.S. / PVC foot rests at 300 mm spacing, benching and making channels with 1:2:4 cement concrete neatly finished, including excavation, in all kind of soil including (hard rock), dewatering, refilling, watering, ramming and removing the surplus excavated material and shifting within the site limit as directed by site in charge and making good the same complete as required. 75 mm fillet shall be made with C.M. 1:3 all round the external joint between the bed concrete and brick masonry wall of chamber.

Benching

Channels and benching inside the inspection chambers shall be done in cement concrete 1:2:4, rendered smooth with neat cement. The channel provided shall be of

semicircular shape of the same diameter as the diameter of the pipe drain with vertical walls. The depth of channel shall be equal to the pipe drain diameter and the P.C.C. benching top will have a slope of 1 in 12 from the side walls to the channel.

Steps

Steps shall be provided wherever the depth of the chamber is more than 1.2 m. Foot

rest shall be C.I. rungs weighing 5.3 kg and conforming to IS 5455-1969. These shall be embedded 20 cm deep in 20 × 20 × 10 cm blocks of P.C.C. 1:3:6. The blocks with C.I. foot rest placed in its centre shall be cast in site along with masonry.

Footrest shall be placed 300 mm apart vertically and 375 mm horizontally in staggered fashion. First footrest shall be 450 mm below top. Footrest shall be painted with bituminous paint and the portion embedded shall be painted with thick cement slurry before fixing.

Testing

Chamber after it is raised above highest expected subsoil water level in monsoon shall be tested for water tightness. The mouths of all pipes entering the chamber shall be suitably plugged with brick masonry or wooden or any other type of plug. Chamber under test shall then be filled with water up to general subsoil water level and the level observed for one hour, it shall then be deemed as watertight.

During testing the pit around shall be kept free of water and CONTRACTOR shall observe the places where leakage takes place and take steps to correct the same.

The cover shall be LD-2.5 / MD-12.5 / HD-25 as per placing of the chamber

b) RCC INSPECTION CHAMBER

The chamber of the 900mm X 450mm size indicated in the drawings shall be the internal size of chamber. Unless otherwise specified, inspection chambers shall be provided at all changes of direction of drains and where branch drain meets the main drain. Chambers shall be of such

size as to allow necessary examination and clearance of drains. The minimum internal sizes shall be taken as per detail drawings; standards specified and local byelaws if any. The work shall be done strictly as per standard drawings and following specifications. Inspection chambers shall be constructed in reinforced cement concrete to grade M20. The base and walls shall be designed for all loads coming over including the earth and water pressure. Inside walls chambers shall be plastered with 20mm thick cement plaster 1:3 mixed with waterproofing material and finished smooth with a floating coat of neat cement. External walls shall be plastered in CM 1:3 and sponge finished.75 mm fillet shall be made with C.M. 1:3 all round the external joint between the bed concrete and brick masonry wall of chamber.

Benching

Channels and benching inside the inspection chambers shall be done in cement concrete 1:2:4, rendered smooth with neat cement. The channel provided shall be of

semicircular shape of the same diameter as the diameter of the pipe drain with vertical walls. The depth of channel shall be equal to the pipe drain diameter and the P.C.C. benching top will have a slope of 1 in 12 from the side walls to the channel.

Steps

Steps shall be provided wherever the depth of the chamber is more than 1.2 m. Foot

rest shall be C.I. rungs weighing 5.3 kg and conforming to IS 5455-1969. These shall be embedded 20 cm deep in 20 × 20 × 10 cm blocks of P.C.C. 1:3:6. The blocks with C.I. foot rest placed in its centre shall be cast in site along with masonry.

Footrest shall be placed 300 mm apart vertically and 375 mm horizontally in staggered fashion. First footrest shall be 450 mm below top. Footrest shall be painted with bituminous paint and the portion embedded shall be painted with thick cement slurry before fixing.

Testing

Chamber after it is raised above highest expected subsoil water level in monsoon shall be tested for water tightness. The mouths of all pipes entering the chamber shall be suitably plugged with brick masonry or wooden or any other type of plug. Chamber under test shall then be filled with water up to general subsoil water level and the level observed for one hour, it shall then be deemed as watertight. During testing the pit around shall be kept free of water and CONTRACTOR shall observe the places where leakage takes place and take steps to correct the same.

The cover shall be LD-2.5 / MD-12.5 / HD-25 as per placing of the chamber.

6.7 Chamber Covers

Covers shall be installed as per the location of manhole, inspection chamber, gully trap. At pedestrian movement 2.5 tonne, at light vehicle 12.5 tonne and at fire tender movement 25 tonne loading to be considered for selecting the cover. The covers shall have specified weight as specified in IS codes with double seal.

a) Cast Iron manhole cover and frame:

As per IS: 1726 double seal Suitable for manhole size manhole with lockable and lifting arrangement.

b)Steel Fibred Reinforced Concrete Covers (SFRC Covers)

The steel fibred reinforced concrete covers shall be heavy duty as per IS 12592 (Part-I & II) with adequate steel reinforcement having thickness suitable for loading, anti-corrosive bitumen painted M.S. plate, Rim and on M.S. lifting hooks, admixture like plasticizer bond-improving compound, shrinkage resistance compound abrasion resistant complete, as per approved design. Heavy duty SFRC covers shall be provided in driveways.

c) Ductile Iron

Manhole Cover Double seal lockable type frame suitable for diameter, square or rectangular size with clear opening with suitable lifting arrangement.

6.8 Gratings

Gratings shall be installed as per the location of Catch basins. At pedestrian movement 2.5 tonne, at light vehicle 12.5 tonne and at fire tender movement 25 tonne loading to be considered for selecting the cover.

a) Ductile iron grating with frame

The gratings and frame shall be manufactured from appropriate grade of Ductile iron (Spheroid graphite or nodular iron) conforming to IS 1865. However Grade SG500/7 & SG500/7A is recommended as per manufacturer specifications.

The micro-structure of ductile iron shall contain minimum 80 percent graphite in the form of V or VI designations as specified in IS7754.

The castings shall be sound, clean and free from blow-holes, slag inclusions, distortion, hard spots, sand—fusion ,porous space sand/air holes, cold shuts and all surface and other defects . They shall be well dressed, fettled and shall be straight, regular and true in every respect, Casting shall not be welded or plugged except by agreement between the ENGINEER-IN-CHARGE in charge & manufacturer as per site requirement.

b) Steel Fibred Reinforced Concrete gratings

The steel fibred reinforced concrete gratings shall be heavy duty as per IS 12592 (Part-I & II) with adequate steel reinforcement having thickness suitable for loading, anti-corrosive bitumen painted M.S. plate, Rim and on M.S. lifting hooks, admixture like plasticizer bond-improving compound, shrinkage resistance compound abrasion resistant complete, as per approved design. Heavy duty SFRC grating shall be provided in driveways.

c) M.S gratings

The M.S gratings shall be as shown in the drawings.

6.9 Box Drains

Storm water drains will be of RCC M20 grade buried box with Inspection Chambers/Surface box as per layout drawing and standard details.

Buried Box drain with Inspection chambers as per storm water layout drawing. The water inlet system for this type of drain will be through catch basins/grating.

Surface box drains as per storm water layout drawing. The water inlet system for surface drains in general will be gratings. However, catch basins might be provided for surface drains as per layout drawings depending on their location in Right of Way.

6.10 Making Connections

Contractor shall connect the new sewer line to the existing manhole by cutting the walls benching and restoring them to the original condition. A new channel shall be cut in the benching of the existing manhole for the new connection. Contractor shall remove all sewage and water if encountered in making the connection without additional cost.

6.11 Grease Separators

Grease separators to be as shown in the drawings as per following:

a) **Prefabricated Grease Interceptor**

The Product shall be of specification EN 1825. The separators shall be Prefabricated in PE (Polyethylene) or S.S. depending on the applications and requirements. Product availability for all site conditions like Above the Ground applications, Under the Ground Application & Below Sink Applications (At source).The Product can be upgraded in Retrofit applications also. The opening of All Grease Separators shall be Air and Water Tight.

Prefabricated Grease interceptor shall be of HDPE / Polyethylene conforming to DIN EN 1825 / DIN 4040 -100 suitable for underground installation similar to ACO Lipumax-P-D. Including concrete frame with double seal D 400 Cover suitable for loading. Opening to be 600 mm diameter clear. Shall be odour free when closed.

Capacity shall be as shown in the drawings.

b) **Masonry Grease Interceptor**

1. Size of Grease Trap

The size given in drawings/standard details shall be internal size of chamber. S.S/FRP strainer bucket with lifting handle at inlet shall be provided as shown in drawings. Also provide vent and terminated at high level as per site condition The work shall be done strictly as per standard drawing and following specifications.

2. Bed Concrete

Shall be in 1:4:8 cement concrete 150 mm thick.

3. Brick work

Brick work shall be with best quality bricks in I:5 CEMENT MORTAR. Baffle walls shall be of R.C.C and of size as shown in drawings. Brick partition constructed of best quality table moulded bricks in cement mortar 1:5 shall be provided for the entire height of chamber.

4. Plaster

The walls of chamber shall be plastered from inside with 12 mm thick cement plaster 1:3 and finished smooth with a floating coat of neat cement & rough plaster on outside in cement mortar 1:3.

5. Chamber Covers

Covers shall be of size and duty as mentioned in drawings. Covers shall be of 600mm dia cast iron D-400 as per the details given in the drawing and shall be fixed on frame embedded in concrete.

I steps shall be provided at two corners of the chamber.

All Cast Iron and MS items shall be painted with two coats of bit mastic paint.

The covers and frames shall be coated with a black bituminous composition. The coating shall be smooth and tenacious. It shall not flow when exposed to a temperature of 63° C and shall not brittle as to chip off at a temperature of 0° C.

6.12 Kerb Drain

The Product shall be of specification EN1433. The material for the KERBDRAIN should be made of Polymer Concrete. The Product shall take a Load Class of D400. It shall have Chemical Resistance to Salt and Zero percent Water Absorption.

6.13 Testing of services

All lengths of the sewer and drain shall be carefully tested for water tightness by means of water pressure maintained for not less than 30 minutes. Testing shall be carried out from manhole to manhole. All pipes shall be subject to a test pressure of 1.5 meter head of water. The test pressure will however, not exceed 6 meters head at any point. The pipes shall be plugged preferably with standard design plugs or with rubber plugs on both sides, the upper end shall, however, be connected to a pipe for filling with water and getting the required head poured at one time.

Sewer lines shall be tested for straightness by :

i. Inserting a smooth ball 12 mm less than the internal diameter of the pipe. In the absence of obstructions such as yarn or mortar projecting at the joints the ball shall roll down the invert of the pipe and emerge at the lower end.

ii. means of a mirror at one end a lamp at the other end. If the pipe is straight the full circle of light will be seen otherwise obstructions or deviations will be apparent.

iii. The contractor shall give a smoke test to the drain and sewer at his own expense and charges, if directed by the Owner's site representative.

iv. A test register shall be maintained which shall be signed and dated by contractor and Owner's site representative.

7. VALVES ,FITTINGS & ACCESSORIES

General

The Contractor shall supply and install all valves as indicated on the drawings and as required for the proper and efficient operation and maintenance of the entire systems. All valves supplied shall be suitable for the working pressure and test pressure of the various water supply systems. All valves other than automatic control valves shall be full line size. Each valve shall have a purpose made reference number plate or label engraved or stamped indicating the manufacturer's catalogue number, pressure and temperature ratings. Valves shall be arranged so that clockwise rotation of the spindle will close the valve. Demo labels are not acceptable. Furnish all valves and accessory material necessary in the piping whether or not shown on drawings for system operation.

All valves (gate, check, safety) shall be of gun metal up to size of 50MM Dia and above that all valves shall be of CI, except wherever specified, conforming to PN rating of 16.

Valves shall either be of screwed type up to 50 mm and flanged type above 50 mm, as specified, with suitable flanges and non-corrosive bolts and gaskets. Flanges shall be machined on faces and edges. Flanges shall conform to ISO 7005, IS 6392, BS EN 1092-1/ BS 4504.The flange face should be at right angles to the valve centreline. Back side of valve flanges shall be machined or spot faced for proper seating of the head and nut.

Valve shall be suitable for frequent operation as well as operation after long periods of idleness in either open or closed position.

All valves shall be packed with an approved packing and threads shall be coated with oil and graphite. Packing should be replaced when found deteriorated on site. Where possible locate all valves at convenient positions of operation from the floor with valve stems upright. Valves that are flanged shall have flanges comply with BS 4504 as for pipe work. Provide valves of the same manufacturer throughout, where possible.

All valves shall be with screwed or flanged ends as required by the piping system in which they are installed based on pipe size.

Valves shall be selected for the working pressure required.

Plastic or metal plates (rust-less) shall be provided to indicate the open/close status as well as the use of each valve in the pump and tank rooms, and in the town main.

7.1 Gate, globe, safety Valves

Gate, globe, safety valves shall be of gun metal non rising spindle valves suitable for the particular service as called for. All valves shall be of the particular duty and design as called for. Valves shall either be of screwed type or flanged type, with suitable flanges and non corrosive bolts and gaskets. Tail pieces as required shall be supplied along with valves. Gate, globe valves shall conform to Indian Standard IS:778

Sluice valves, where called for shall be flanged sluice valves of cast iron body. The spindle, wall seat and wedge nuts shall be gunmetal. They shall generally have non rising spindle and shall be of the particular

duty and design called for. The valves shall be supplied with suitable flanges, non corrosive bolts and asbestos fiber gasket. Sluice valve shall conform to Indian standard IS:780 and IS:2906.

sluice valve shall be of rising spindle type. The valve shall be furnished with a bushing arrangement for replacement of packing without leakage.

All the hand wheels shall be arranged to turn in a clockwise direction to close the valve. The direction of rotation for opening and closing of the valve shall be indicated on the hand wheels.

7.2 Butterfly valve:

Butterfly valves shall be of double eccentric and resilient seated type generally as per BS EN 593, BS 5155 and IS 13095.

Butterfly valves shall be suitable for bi-directional pressure testing with dead-tight shut off even after long period of operation. The valves shall be of double flanged long type.

The valve shall be free from induced vibrations. Valve shall be suitable for mounting in any position.

The valve seat shall be of replaceable design. When the valve is fully closed, the seal shall seat firmly. The seat surfaces shall be machined smooth to provide a long life for the seal. All fasteners shall be set flush so as to offer the least resistance possible to the flow through the valve.

The shaft shall be stainless steel with Bronze or equivalent seal with self-lubricating bearings. Disc pins shall be stainless steel. Rings shall be bi-directional self-adjusting suitable for pressure or vacuum service. Removal and replacement of seals shall be possible without removing the operating mechanism, valve shaft and without removing the valve from the pipeline. Valve shafts shall be a one-piece unit extending completely through the valve disc, or of the "stub shaft" type, which comprises two separate shafts inserted into the valve disc hubs.

All valve spindles and hand wheels shall be positioned to give good access for operational personnel. Valve of diameter 450 mm and above shall be provided with enclosed gear arrangement for ease of operation. The gear box shall be of worm and worm wheel design type, totally enclosed, grease filled and weather proof. The operation gear shall be such that they can be opened and closed by one man against an unbalanced head of 1.15 times the specified rating. Valve and gearing shall be such as to permit manual operation in a reasonable time and not exceed a required rim pull of 200 N.

All hand wheels shall be arranged to turn in a clockwise direction to close the valve, the direction of rotation for opening and closing being indicated on the hand wheels.

Material of construction of valves shall comply with following requirement:

Item	PN 10 & PN 16 Valves
Body	Ductile Iron DIN 1693-GGG40 / Spheroidal Graphite Iron IS 1865 Gr 400/12
Disc	Ductile Iron DIN 1693-GGG40 / Spheroidal Graphite Iron IS 1865 Gr 400/12
Shaft	Stainless Steel BS 970 Grade 431 S 29
Body Seat	Nickel weld overlay micro finished

Disc seal	EPDM
Seal Retaining ring	Ductile Iron DIN 1693-GGG40
Shaft Bearing	Bronze with EPDM 'O' ring seals
Internal Fasteners	Stainless steel SS316
Nuts, bolts & washers for pipe flanges	High tensile steel hot dip galvanized

The disc shall be designed to withstand the maximum pressure differential across the valve in either direction of flow. The disc shall be contoured to ensure the lowest possible resistance to flow and shall be suitable for throttling operation.

Valves shall be capable of closing against the maximum flow that can occur in system. The shaft shall be designed to withstand the maximum torque that will be imposed by the operator. It shall be secured to the discs by tapered stainless steel cotter pins.

Valves shall be provided with position indicator to show the position of the disc, mounted on the driven shaft end.

Rigid adjustable stop mechanism shall be provided within the gear box or elsewhere on the valve to prevent movement of the disc beyond the fully open or closed position (i.e. set points).

7.3 Ball Valves

The ball valve shall be made forged brass and suitable for test pressure of pipe line. The valve shall be internally threaded to receive pipe connections.

Forged brass ball valves with brass ball / stem, union / flange, washer, nuts & bolts. Rated to temperature of 85 Deg C and tested to a pressure not less than 15 Kg/Sq.cm. Including covering with nitrile rubber insulation having protective coating against mechanical damage as per manufacturer's specification (GI boxing to be provided).

The ball shall be made from brass and machined to perfect round shape and subsequently chrome plated. The seat of the valve body-bonnet gasket and gland packing shall be of Teflon.

The handle shall be provided with PVC jacket. The handle shall also indicate the direction of 'open' and 'closed' situations. The gap between the ball and the teflon packing shall be sealed to prevent water seeping.

The handle shall also be provided with a lug to keep the movement of the ball valve within 90°. The lever shall be operated smoothly and without application of any unnecessary force.

CPVC Valves of sizes up to 50 mm (2 inches) in diameter shall be with union ends and for valves of sizes larger than 50 mm (2 inches) in diameter shall be with flange end

7.4 Float valve

Approved quality high pressure rated Gun Metal Float Valve with copper ball float and brass rods of required length suitable for test pressure of not less than 15 Kg/sq.cm. of the desired sizes

The copper ball shall have bronze welded seams. The closing/opening mechanism incorporating the piston and cylinder shall be non-corrosive metal and include washers. The size and construction of ball valves and float shall be suitable for desired working pressure operating the supply system. Where called for brass valves shall be supplied with brass hexagonal back nuts to secure them to the tanks and a socket to connect to supply pipe.

7.5 Pressure Reducing Valve Set

Each pressure reducing valve set shall be complete with pressure reducing or pressure regulating valve, isolating valves, pressure gauges on inlet and outlet, pressure relief valve on outlet and filter on inlet.

Each pressure reducing valve shall contain loading neoprene diaphragm and a full floating, self aligning, ignition resistant seat and shall be of the single stage, pressure reduction type with provision for manually adjusting the delivery pressure. The valve shall fail safe to the low pressure.

Valves shall be capable of operating at the maintaining automatically the respective delivery pressure and flow rates as indicated and shall not be liable to creep. Valves shall also be capable of maintaining the pre-set downstream pressure under static condition.

The filter on each inlet to a pressure reducing valve shall be of replaceable porous sintered metal type. (Warranty period 12 months from date of commissioning)

7.6 Pressure Relief Valves

Each pressure relief valve shall be of the fully enclosed type and fitted with hand easing gear.

Each pressure relief valve in a pressure reducing station shall have a flow capacity equal to that of the pressure reducing valve.

Pressure relief valves in locations other than reducing stations shall have flow capacities equal to that of the associated equipment

7.7 Double Regulating Valve (Balancing Valve)

Double Regulating Valve shall be made of bronze body, bonnet ,seat & disc shall be of DZR copper Alloys ,EPDM rubber 'O' Ring seal & Plastic hand wheels to sustain Maximum operating flow temperature 200℃ & Max. Operating Pressure 16 bar (up to 45ºC). Double regulating valve shall confirm to BS 7350: 1990.

7.8 Water Hammer Arrestor

Water Hammer Arrestor shall be made of brass body, Acetal resins Diaphragm, stainless Steel Spring as per AISI 303, sustain Maximum temperature 130℃ & Max Hammer pressure of 40 bar. The water hammer arrestor shall be externally threaded to receive pipe connections. Water Hammer Arrestor Shall Confirm to ASSE 1010.

7.9 Non Return Valves

C.I. horizontal / vertical non return valve tested to a pressure not less than 15 Kg/Sqcm, Including rubber gasket, flanges, union, nuts, bolts & washers complete as required.

Non return valve shall be gun metal for sizes up to 50 mm. The valve shall be as per IS 5312. The minimum thickness of metal for bodies and covers shall be 8mm. Each valve shall carry an arrow very

prominently to indicate the direction of flow. The arrow shall be cast integrally on the body. The flange and their dimensions of drilling shall be in accordance with IS 1538

Coating:

Immediately after casting and before machining, all cast iron parts shall be thoroughly cleaned, and before rusting commences shall be coated by dipping in a bath containing a composition having a tar base and maintained at a temperature between 143 and 166 degree Celsius. The coating shall be as per IS 5312

Testing:

Hydrostatic test shall be as per IS 5312.

Valve body shall be subjected to the hydrostatic tests for a pressure of 2.4MPa (gauge) for 5 minute and valve seat for a pressure of 1.6MPa (gauge) for 2 minutes.

The material of construction of the Non Return Valves for sizes above 50 mm shall be as follows:

Component	**Material**
Body, cover, hinges and Doors	Gray cast iron : IS 210
Body Rings	Leaded tin bronze: IS 318
Bearing bushes	Leaded tin bronze: IS 318
Bolts and nuts	Carbon steel: IS 1363

7.10 Pressure Gauge

The pressure gauge shall be constructed of die cast aluminium and stove enamelled. It shall be weather proof with an IP 55 enclosure. It shall be a stainless steel Bourden tube type pressure gauge with a scale range from 0 to 16 Kg / cm square and shall be constructed as per IS:3524. Minimum dial size of 100mm. Each pressure gauge shall have a siphon tube connection with venting valve. The shut off arrangement shall be by Ball Valve with venting.

Calibration certificate shall be obtained and submitted for each pressure gauge.

7.11 Strainer

Y-type strainers shall be installed where indicated on the drawings or where specified, and shall be the same size as the pipe lines in which they are installed. The strainer bodies shall be heavy and durable, and shall be constructed of high quality with bottoms drilled and plugged, provided with isolation valve. The directional flow shall be as shown by arrow stamped on strainer body.

Each strainer shall be equipped with an easily removable cover and sediment basket. The basket shall be made of sheet brass not less than 0.63 mm thick (0.025 inch 22 gauge), with small perforations of

sufficient number to provide a net free area through the basket of at least 4 times that of the entering pipe.

Strainer at OHT out let shall be self cleaning with inbuilt ball valve for flushing/cleaning .

7.12 Thrust Block

All buried pipes to be provide with thrust blocks of cement concrete 1:2:4 (1 cement: 2 coarse sand : 4 graded stone aggregate of 20 mm nominal size) shall be constructed on all bends, change in direction as directed by the Owner's site representative.

7.13 Valve Chambers

Provision of suitable brick masonry chambers in cement mortar 1:5 (1 cement : 5 coarse sand) on cement concrete foundations 150 mm thick 1:5:10 mix (1 cement:5 fine sand : 10 graded stone aggregate 20 mm nominal size) with 15 mm thick cement plaster inside and outside finished with a plaster inside and outside finished with a floated coat of neat cement inside with cast iron surface box approved by fire brigade including excavation, back-filling complete shall be made.

The excavation for chambers shall be done true to dimension and level indicated on plans or as directed by the Owner's site representative.

Concrete shall be of cement concrete 1:3:6 (1 cement : 3 coarse sand : 6 graded stone aggregate 40 mm nominal size.

Brick shall be of class designation 75 in cement mortar 1:5 (1 cement : 5 fine sand)

Inside Plastering not less than 15 mm thick shall be done in cement mortar 1:3 (1 cement : 3 fine sand) finished with a floating coat of neat cement.

7.14 Flexible Connector

A. Flexible connectors shall be of synthetic fiber reinforced rubber, twin sphere type for flush water and 316 stainless steel bellow type for type fresh water system. Details shall be submitted to the Architect at the time of tender.
B. Pressure rating of the flexible connectors shall be the same as the system pipe work unless otherwise noted on drawings.
C. Flexible connectors shall be installed at where shown on drawings and at all pump suctions and discharges. The materials of the flexible connectors shall be suitable for the substances to be conveyed.

7.15 Puddle Flanges

G.I. puddle flanges fabricated of 750 mm long heavy class pipe pieces fixed to R.C.C. water tanks wall / slab including flanged joints with bolts, nut, washers and rubber insertion 3mm thick testing the flange and joints etc. completer for pipes of following pipe diameter. (The entire fitting shall be hot dipped galvanised (Flanges shall confirm to BS-10 Table-E)

7.16 Air Vent

Gun metal/ C.I vent with brass mosquito proof coupling and air filter including return bend, complete as required. The entire fitting shall be hot dip galvanised. Each air valve shall be provided with an isolation gun metal full way valve for size 65 mm dia and below and C.I flanged valve 80 mm dia and above.

7.17 Ferrules

The ferrules for connection with main shall generally conform to IS:2692. It shall be of non-ferrous materials with a bell mouth cover and shall be of nominal bore as specified. The ferrule shall be fitted with a screw and plug or valve capable of completely shutting of the water supply to the communication pipe, as and when required.

For fixing ferrule in cast iron mains, the empty main shall be drilled and tapped at 45 deg to the vertical and the ferrule screwed in. The ferrule must be so fitted that no portion of the shank shall be left projecting within the main into which it is fitted.

7.18 Water Meter

Water meters of approved make and design shall be supplied for installation at locations as shown. The water meters shall meet with the approval of local supply authorities. Suitable valves (isolation, strainer, NRV etc) and chambers or wall meter box to house the meters shall also the be provided along with the meters.

The meters shall conform to Indian Standard IS:779 and IS:2373. Calibration certificate shall be obtained and submitted for each water meter.

Provision shall also be made to lock the water meter. The provision shall be such that the lock is conveniently operated from the top. Where the provision is designed for use in conjunction with padlocks, the hole provided for padlocks shall be a diameter not less than 4mm.

Fixing , testing and commissioning water meter with direct reading dial in KL with all necessary fitting such as threaded pieces, unions pressure gauge, isolation cock, flanges piece for future removal, flanges / unions complete with all necessary testing charges and obtaining test certificates from municipal authorities, on following size pipe lines (1 no. strainer shall be provided at inlet & NRV at outlet cost shall be inclusive for the same).

water meters shall be located in masonry chambers of appropriate size. A pit of suitable dimension shall be dug at the point where the connection is to be made with ring main and earth removed upto 150mm below the main. The flow of water in main shall

be disconnected by operating the nearest sluice valve on the main. The main shall be drilled and slopped at 45 to the vertical and the ferrule of required size shall be screwed in. the ferrule

shall be fitted in a manner so that no portion of projection of the shank shall be left projecting within the main into which it is fitted. Ferrule shall be non ferrous material with a CI bell mouth cover and shall be of nominal bore as required.

7.19 Monorail with chain pulley block

The scope includes supply, installation, testing and commissioning of cranes consisting of 2 Ton chain pulley block, trolley and monorail conforming to IS 3832:2005.

Manual hoists shall be complete with hand-chain, trolley, pulley block, hook, hand and load chains, brake and other accessories. They shall comply with the latest applicable standards, regulations and safety codes in the locality where equipment will be installed.

Each hoist shall be operated on a monorail (I-Beam) which will be supplied and installed by the contractor. The factor of safety shall not be less than 5. The load chain may be heat-treated to give ductility, toughness and conforming to I.S. 3109/B.S. 1663/B.S. 3114. The load wheel is to be made from heavy duty malleable castings. The hand chain is to Conform with B.S. 6405:1984 and hand chain wheel may be made from pressed sheet steel with roller type guarding.

Gears shall be cut from solid cast or forged steel blanks or shall be stress–relieved welded steel construction. Pinions shall be of forged carbon or heat treated alloy steel. Strength, Quality of Steel, heat treatment, face, pitch of teeth and design shall confirm to BS-436, BS-545 and BS-721. Spur and helical gears must comply with B.S. 436 and worm with B.S. 721.

Bearing must be ball and roller type conforming to I.S. 2513 / B.S. 2525-32:1954. Proper lubricating arrangements are to be provided for bearings and pinions.

The brake for the lifting gear shall be automatic and always in action.

The proof testing of each chain pulley block is to be carried out as per latest applicable standards. The safe working load is to be marked in such way that is clearly visible from the operating level.

All components/material used shall be new. No spurious or counterfeit material/components should be used in the construction. This will be cause of straightaway rejection at any stage of the work.

The quality documents, O & M manuals and electrical drawings shall be provided and shall be available at all times at site.

All monorails shall be I-beam size ISMB 300 with material as per IS: 2062, grade-B or superior. The straightness of the beam will be suitable for crane duty and shall be as per applicable IS or equivalent standard. The I-Beam shall only be from TATA/Jindal/SAIL/equivalent.

7.20 Aluminium Step Ladder

Aluminium ladder removable type not less than 4 meter should be provided by the vendor.

7.21 Automatic water filling system and controls

a) Ultrasonic type

Auto water filling system shall be provided for water tank as shown in the drawing along with all controls, Control panel, level measuring instruments and accessories.

The level instrument shall be designed for continuous operation. The level instrument shall be of ultrasonic type consisting of non-contact type level sensor, level transmitter unit and panel mounted level indicator.

The level sensor shall be installed on the structure at the reservoir compartments. Due care shall be taken in selecting the place such that the ultrasonic beam does not get obstructed by the walls or any equipment in the structure.

The level sensor and transmitter shall be properly protected by providing metallic covers to protect it from tampering.

Temperature compensation shall be provided as necessary.

To reduce the effect of water turbulence in reservoir, averaging facility should be provided in the transmitter unit for providing steady readings.

The instrument performance and accuracy shall not be affected due to spurious reflections, absorption, temperature fluctuations, specific gravity changes, condensation and rainfall. Facilities shall be provided in the programming for rejection of spurious reflections.

Detailed specifications

General		
Service	:	Water level measurements at reservoir compartments.
Accuracy	:	± 5 mm or better
Quantity	:	Respective UGT GA drawing as attached in Tender
Level Sensor and Transmitter		
Type	:	Ultrasonic type level
Output	:	4-20 mA DC (isolated).
Mounting	:	On reservoir compartments.
Programming facility	:	Required
Display unit	:	Digital panel meter on ICP. Front facia of control section of ICP panel
Type of Display	:	LED / Backlit LCD
No. of digits	:	41/2
Unit of measurement	:	In Meters of elevation

b) Level sensors and filling system -Transfer system

Supplying, testing and commissioning automatic level controller float switch (Hi/Low) in for automatic filling as per the drawings including necessary control panel, level sensors and control cabling and inter-connection between panel & float switches.

Each probe shall be of the correct length for the particular application and tank location. Electrodes shall be of polished stainless steel 20 mm OD. Electrode holders shall be weatherproof in all respect.

The earthing probes shall be connected and wired to the building earth systems of the building.

Each set of electrodes shall be installed inside a 230 mm diameter PVC pipe acting as a wave barrier.

The level switch set shall operate with a stepped down voltage at 24V maximum. Stepped-down transformers shall be provided for each set of control probes and shall be installed inside control cubicles.

c) Level sensors and filling system - Hydro pneumatic

Supplying, testing and commissioning stand alone automatic level controller float switch (Hi/Low) in for automatic filling as per the drawings including necessary control panel, level sensors and control cabling and inter-connection between panel & solenoid/Motorised valve.

System shall be microcontroller, designed, developed and manufactured for water Tank Filling applications for water supply systems. The details shall be as per, Controls Tank Levels by operating Electrical Solenoid/Motorised Valves

Micro controller

IP65 Weatherproof Enclosure

AC Voltage Input - 230VAC

24A AC, 2A Output to operate Solenoid Valves

Output is protected with fuse

Input Connections for Low, High Float Switches

Indication for Power on, Fault, Pump On, Pump Off, Tank Full and Tank Empty.

Auto Operation based on the Float Level Switch signals.

Manual Operation Solenoid Valves through membrane type On / Off Push Buttons.

7.22 Solenoid Valves/Motorised valves

Automatic control valves shall be of the suitable sizes normally closed with reverse flow design diaphragm type with slow opening and closing action for protection against surge pressure. Actuation shall be by one-piece solenoid with captured plunger and spring

Construction shall provide for convenient access to functional parts without removal of valve from pipeline. A manual flow control adjustment, with shut-off capability shall be furnished on all valves. Valves shall have a manual internal and external bleed operation. Valve pressure rating shall not be less than 10 bars. Valve shall have a self flushing screen.

The solenoid functional parts shall be stainless steel, brass or bronze for corrosion resistance. A mechanism shall be provided for bleeding of the diaphragm chamber for manual operation. Valves shall be fabricated from heavy cast brass. Inlet and outlet shall be threaded BSP.

All valves shall be provided with a pressure regulator capable of regulating downstream pressure between 1 to 6.5 bars (within an accuracy of +/- 0.35 bar) regardless of upstream pressure. It shall provide full and accurate pressure regulating capabilities irrespective of whether it is operated electrically or manually.

7.23 Pressure switch

Non indicating type, field mounted Pressure Switches of aluminium casing (epoxy coated), and 316 SS element and accuracy of +/-1% of span, including accessories like snubbers for pump discharge applications ,name plate & mounting brackets. Material of accessories shall be SS. Auto reset micro switch with internal adjustment for set values with 2 SPDT contacts rated for 0.2 A at 220 V DC. IP 65 degree of protection for enclosure. Over range protection 50% above maximum pressure. Scale for setting shall be provided.

7.24 High pressure switch

High pressure switch should be provided at discharge line common header

HPS is provided for differential pressure arrangement. Bidder will select the HPS based on “cut-in” and “cut-out” pressure.

7.25 Execution

I. All valves shall be installed only in the upright vertical or horizontal positions unless specifically otherwise required by the drawings.
II. All valves shall be installed in accessible locations to facilitate easy removal for repair or replacement.
III. Install with operating clearance for handle and stem.
IV. Install isolation valves on equipment so that valve and piping do not interfere with equipment removal or maintenance. Install unions or flanges on equipment side of valves.
V. Provide 25mm drain valves with threaded ends for hose connections at drain points, at main shutoff valves, low points of piping systems, bases of vertical risers, and at equipment.
VI. Provide required manual or automatic vent valves at high points of piping systems to facilitate venting of air and to ensure quiet operation.
VII. Provide renewable bronze seat rings and bronze spindles for cast iron body valves.
VIII. Provide chain operated sheaves and chains for all valves which are more than 2.5m above the floor in Mechanical Equipment Rooms.
IX. Furnish and install other valves, check valves, cocks, etc., as required for the complete and proper valuing of the entire installation.
X. Install butterfly valves in horizontal piping with stem in the horizontal position so that bottom of disk lifts in the direction of flow.
XI. Install butterfly valves in vertical piping at pumps with stem perpendicular to pump shaft.

7.26 Protection against corrosion

All embedded piping material and accessories shall be suitably protected against corrosion. All embedded GI pipes shall be wrapped throughout with 1mm thick fiberglass RP tissue laid in bitumen with overlaps in joints and final coat of bitumen paint. Where GI pipes are laid under floors, trenches etc shall be encased with 100mm thick fine sand all-round in additions to the protective coating as stated above.

7.27 Measurement

All pipes above ground shall be measured per linear meter (to the nearest cm) and shall be inclusive of all fittings e.g. coupling, tees, bends, elbows, unions, flanges and U clamps with nuts, bolts & washers fixed to tall or other standard supports.

7.28 Testing

The Contractor shall notify the Architect three days in advance of any test so that the Architect can witness the tests if he so wishes.

All water supply system shall be tested to hydrostatic pressure test of at least one and a half (1.5) times the maximum pressure but not less than 10Kg/Sq.cm for a period of not less than 8 hours. All leaks and defects in joints revealed during the testing shall be rectified and got approved at site by retest. Piping required subsequent to the above pressure test shall be retested in the same manner.

System may be tested in sections and such sections shall be entirely retested on completion.

The Contractor shall make sure that proper noiseless circulation of fluid is achieved through the entire piping network of the system concerned. In case of improper circulation, the contractor shall rectify the defective connections. He shall bear all expenses for carrying out the above rectifications including the tearing up and refinishing of floors and walls as required.

In addition to the sectional testing carried out during the construction, contractor shall test the entire installation after connections to the overhead tanks or pumping system or mains. He shall rectify all leakages and shall replace all defective materials in the system. Any damage done due to carelessness, open or burst pipes or failure of fittings, to the building, furniture and fixtures shall be made good by the contractor during the defects liability period without any cost.

After commissioning of the water supply system, contractor shall test each valve by closing and opening it a number of times to observe if it is working efficiently. Valves which do not effectively operate shall be replaced by new ones at no extra cost and the same shall be tested as above.

A test register shall be maintained and all entries shall be signed and dated by Contractor(s) and Owner's site representative.

7.29 Shifting of excavated surplus material

Contractor shall make his own arrangement to shift the surplus excavated material within the site limits as directed by Engineer in charge.

8. Solar Water Heating System

a) Scope:

Supplying, storing, handling, erecting, testing and commissioning of Solar water heating system complete with Collectors, SS 304 horizontal double jacket hot water tank suitable for minimum 5.0 Kg /Sq.cm operating pressure, Heat absorbers, designed structured supports, painting, GM Valves on delivery & suction sides inlet and outlet connection with GM valves with Solar Panels, pressure & temperature gauges, capable of specified heat transferring capacity, copper thermic fluid pipes clamps, hangers etc with suitable insulation and expansion bellows of suitable temp/ pressure rating (from heat storage tanks to solar panels), testing of thermic fluid pipes, temperature controllers at primary sides to start & stop solenoid valve on primary sides, interlocked with Solar Collector to ensure complete automatic control in all respects with control panel. System shall have built in Air Venting and Anti oxidant system as required by client / consultant
It is proposed to establish compact Package Solar Water Heating System of capacity as indicated on drawings and schematics with M.S. storage tanks and copper absorber plates.

b) Process Description:

SWH shall consist of absorber, storage tank, insulation, piping and a transparent cover. Solar energy shall heat the absorber surface and water (direct) flowing through tubes attached to the absorber Heated water shall be transferred to the insulated storage tank with pump (active) convection. Transparent cover (glass or plastic) shall be placed above the absorber to reduce heat losses due to radiation and also on account of wind flowing over the absorber. Bottom and sides of the absorber shall be covered with insulation to reduce both types of heat losses. The absorber, cover and insulation shall be placed within a plastic or metal container.

c) Design of solar water heater shall be based on a collector box assembly situated below a storage tank. Within the box shall be an absorber made of black copper or S.S. sheets, to the back of which shall be attached copper pipelines. Absorber shall be covered with transparent glass and insulated at the back and sides to reduce heat losses. Collector shall work like a miniature greenhouse trapping heat that shall be transferred to the water in the pipes. Cold water shall flow from the bottom of the storage tank to the collector, from which heated water shall rise to the top of the storage tank.

d) Collector size shall be as per drawings. Collector box shall be of extruded aluminum alloy of grade 6060 T5 and finish of anodized, natural color, 15 microns. Glass retaining shall be extruded aluminum angle of thickness 1.2 mm, back sheet of aluminum 0.71 mm, riveted & sealed. Glass shall be of 4 mm thick, toughened,low iron content with 85% minimum transmissivity. Glass beading / sealing shall be of EPDM, grommets of EPDM with inside / outside locking collar, end connection of 4mm thick brass flanges with EPDM gaskets. Insulation shall be of 48 kg/m3 density mineral fiber wool with reflective foil of aluminum 50 microns. Frame corners shall be sealed from inside with silicon sealant. Frame fitment shall be click fitment without any self tapping Screws.

e) Absorber shall be of coating selective, black chrome with absorptivity 96.00 + 0.02, emissivity 0.12 + 0.02 and bonding b/w. Fin & Riser shall have Laser / Ultrasonic welding and bonding between header & riser shall have metallurgical bonding. Fin shall be of 99.9 % copper. Number of fins shall be 09 (nine), which shall be tested under suitable pressure. Header shall be of 99.9% + 0.01 copper -25mm x 22 SWG and riser of 99.9% + 0.01 Copper – 12mm x 24 SWG.

f) Solar water heaters shall be installed on a shadow-free roof with sufficient strength to carry the collector and storage tank. There shall be provision to adjust the inclination of the collector to receive maximum solar radiation, a drain plug to flush the system, an air vent to release air locks and proper supports and piping.

g) Tanks :

Solar hot water tanks shall be fabricated from heavy gauge stainless steel (S.S. 304) sheets. Necessary inlet, outlet and drain connections shall be provided along with makeup float valve, water level gauge tube, 75mm dia. vent connection and an access manhole not less than 450mm dia.

Tank shall be insulated and cladded with 28 gauge aluminium sheets. Tank can be either vertical or horizontal subject to the space availability at site.

h) Pumps :

Solar water circulating pumps shall be mono block type with cast iron body and bronze impellers mounted on stainless steel shaft running in sleeve/ ball/ roller bearings with suitable high temperature lubrication. Discharge end of the pumps shall have seal trust bearings while the inlet end shall have mechanical seals and flexible coupling. Net Positive Suction Head requirements of the pumps shall be sufficiently within the maximum N.P.S.H. available so as to avoid cavitation and vapour locking. Pumps shall be connected to 1500 rpm., T.E.F.C. ball bearing motors, factory mounted and aligned on common base. Pumps shall be provided with coupling guards, test and/or air vent cocks, suction and discharge shut off valves, discharge check valves, suction Y-strainers with brass screen, flexible connectors and pressure gauges at suction and all other standard accessories
whether specified or not. Pumps, fittings and accessories shall be insulated.

i) Piping :

All piping, fittings, valves, strainers, insulation shall be as specified in Section B for Water Supply Piping.

j. Insulation and Wrapping

All hot water supply and solar hot water system tanks shall be insulated in the manner
specified hereinafter

1. Closed cell Elastomeric Foam Insulation

Elastomeric foam insulation shall be used with an insulating value of not more than0.038 W/mK. Valves, fittings and all other appurtenances through which water passes shall be insulated with mitred sections of preformed insulation of a thickness equal to the insulation on the adjoining pipe. Permeability factor shall be greater than or equal to 7000. Density shall be between 65 to 80 kg/m3. Fire rating per BS Part 7 shall be minimum Class 1, surface spread of flame shall be to BS 476 Part 5 - Class P and fire propagation shall be to BS 476 Part 6 - Class O. Water vapor permeability shall be maximum 0.09 microgram/N.h.

2. Elastomeric foam insulation shall be installed under supervision.

3. Insulation supplier shall provide thickness calculations. The minimum thickness shall be 19mm. The thickness calculation shall minimize heat loss and prevent condensation.

9. Storage Tanks and Connections

The contractor shall provide all inlets, outlets, washouts, vents, ball cocks, overflows control valves and all such other piping connections including level indicator to water storage tanks as called for. All pipes crossing through RCC work shall have puddle flanges fabricated from GI pipes of required size and length and welded to 8 mm thick GI plate. All puddle flanges must be fixed in true alignment and level to ensure further connection in proper order.

The overflow pipe shall be so placed to allow the discharge of water being readily seen. The overflow pipe shall be of size as indicated.

Expansion joints shall be used only in those cases where anticipated thermal expansion will cause the line or tank to be over-stressed.

The following provisions should be made by the plumbing contractor in the Water Storage Tank

1) Manhole cover.
2) Manhole with double sealed manhole cover insecticide department approved..
3) Inlets, outlets over flows, drains and insect proof vent cowls as required on Drawings.

Puddle Flanges

Puddle flanges fabricated of 750 mm long pipe pieces to R.C.C. water tanks wall / slab. The entire fitting shall be hot dipped galvanised (Flanges shall confirm to BS10 Table E).

GI Vent

GI vent with brass mosquito proof coupling and air filter including return bend, complete as required. The entire fitting shall be hot dip galvanised.

Cover

Cast Iron manhole cover and frame as per IS:1726 Suitable for 560mm diameter, manhole with lockable and lifting arrangement. The entire item shall be epoxy coated and approved by insecticide department. Light Duty double seal for OHT and heavy duty double seal for UGT

PVC Foot rests for Water Tanks

Providing and fixing safely foot rest of required shape of minimum 6 mm thick plastic encapsulated as per IS 10910 on 12mm dia steel bar as per IS 1786 having minimum cross section as 23mm x 25mm overall minimum length 263 mm nad width as 165 mm with minimum 112 mm space between protruded legs having 2mm tread on top surface by ribbing besides necessary and adequate anchoring projection on tail length of 138 mm and suitable to withstand and bend test and chemical resistance test as per manufacturer specification.

Preferably footrest shall be fixed before concreting of walls for UG tank or fixed cement concrete 1:2:4 mix with proper anchoring.

Tank fittings

A. Overflow pipes shall be:

1) Dipped down inside tanks so as to terminate in a position maximum 150mm above bottom of tanks.
2) Provided with metal hinged flaps at outlets.
3) Discharge in conspicuous position.

B. Strainers with Anti-vortex Plate shall be:

1) 3mm thick brass strainer
2) With 3mm thick galvanized mild steel anti-vortex plates
3) With total perforation area of 3mm maximum diameter holes not less than twice of the cross section area of pump suction pipe.
4) Self cleaning strainer with built-in ball valve

Connections to RCC water tanks

The contractor shall provide all inlets, outlets, washouts, vents, ball cocks, overflows control valves and all such other piping connections including level indicator to water storage tanks as called for. All pipes crossing through RCC work shall have puddle flanges fabricated from GI pipes of required size and length and welded to 8 mm thick G.I plate. All puddle flanges must be fixed in true alignment and level to ensure further connection in proper order. All sleeves up to 50 mm shall be G.I treaded.

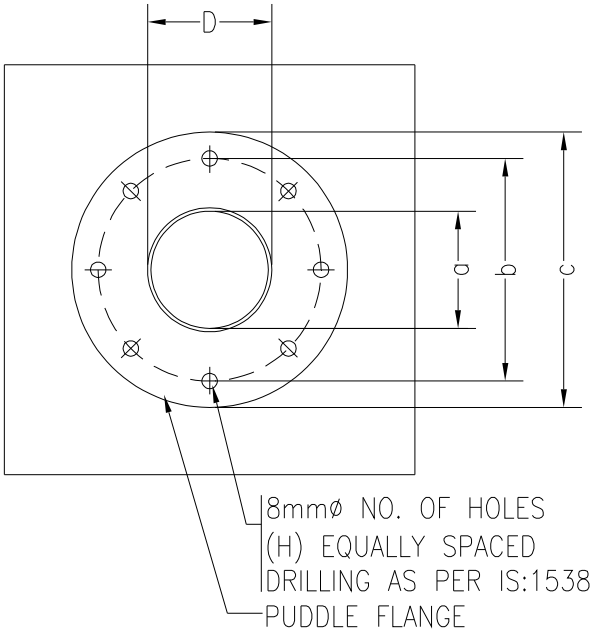
Full way gate valves of a approved make shall be provided as near the tank as practicable on every outlet pipe from the storage tank except the overflow pipe. Overflow and vent pipes shall terminate with mosquito proof mesh.

Plate Size			
Sr. No	Dia. Of Pipe	Size of Plate	Thickness
1	Upto 150 dia.	150+D+150mm	8mm
2	200 dia.	200+D+200mm	8mm
3	300 dia.	200+D+200mm	8mm

Puddle Flanges

The contractor shall provide all inlets, outlets, washouts, vents, ball cocks, overflows Control valves and all such other piping connections including level indicator to water Storage tanks as called for. All pipes crossing through RCC work shall have puddle flanges Fabricated from GI pipes of required size and length and welded to 8mm thick G.I plate. All puddle flanges must be fixed in true alignment and level to ensure further connection in proper order.

Schedule of Flanges					
Flange as per IS : 1538 (Part-IV)					
Sr. No.	Description	a	b	c	No. of Holes
1	65 dia. Pipe	65 dia.	140	175	4
2	80 dia. Pipe	80 dia.	150	190	4
3	100 dia. Pipe	100 dia.	190	225	8
4	150 dia. Pipe	150 dia.	250	300	8
5	200 dia. Pipe	200 dia.	300	350	8
6	250 dia. Pipe	250 dia.	350	400	12
7	300 dia. Pipe	300 dia.	400	450	12



EXECUTION

Tank Disinfection

I. Disinfect all potable water tanks including concrete water tanks according to the following method:
II. A solution of 200-mg/L available chlorine shall be applied directly to the surfaces of all parts of the storage facility that would be in contact with water when the storage facility is full to the overflow elevation.
III. The chorine solution may be applied with suitable brushes or spray equipment. The solution shall thoroughly coat all surfaces to be treated, including the inlet and outlet piping, and shall be applied to any separate drain piping such that it will have available chlorine of not less than 10mg/L when filled with water. Overflow piping need not be disinfected.

IV. The disinfected surfaces shall remain in contact with the strong chlorine solution for at least 30-min. after which potable water shall be admitted, the drain piping shall be purged of the 10-mg/L chlorinated water, and the storage facility shall then be filled to its overflow level. Following this procedure, and subject to satisfactory bacteriological testing and acceptable aesthetic quality, water may be delivered to the distribution system.

V. The final parameters of the tank water should match the parameters of the inlet water of the overhead tank.

10. Earth works, Civil, Concrete and Allied works

10.1 CHAPTER 1: Earth works

Scope

This specification covers the general requirements of earthwork in excavation in different materials, site grading, filling in areas, filling back around foundations and in plinths, conveyance and disposal of surplus soils or stacking them properly as shown on the drawings and as directed by the ENGINEER-IN-CHARGE and all operations covered within the intent and purpose of this specification.

Applicable codes

The more important Codes, Standards and Publications applicable to this section are listed hereinafter:

IS 1200	Method of measurement of building and civil engineering works.
(Part 1)	Part 1 Earthwork
(Part 27)	Part 27 Earthwork done by mechanical appliances.
IS 3764	Excavation work-code of safety.
IS 2720	Methods of test for soils:
(Part 1)	Part 1 Preparation of dry soil samples for various tests.
(Part 2)	Part 2 Determination of water content.
(Part 3)	Part 4 Grain size analysis.
(Part 5)	Part 5 Determination of liquid and plastic limit.
(Part 7)	Part 7 Determination of water content-dry density relation using light compaction.
Part (9)	Part 9 Determination of dry density - moisture content relation by constant weight of soil method.
(Part 14)	Part 14 Determination of density index (relative density) of cohesionless soils.
(Part 28)	Part 28 Determination of dry density of soils in place, by the sand replacement method.
(Part 33)	Part 33 Determination of the density in place by the ring and water replacement method.
(Part 34)	Part 34 Determination of density of soil in place by rubber balloon method.
(Part 38)	Part 38 Compaction control test

Drawings

the engineer-in-charge will furnish drawings wherever, in his opinion, such drawings are required to show areas to be excavated/ filled grade level, sequence of priorities etc. the contractor shall follow strictly such drawings.

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 EMPLOYER'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 8m 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 within the lead specified and levelling the same so as to provide natural drainage. Rock/soil excavated shall be stacked properly as approved by the

ENGINEER-IN-CHARGE. 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. Rock shall be stacked separately.

Top soil shall be stock piled separately for later re-use.

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 ENGINEER-IN-CHARGE. Where earthfill is intended, the area shall be stripped of all loose/ soft patches, top soil containing objectionable matter/ materials before fill commences.

Precious objects, Relics, Objects of antiquity, etc.

All gold, silver, oil, minerals, archaeological and other findings of importance, trees cut or other materials of any description and all precious stones, coins, treasures, relics, antiquities and other similar things which may be found in or upon the site shall be the property of the EMPLOYER and the CONTRACTOR shall duly preserve the same to the satisfaction of the EMPLOYER and from time to time deliver the same to such person or persons as the EMPLOYER may from time to time authorize or appoint to receive the same.

Classification

All materials to be excavated shall be classified by the ENGINEER-IN-CHARGE, into one of the following classes and shall be paid for at the rate tendered for that particular class of material. No distinction shall be made for the water content in the excavated material that is dry/ wet shall be treated as same. The decision of the ENGINEER-IN-CHARGE regarding the classification of the material shall be final and binding on the CONTRACTOR.

For measurement / payment purpose, earthwork shall be classified under any of the following categories:-

I) Ordinary and Hard Soils

These shall include all kinds of soils containing kankar, sand, silt, murrum and/or shingle, gravel, clay, loam, peat, ash, shale, etc., which can be generally

(a) Manually excavated by spade, pick axes and shovel

(b) Mechanically excavated by Poclain under maximum bucket digging force of 13.5KN and

(c) which are not classified under "Soft and Decomposed Rock" and "Hard Rock" defined in clause

This shall also include embedded rock boulders not longer than 1 metre in any one direction and not more than 200mm in any one of the other two directions.

II) Soft / Decomposed/ highly fractured Rock

This shall include Rock, boulders (larger than stated in clause 7.2.1), slag, chalk, slate, hard micaschist, laterite and all other materials requiring mechanical excavation and are having:-

(a) Unconfined Compressive Strength (UCS) value less than 125 Kg/cm^2

(b) Closely spaced fractures within 200mm distance and joint openings of more than 1mm.

(c) Degree of weathering as highly to completely weathered rock

(d) in the opinion of ENGINEER-IN-CHARGE is rock, but does not need blasting and could be removed

i) Manually with picks, hammer, crow bars, wedges,

ii) Mechanically with pneumatic breakers or hydraulic breakers under maximum hydraulic operating pressure of 122 bars.

The mere fact that the CONTRACTOR resorts to blasting for reasons of his own, shall not qualify for classification under 'Hard Rock'.

This shall also include excavation in macadam and tarred roads and pavements. This shall also include rock boulders not longer than 1 metre in any direction and not more than 500 mm in any one of the other two directions. Masonry to be dismantled will also be measured under this item.

Hard Rock

This shall include all rock occurring in large continuous masses which cannot be removed except by blasting and cannot be covered under the description specified in the above clause I& II

Hard rock is a rock requiring mechanical excavation and are having:-

(a) UCS value 125 Kg/cm^2 and above

(b) Continuous sheet of mass

(c) Degree of weathering as moderately / slightly / fresh

(d) Requiring blasting

(e) Mechanically with hydraulic breakers under hydraulic operating pressure above 122 bars

Concrete work, both reinforced and unreinforced, to be dismantled will be measured under this item, unless a separate provision is made in the Schedule of Quantities

Excavation

All excavation work shall be carried out by mechanical equipment unless, in the opinion of ENGINEER-IN-CHARGE, the work involved requires it to be carried out by manual methods.

Excavation for permanent work shall be taken out to such widths, lengths, depths and profiles as are shown on the drawings provided by the CONTRACTOR or such other lines and grades as may be agreed with the ENGINEER-IN-CHARGE. 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 lean concrete as approved by the ENGINEER-IN-CHARGE. 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 drawings provided by the CONTRACTOR as agreed with the ENGINEER-IN-CHARGE. Should any excavation be taken below the specified elevations, the CONTRACTOR shall fill it up with concrete of the same class as in the foundation resting thereon, upto the required elevation at no cost to the EMPLOYER.

All excavations shall be to the minimum dimensions required for safety and ease of working. Prior approval of the ENGINEER-IN-CHARGE 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. Excavation shall be carried out with such tools, tackles and equipment as described herein before. Blasting or

other methods may be resorted to in the case of hard rock; however not without the specific permission of the ENGINEER-IN-CHARGE.

The ENGINEER-IN-CHARGE may also direct that in some extreme case, the rock may be excavated by heating and sudden quenching for splitting the rock. Fire-wood shall be used for burning and payment shall be made for such work as called for in the schedule of quantities.

Dewatering

During the excavation, if subsoil water is met with CONTRACTOR shall provide necessary equipment and laborers for dewatering the trenches. The CONTRACTOR shall also make necessary arrangement for the disposal of drained water to nearby storm water drain or in a pit if allowed by the ENGINEER-IN-CHARGE. In no case the water shall be allowed to spread over the adjoining area. Before discharging this water into public sewer/drain, the CONTRACTOR shall take necessary permission from the local authorities.

Stripping loose 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 ENGINEER-IN-CHARGE, to fall or otherwise endanger the workmen, equipment, or 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 the 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 ENGINEER-IN-CHARGE, is likely to become loose or unstable later, shall also be promptly and satisfactorily removed.

Fill, Back filling and Site grading

General

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

No earth fill shall commence until surface water discharges and streams have been properly intercepted or otherwise dealt with to the approval of the ENGINEER-IN-CHARGE.

Material

To the extent available, selected surplus soils from excavations as approved by the ENGINEER-IN-CHARGE 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. 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 murum or earth to fill the voids and the mixture used for filling. If fill material is required to be borrowed, 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 ENGINEER-IN-CHARGE. 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 off as directed by ENGINEER-IN-

CHARGE. The CONTRACTOR shall provide the necessary access roads to borrow areas and maintain the same if such roads do not exist.

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

As soon as the work in foundations has been accepted and measured, 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, before the succeeding one is laid. Each layer shall be consolidated to the satisfaction of ENGINEER-IN-CHARGE. Earth shall be rammed with approved mechanical compaction machines. Usually no manual compaction shall be allowed unless the ENGINEER-IN-CHARGE is satisfied that in some cases manual compaction by tampers cannot be avoided. The final backfill surface shall be trimmed and levelled to a proper profile to the approval of the ENGINEER-IN-CHARGE.

Plinth Filling

Plinth filling shall be carried out with approved material as described hereinbefore in layers not exceeding 15cm, watered and compacted with mechanical compaction machines. The ENGINEER-IN-CHARGE may, however, permit manual compaction by hand tampers where he is satisfied that mechanical compaction is not possible. 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 the plinth fill shall 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 ENGINEER-IN-CHARGE. 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 case be upto a maximum of 300mm. 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 ENGINEER-IN-CHARGE obtained prior to commencing filling.

Rolling shall commence from the outer edge and progress towards the centre and continue until compaction is to the satisfaction of ENGINEER-IN-CHARGE, 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.

Sand Filling

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 ENGINEER-IN-CHARGE has inspected and approved the fill.

Filling in Trenches

Filling in trenches for pipes and drains shall be commenced as soon as the joints of pipe and drains have been tested and passed. The backfilling material shall be properly consolidated by watering and ramming, taking due care that no damage is caused to the pipes.

Where the trenches are excavated in soil, the filling from the bottom of the trench to the level of the centre line of the pipe shall be done by hand compaction with selected approved earth in layers not exceeding 8 cm; backfilling above the level of

the centre line of the pipes shall be done with selected earth by hand compaction, or other approved means in layers not exceeding 15 cm.In case of excavation of trenches in rock, the filling upto a level 30 cm above the top of the pipe shall be done with fine materials such as earth, murum, etc. The filling up to the level of the centre line of the pipe shall be done by hand compaction in layers not exceeding 8 cm whereas the filling above the centre line of the pipe shall be done by hand compaction or approved means in layers not exceeding 15 cm. The filling from a level 30 cm above the top of the pipe to the top of the trench shall be done by hand or other approved mechanical methods with broken rock filling of size not exceeding 15 cm mixed with fine material as available to fill up the voids.

Filling of the trenches shall be carried out simultaneously on both sides of the pipe to avoid unequal pressure on the pipe.

General site Grading

Site grading shall be carried out as indicated in the drawings and as directed by the ENGINEER-IN-CHARGE. Excavation shall be carried out as specified in the specification. Filling and compaction shall be carried out as specified under Clause 10.0 and elsewhere unless otherwise indicated below.

The fill shall be placed in layers not exceeding 150 mm and leveled uniformly and compacted before the next layer is deposited.

Field compaction tests shall be carried out in each layer of filling until the fill to the entire height has been completed. 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.

The fill shall be carried out to such dimensions and levels as indicated on the drawings after the stipulated compaction. The fill will be considered as incomplete if the desired compaction has not been obtained.

If so specified, the rock as obtained from excavation may be used for filling and leveling to indicate grades without further breaking. In such an event, filling shall be done in layers not exceeding 50 cm approximately. After rock filling to the approximate level, indicated above has been carried out, the void in the rocks shall be filled with finer materials such as earth, broken

stone, etc. and the area flooded so that the finer materials fill up the voids. Care shall be taken to ensure that the finer fill material does not get washed out. Over the layer so filled, a 100 mm thick mixed layer of broken material and earth shall be laid and consolidation carried out by a 12 ton roller. No less than twelve passes of the roller shall be accepted before subsequent similar operations are taken up.

Fill Density

The compaction, where no higher standard of compaction is specified or shown on the drawings, shall comply with minimum 95% of maximum laboratory dry density as per IS 2720 (Part 8) 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.

Timber Shoring

Timber shoring shall be required to keep the sides of excavations vertical to ensure safety of adjoining structures or to limit the slope of excavations, or due to space restrictions or for other reasons. Such shoring shall be carried out, except in an emergency, only under instructions from the ENGINEER-IN-CHARGE.

The withdrawal of the timber shall be done carefully to prevent the collapse of the pit or trench. It shall be started at one end and proceeded with, systematically to the other end. Concrete or masonry shall not be damaged during the removal of the timber.

In the case of open timbering, the entire surface of the side of trench or pit is not required to be covered. The vertical boards of minimum 25 cm x 4 cm sections shall be spaced sufficiently apart to leave unsupported strips of maximum 50 cm average width.

The detailed arrangement, sizes of the timber and the spacing shall be subject to the approval of the ENGINEER-IN-CHARGE. In all other respects, the EMPLOYER's Requirements for close timbering shall apply to open timbering.

In case of large pits and open excavations, where shoring is required for securing safety of adjoining structures or for any other reasons and where the planking across sides of excavations/pits cannot be strutted against, suitable inclined struts supported on the excavated bed shall be provided. The load from such struts shall be suitably distributed on the bed to ensure no yielding of the strut.

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 ENGINEER-IN-CHARGE.

Lead

Lead for deposition/ disposal of excavated material, shall be as specified in the respective item of work. For the purpose of measurement of lead, the area to be excavated or filled or area on which excavated material is to be deposited/ disposed off shall be divided into suitable blocks and for each of the blocks, the distance between center lines shall be taken as the lead which shall be measured by the shortest straight line route on the plan and not the actual route taken by the

CONTRACTOR. No extra compensation is admissible on the grounds that the lead including that for borrowed material had to be transported over marshy or 'katcha' land/ route.

QUALITY CONTROL TESTS DURING CONSTRUCTION

The materials used and the works carried out by the CONTRACTOR shall conform to the EMPLOYER's Requirements prescribed in the preceding clauses.

All quality control tests shall be carried out by the CONTRACTOR under the supervision of the authorized representative of ENGINEER-IN-CHARGE. The results of all completed tests shall be made available to the ENGINEER-IN-CHARGE. The CONTRACTOR shall set up at site, a soil laboratory to carry out all tests and shall provide all equipment, tools, materials and labour for carrying out the same. The testing frequencies specified herein are the minimum but the ENGINEER-IN-CHARGE shall have the full authority to carry out tests as frequently as he may deem necessary to satisfy himself that the materials and works comply with the EMPLOYER's Requirements.

Moisture content Test - One test for every 1000 cubic meters or part thereof of fill.

Compaction Control Tests - A minimum of one measurement

of field density for each 500 sq meters of the compacted area of each layer, or closer as required to yield the minimum number of test results for evaluating a day's work on statistical basis. The determination of field density shall be done in accordance with IS 2720 (Part 28 or 29). Test locations shall be chosen only through random sampling techniques. Control shall not be based on the result of any one test but on the mean value of a set of 5-10 density determinations. The number of tests in one set of measurements shall be 5 as long as it is felt that sufficient control over material and the method of compaction is being exercised by the CONTRACTOR. If considerable variations are observed between individual density results, the minimum number of tests in one set of measurement shall be increased to 10. The acceptance of work shall be subjected to the condition that the mean dry density equals or exceeds the specified density and the deviation for any set of results is below 0.08 gm/cc.

Quality Control Tests at Borrow Pit

At least two boreholes of 6.0 m deep shall be drilled and two trial pits of 2m x 2m x 3m size to be excavated for each 100 m x 100 m area or part thereof. Undisturbed soil samples (90 mm dia and 450 mm long) shall be obtained at every 2.0 mt depth interval or at change of soil formation whichever is less in bore hole. Also from each trial pit at least one representative undisturbed sample shall be collected. All samples collected shall be tested in an approved laboratory to confirm the required characteristics specified in the document.

MEASUREMENT AND PAYMENT

All excavation shall be measured in cubic metre basis. Dimensions for purpose of payment shall be reckoned on the horizontal area of the excavation at the base for foundations of the walls, columns, footings, tanks, rafts or other foundations/ structures to be built, multiplied by the mean depth from the surface of the ground in accordance with the drawings. Excavation in side slopes will not be paid for. The CONTRACTOR may make such allowance in his rates to provide for excavation in side slopes keeping in mind the nature of the soil and safety or excavation.

Reasonable working space, beyond concrete dimensions and shuttering where considered necessary in the opinion of the ENGINEER-IN-CHARGE will be allowed in excavation and considered for payment. However, if concreting is proposed against the excavated sides, no such over-excavation will be permitted. In such cases over-excavation shall be made good by the CONTRACTOR with concrete of the same class as in the foundations at his cost.

Unless otherwise specified, the unit rates quoted for excavation in different types of material shall also account for a basic lead of 100 meters for disposal as specified or directed. Only leads beyond the basic lead of 100 meters will be considered as extra lead and paid for at the rates quoted in the schedules.

Backfilling as per specification the sides of foundations of columns, footings, structures, walls, tanks, rafts, trenches, etc. with excavated material will not be paid for separately. It shall be clearly understood that the rate quoted for excavation including backfilling shall include stacking of excavated material as directed, excavation/ packing of selected stacked material, conveying it to the place of final backfill, compaction etc. as specified. As a rule material to be backfield shall be stacked temporarily within the basic lead of 100 meters unless otherwise directed by the ENGINEER-IN-CHARGE. If the ENGINEER-IN-CHARGE directs/ permits a lead of over 100 meters for such material, the conveyance of the material for the extra distance over the basic lead of 100 meters for backfilling will be paid for.

Payment for fill inside trenches, plinth or similar filling with selected excavated material will be made for only compaction as specified/ directed. Cost of all other operations shall be deemed to have been covered in the rate quoted for excavation. Payment for this work will be made based on measurement of plinth/ trench dimensions filled.

Backfilling, plinth filling etc. with borrowed earth will be paid for at rates quoted. The quoted rate shall include all operations such as clearing, excavation, lead and transport, fill, compaction, etc. as specified. Actual quantity of consolidated filling or actual quantity or excavation in the borrow pits (less such top soil which has been excavated and not used for filling) whichever is less shall be measured and paid for in cubic meters. The lead, lift etc. shall be as indicated in the schedule of quantities.

Actual quantity of consolidated sand filling shall be measured and paid in cubic meters.

The measurement of wooden shoring shall be on sq.m basis of actual area of trench/pit supported and removal after laying water pipeline in case of the wooden shoring is left in the trench as directed by ENGINEER-IN-CHARGE, it shall be measured on cubic meter basis of wood left in the trench. payment for shoring, wooden or MS plate for trenches or pits shall be on sqm basis of actual area protected.

10.2 CHAPTER 2 : Concrete and Allied works scope

10.2.1 Materials

This Specification covers the general requirements for ready mixed concrete and for concrete using on-site production facilities including requirements in regard to the quality, handling, storage of ingredients, proportioning, batching, mixing, transporting, placing, curing, protecting, repairing, finishing and testing of concrete; formwork; requirements in regard to the quality, storage, bending and fixing of reinforcement; grouting as well as mode of measurement and payment for completed works.

It shall be very clearly understood that the specifications given herein are brief and do not cover minute details. However, all works shall have to be carried out in accordance with the relevant standards and codes of practices or in their absence in accordance with the best accepted current Engineering practices or as directed by ENGINEER-IN-CHARGE from time to time. The decision of ENGINEER-IN-CHARGE as regards the specification to be adopted and their interpretation and the mode of execution of work shall be final and binding on CONTRACTOR and no claim whatsoever will be entertained on this account.

10.2.2 APPLICABLE CODES

The following specifications, standards and codes, including all official amendments/revisions and other specifications & codes referred to therein, should be considered a part of this specification. In all cases the latest issue/edition/revision shall apply. In case of discrepancy between this specification and those referred to herein below or other specifications forming a part of this bid document, this specification shall govern.

10.2.2.1 Materials

a)	IS: 269	Specification for 33 grade ordinary portland cement
b)	IS: 455	Specification for portland slag cement.
c)	IS: 1489	Specification for portland-pozzolana cement (Part 1&2).
d)	IS: 8112	Specification for 43 grade ordinary portland cement
e)	IS: 12269	Specification for 53 grade ordinary portland cement.
f)	IS: 12330	Specification for sulphate resisting portland cement.
g)	IS: 383	Specification for coarse and fine aggregates from natural sources for concrete.
h)	IS: 432	Specification for mild steel and medium (tensile steel bars and hard-drawn steel) wires for concrete reinforcement. (Part 1 and 2)
i)	IS: 1786	Specification for high strength deformed steel bars and wires for concrete reinforcement.
j)	IS: 1566	Specification for hard-drawn steel wire fabric for concrete

		reinforcement.
k)	IS: 9103	Specification for admixtures for concrete.
l)	IS: 2645	Specification for integral cement water- proofing compounds
m)	IS: 4990	Specification for plywood for concrete shuttering work.

10.2.2.2 Material Testing

a)	IS: 4031	Methods of physical tests for hydraulic cement (Parts 1 to 15)
b)	IS: 4032	Method chemical analysis of hydraulic cement.
c)	IS: 650	Specification for standard sand for testing of cement.
d)	IS: 2430	Methods for sampling of aggregates for concrete.
e)	IS: 2386	Methods of test for aggregates for concrete (Parts 1 to 8)
f)	IS: 3025	Methods of sampling and test (physical and chemical) for water used in industry.
g)	IS: 6925	Methods of test for determination of water soluble chlorides in concrete admixtures.

10.2.2.3 Material Storage

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

10.2.2.4 Concrete Mix Design

a)	IS: 10262	Recommended guidelines for concrete mix design.
b)	SP:23	Handbook on Concrete Mixes

10.2.2.5Concrete Testing

a)	IS:1199	Method of sampling and analysis of concrete.
b)	IS:516	Method of test for strength of concrete.
c)	IS: 9013	Method of making, curing and determining compressive strength of accelerated cured concrete test specimens.

d)	IS: 8142	Method of test for determining setting time of concrete by penetration resistance.
e)	IS:9284	Method of test for abrasion resistance of concrete.
f)	IS:2770	Methods of testing bond in reinforced concrete.

10.2.2.6 Equipments

IS:1791	Specification for batch type concrete mixers.
IS:2438	Specification for roller pan mixer.
IS:4925	Specification for concrete batching and mixing plant.
IS:5892	Specification for concrete transit mixer and agitator.
IS:7242	Specification for concrete spreaders.
IS:2505	General Requirements for concrete vibrators: Immersion type.
IS:2506	General Requirements for screed board concrete vibrators.
IS:2514	Specification for concrete vibrating tables.
IS:3366	Specification for pan vibrators.
IS:4656	Specification for form vibrators for concrete.
IS:11993	Code of practice for use of screed board concrete vibrators.
IS:7251	Specification for concrete finishers.
IS:2722	Specification for portable swing weigh batchers for concrete (single and double bucket type).
IS:2750	Specifications for steel scaffoldings.

10.2.2.7 Codes of Practice

IS:456	Code of practice for plain and reinforced concrete.
IS:457	Code of practice for general construction of plain and reinforced concrete for dams and other massive structures.
IS:3370	Code of practice for concrete structures for storage of liquids (Parts 1 to 4)
IS:3935	Code of practice for composite construction.
IS:2204	Code of practice for construction of reinforced concrete shell roof.
IS:2210	Criteria for the design of reinforced concrete shell structures and folded plates.
IS:2502	Code of practice for bending and fixing of bars for concrete reinforcement.
IS:5525	Recommendation for detailing of reinforcement in reinforced concrete works.

IS:2751	Code of practice for welding of mild steel plain and deformed bars used for reinforced concrete construction.
IS:9417	Specification for welding cold worked bars for reinforced concrete construction.
IS:3558	Code of practice for use of immersion vibrators for consolidating concrete.
IS:3414	Code of practice for design and installation of joints in buildings.
IS:4326	Code of practice for earthquake resistant design and construction of buildings.
IS:4014	Code of practice for steel tubular scaffolding. (Parts 1 & 2)
IS:2571	Code of practice for laying in situ cement concrete flooring
IS:7861	Part1 - Recommended practice for hot weather concreting
	Part2 – Recommended practice for cold weather concreting
IS:3370	Code of practice for concrete structures for the storage of liquid (Part I to IV)

10.2.2.8 Construction Safety

IS:3696	Safety code for scaffolds and ladders.(Parts 1 & 2)
IS:7969	Safety code for handling and storage of building materials.
IS:8989	Safety code for erection of concrete framed structures.

10.2.2.9 Measurement

IS:1200 Part (1 to 12)	Method of measurement of building and Engineering works (Part 2 and 5)

10.2.3 General

The ENGINEER-IN-CHARGE 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 ENGINEER-IN-CHARGE'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 EMPLOYER's Requirements shall be rejected.

Materials should be selected so that they can satisfy the design requirements of strength, serviceability, safety, durability and finish with due regards to the functional requirements and the environmental conditions to which the structure will be subjected. Materials complying with codes/standards shall generally be used. Other materials may be used after approval of the ENGINEER-IN-CHARGE and after establishing their performance suitability based on previous data, experience or tests.

10.2.3.4 Materials

Cement

Unless otherwise called for by the ENGINEER-IN-CHARGE, Cement shall be ordinary cement conforming to IS: 269 / IS: 455 for Water Supply, Irrigation & storm water drainage works and Sulphate Resisting Portland cement conforming to IS: 12330 for sewerage works. Cement shall be kept in clean dry, moisture-proof covered stores. It shall be adequately protected from condensation, rising damp and atmospheric moisture.

Where portland pozzolana or slag cements are used, it shall be ensured that consistency of quality is maintained, there will be no adverse interactions between the materials and the finish specified is not marred.

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

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

Aggregates

Aggregates shall consist of naturally occurring stones (crushed or uncrushed), gravel and sand. They shall be chemically inert, strong, hard, clean, durable against weathering, of limited porosity, free from dust/silt/ organic impurities/deleterious materials and conform to IS: 383. Aggregates such as slag, crushed over burnt bricks, bloated clay ash, sintered fly ash and tiles shall not be used.

Aggregates shall be washed and screened before use where necessary or if directed by the ENGINEER-IN-CHARGE.

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

The fineness modulus of sand shall neither be less than 2.2 nor more than 3.2.

The maximum size of coarse aggregate shall be as stated on the drawings but in no case greater than 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.

Water

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

The pH value of water shall not be less than 6.

Seawater shall not be used for concrete mixing and curing.

Reinforcement

Reinforcement bars shall conform to IS: 432 and/ or IS: 1786 and welded wire fabric to IS: 1566.

All reinforcement shall be clean, free from pitting, oil, grease, paint, loose mill scales, rust, dirt, dust or any other substance that will destroy or reduce bond.

Special precaution like coating of reinforcement may be provided with the prior approval of ENGINEER-IN-CHARGE.

Wastage

Wastage allowance for cement and steel shall be as specified under Instruction to Bidders.

Samples and Tests

All materials used for the works shall be tested before use. The frequency of such confirmatory tests shall be decided by ENGINEER-IN-CHARGE.

Manufacturer's test certificate shall be furnished for each batch of cement/steel and when directed by ENGINEER-IN-CHARGE samples shall also be got tested by the CONTRACTOR in a laboratory approved by ENGINEER-IN-CHARGE at no extra cost to EMPLOYER. However, where material is supplied by EMPLOYER, all testing charges shall be borne by EMPLOYER, but transportation and preparation of material samples for the laboratory shall be done by CONTRACTOR at no extra cost.

Sampling and testing of aggregates shall be as per IS: 2386 under the supervision of ENGINEER-IN-CHARGE. The cost of all tests, sampling, etc. shall be borne by CONTRACTOR. For coarse aggregate crushing value shall be tested.

Water to be used shall be tested to comply with clause 5.4 of IS: 456.

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.

Storing of Materials

All materials shall be stored in a manner so as to prevent its deterioration and contamination which would preclude its use in the works. Requirements of IS: 4082 shall be complied with.

The CONTRACTOR will have to make his own arrangements for the storage of adequate quantity of cement. If such cement is not stored properly and has deteriorated, the material shall be rejected. Cement bags shall be stored in dry weatherproof shed with a raised floor, well away from the outer walls and insulated from the floor to avoid moisture from ground. Not more than 15 bags shall be stacked in any tier. Storage arrangement shall be approved by the ENGINEER-IN-CHARGE. Storage under tarpaulins shall not be permitted. Each consignment of cement shall be stored separately and consumed in its order of receipt.

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

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

The reinforcement shall be stacked on top of timber sleepers to avoid contact with ground/water. Each type and size shall be stacked separately.

10.2.5 Concrete

General

Concrete grade shall be as designated on drawings. Concrete in the works shall be “DESIGN MIX CONCRETE” OR “NOMINAL MIX CONCRETE”. All concrete works of up to grade M15 shall be nominal mix concrete whereas all other grades, M20 and above, shall be design mix concrete.

Design Mix Concrete

Design Mix Concrete are classified in three categories, viz. "Normal Concrete (M)", "Heavy Concrete (H)", "Super Heavy Concrete (SH)". Each class of concrete shall be identified by a prefix and two numbers. Prefix "M" would denote Normal Concrete, prefix "H" would denote heavy concrete and prefix "SH" would denote super heavy concrete. The two numbers e.g. 25 - 40 would denote the crushing strength of cube at 28 days in N/sq.mm and maximum size of the coarse aggregates in millimeters respectively.

Normal concrete shall have a net dry unit weight of not less than 25 kN/cum, for the finished structure after curing, Heavy concrete shall have a net dry unit weight of not less than 36.30 kN/cum, for the finished structure after curing and special heavy concrete shall have a net dry unit weight of not less than 41 kN/cum for the finished structure after curing.

Mix Design & Testing

For Design Mix Concrete, the mix shall be designed as per any of four methods given in 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 in addition be such that it is cohesive and does not segregate during placement and should result in a dense and durable concrete capable of giving the specified finish. 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 grade of concrete shall be as per Table 5 of IS: 456 for various exposure conditions of concrete. For various environmental conditions, refer Table 3 of IS: 456.

The minimum cement content for Design Mix Concrete shall be as per Table 5 of IS: 456 or as given below, whichever is higher.

Grade of Concrete, M	Minimum Cement Content in kg/cum. of Concrete
20	300
25	320
30	340
35	360
40	360
45	400

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

Grade of Concrete M	**Minimum Compressive Strength N/Sq.mm at 7 days**	**Specified Characteristic minimum compressive strength N/sq.mm at 28 days**
15	10.0	15.0
20	13.5	20.0
25	17.0	25.0
30	20.0	30.0
35	23.5	35.0
40	27.0	40.0
45	30.0	45.0

Where single size graded coarse aggregate are not available, aggregates of different sizes shall be properly combined. The CONTRACTORs mix design shall show that combined grading of coarse aggregate meets the requirements of Table 2 of IS: 383 for graded aggregates.

Batching and Mixing of Concrete

Proportions of aggregates and cement, as per approved 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 ±2% for cement and ±3% for aggregate. The batching equipment shall be calibrated at the frequency decided by ENGINEER-IN-CHARGE.

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 ENGINEER-IN-CHARGE shall be maintained. Each time the work stops, the mixer shall be cleaned out, and while recommencing, the first batch shall have 10% additional sand and cement to allow for sticking in the drum.

Arrangement should be made by CONTRACTOR to have the cubes tested at his own expense in an approved laboratory or in field with prior consent of ENGINEER-IN-CHARGE. Sampling and testing of strength and workability of concrete shall be as per IS: 1199, IS: 516 and IS: 456.It is preferable to cast additional cubes (minimum 3 specimen) for testing at 7 days and 14 days.

10.2.6 Nominal mix concrete

Mix Design & Testing

Mix design 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 3 of IS: 456. However it will be the CONTRACTOR's sole responsibility to adopt appropriate nominal mix proportions to yield the specified strength.

Batching & Mixing of Concrete

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

10.2.7 Ready Mixed Concrete

All specification as per IS: 4926 – "Specification for ready mixed concrete" shall be used.

The CONTRACTOR shall identify at least two sources of ready mix concrete supplier and get it approved by ENGINEER-IN-CHARGE prior to start of the Works. Any change in the source of the RMC, shall be got approved by the ENGINEER-IN-CHARGE.

The design mix prepared by the RMC supplier shall be the responsibility of the CONTRACTOR. The testing of concrete as per Codal provisions and the specifications shall be done by the CONTRACTOR same as the normal concreting works.

10.2.8 Formwork

Formwork shall be all inclusive and shall consist of but not limited to shores, bracings, sides of footings, walls, beams and columns, bottom of slabs, etc. including ties, anchors, hangers, inserts, false work, wedges, etc.

The design and engineering of the formwork as well as its construction shall be the responsibility of CONTRACTOR. However, if so directed by ENGINEER-IN-CHARGE, the drawings and calculations for the design of the formwork shall be submitted to ENGINEER-IN-CHARGE for approval.

Formwork shall be designed to fulfil the following requirements:

i) 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.

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

iii) Capable of withstanding without deflection the worst combination of selfweight, reinforcement and concrete weight, all loads and dynamic effects

iv) arising from construction and compacting activities, wind and weather forces.

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

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

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

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

The formwork may be of lined timber, waterproof / plastic coated plywood, steel, plastic depending upon the type of finish specified. Sliding forms and slip form may be used with the approval of ENGINEER-IN-CHARGE. Timber for formwork shall be well seasoned, free from sap, shakes, loose knots, worm holes, warps and other surface defects. Joints between formwork and formwork and between formwork and structure shall be sufficiently tight to prevent loss of slurry from concrete using foam and rubber seals.

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 ENGINEER-IN-CHARGE. CONTRACTOR shall equip himself with enough quantity of 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 may 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 or shown on drawings 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 ENGINEER-IN-CHARGE, the open excavation is firm enough (in hard non-porous soils) to act as a form. Such excavation shall be slightly larger, as directed by ENGINEER-IN-CHARGE, than that required as per drawing to compensate for irregularities in excavation.

CONTRACTOR shall provide adequate props of adjustable steel pipes 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 1.5 m or as directed by

ENGINEER-IN-CHARGE. 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 removed. Placed concrete affected by faulty formwork, shall be entirely removed and formwork corrected prior to placement of new concrete at CONTRACTOR's cost.

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

i) Development of adequate concrete strength;

ii) Permissible deflection at time of striking form work;

iii) Curing procedure employed - its efficiency and effectiveness;

iv) Subsequent surface treatment to be done;

v) Prevention of thermal cracking at re-entrant angles;

vi) Ambient temperatures; and Aggressiveness of the environment (unless immediate adequate steps are taken to prevent damage to the concrete).

Before removing formwork of soffit of slabs/ beams compressive strength at 7/14/21 days shall be checked.Under normal circumstances (generally where temperatures are above 20 Deg. C) forms may be struck after expiry of the period given in IS: 456 unless directed otherwise by ENGINEER-IN-CHARGE. For Portland Pozzolana/slag cement the stripping time shall be suitably modified as directed by the ENGINEER-IN-CHARGE.

It is the CONTRACTOR's responsibility to ensure that forms are not struck until the concrete has developed sufficient strength to support itself, does not undergo excessive deformation and resists surface damage and any stresses arising during the construction period.

10.2.9 Reinforcement Fabrication And Placement

Reinforcing bars supplied in the form of bent coils shall be straightened cold without damage at no extra cost. No bending shall be done when ambient temperature is below 5 0C. Suitable preheating may be permitted if steel bar bending is to be done at below 0 0C. Bars supplied in bent coils shall be straightened only by machine.

All bars shall be accurately bent gradually and according to the sizes and shapes shown on the drawings/ schedules or as directed by ENGINEER-IN-CHARGE. Bar bending machines shall be used to achieve desired accuracy.

Re-bending or straightening incorrectly bent bars shall not be done without approval of ENGINEER-IN-CHARGE.

Reinforcement shall be accurately fixed and maintained firmly in the correct position by the use of blocks, spacers, chairs, binding wire, etc. to prevent displacement during placing and compaction of concrete. The tied in place reinforcement shall be approved by ENGINEER-IN-CHARGE prior to concrete placement. Spacers (PVC or Concrete) shall be of such material and design as will be durable, not lead to corrosion of the reinforcement and not cause spalling of the concrete cover.

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

Substitution of reinforcement, laps/splices not shown on drawing shall be proposed by CONTRACTOR and approved by ENGINEER-IN-CHARGE.

If permitted by ENGINEER-IN-CHARGE, welding of reinforcement shall be done in accordance with IS: 2751, IS: 9417 and SP: 34 as applicable.

Tolerance on placement of reinforcement shall be as per Cl. 12.3 of IS: 456.

10.2.10 Tolerances

Tolerance for formed and concrete dimensions shall be as per IS: 456 and/ or ACI-117-90, ACI-347 unless specified

Tolerance specified for horizontal or vertical building lines or footings shall not be construed to permit encroachment beyond the legal boundaries.

Tolerance for top of concrete of equipments and structural steel foundations shall be as under:

i) Where grout thickness is less than or equal to 25mm: +5mm and -10mm.

ii) Where grout thickness is more than 25mm: ±15mm.

10.2.11 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 ENGINEER-IN-CHARGE.

10.2.12 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.

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

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 **:**

i) Continuously between construction joints and pre- determined abutments.

ii) Without disturbance to forms or reinforcement.

iii) 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.

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

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

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

vii) 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.

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

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

x) 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 for compaction of concrete shall be electrically operated and vibrator needles shall be of 60 mm size only. Immersion vibrators shall be inserted vertically at points not more than 450 mm

apart and withdrawn slowly till air bubbles cease to come to the surface, leaving no voids. When placing concrete in layers advancing horizontally, care shall be taken to ensure adequate vibration, blending and melding of the concrete between successive layers. Vibrators shall not be allowed to come in contact with reinforcement, formwork and finished surfaces after start of initial set.

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

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

10.2.13 Curing

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

i) Premature drying out, particularly by solar radiation and wind;

ii) leaching out by rain and flowing water;

iii) rapid cooling during the first few days after placing;

iv) high internal thermal gradients;

v) low temperature or frost;

vi) Vibration and impact which may disrupt the concrete and interfere with its bond to the reinforcement.

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

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

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

Extra precautions shall be exercised in curing concrete during cold and hot weather as per Clause no. 8.3 of IS: 7861(Part II) and Clause no. 8.2 of IS: 7861(Part I) respectively.

Curing arrangement shall be subjected to ENGINEER-IN-CHARGE's approval.

10.2.14 Foundation Bedding

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

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

10.2.15 Finishes

General

The formwork for concrete works shall be such as to give the finish as specified. The CONTRACTOR shall make good as directed any unavoidable defects consistent with the type of concrete and finish specified; defects due to bad workmanship (e.g. damaged or misaligned forms, defective or poorly

compacted concrete) will not be accepted. CONTRACTOR shall construct the formwork using the correct materials and to meet the requirements of the design and to produce finished concrete to required dimensions, plumbs, planes and finishes.

Integral Cement Finish on Concrete Floor

In all cases where integral cement finish on a concrete floor has been specified, the top layer of concrete shall be screeded off to proper level and tamped with tamper having conical projections so that the aggregate shall be forced below the surface. The surface shall be finished with a wooden float and a trowel with pressure. The finish shall be continued till the concrete reaches its initial set. No cement or cement mortar finish shall be provided on the surface. Where specified, a floor hardener as approved by the ENGINEER-IN-CHARGE shall be supplied and used as recommended by the manufacturer.

10.2.16 Repair And Replacement Of Unsatisfactory Concrete

Immediately after the shuttering is removed, all the defective areas such as honey-combed surfaces, rough patches, and holes left by form bolts etc. shall be inspected by the ENGINEER-IN-CHARGE who may permit patching of the defective areas or reject the concrete work.

All through holes for shuttering shall be filled for full depth and neatly plugged flush with surface.

Rejected concrete shall be removed and replaced by the 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 ENGINEER-IN-CHARGE.

Bonding between hardened and fresh concrete shall be done either by placing cement mortar or by applying epoxy. The decision of the ENGINEER-IN-CHARGE as to the method of repairs to be adopted shall be final and binding on the CONTRACTOR. The surface shall be saturated with water for 24 hours before patching is done with 1:5 cement sand mortar. The use of epoxy for bonding fresh

concrete shall be carried out as approved by the ENGINEER-IN-CHARGE.

All the form bolt repairs and delayed repairs shall be carried out using a proportion of white cement in repair mix to the approval of the ENGINEER-IN-CHARGE so as to match the colour of the surrounding area.

CONTRACTOR shall submit a method statement for such repairs to ENGINEER-IN-CHARGE for approval.

10.2.17 Testing Concrete Structures For Leakage

Water testing of concrete structures shall be done with potable water. Hydro-static test for water tightness shall be done at full storage level or soffit of cover slab, as may be directed by the ENGINEER-IN-CHARGE. This test shall be carried out preferably in dry season in accordance with the procedure given below :

In case of structures whose external faces are exposed, such as elevated tanks, the requirements of the test shall be deemed to be satisfied if the external faces show no sign of leakage or sweating and

remain completely dry during the period of observation of seven days after allowing a seven day period for absorption after filling with water.

In the case of structures whose external faces are submerged and are not accessible for inspection, such as underground tanks, the structures shall be filled with water and after the expiry of seven days after the filling; the level of

the surface of the water shall be recorded. The level of water shall be recorded again at subsequent intervals of 24 hrs. Over period of seven days. Backfilling shall be withheld till the tanks are tested. The total drop in surface level over a period for seven days shall be taken as an indication of the water-tightness of the structure. The ENGINEER-IN-CHARGE shall decide on the actual permissible nature of this drop in the surface level, taking into account whether the structures are open or closed and the corresponding effect it has on evaporation losses. Unless specified otherwise, a structure whose top is covered shall be deemed to be water tight if the total drop in the surface level over a period of seven days does not exceed 40 mm.

Each compartment/segment of the structure shall be tested individually and then all together.

For structures such as pipes, tunnels, etc. the hydrostatic test shall be carried out by filling with water, after curing as specified, and subjecting to the specified test pressure for specified period. If during this period the loss of water does not exceed the equivalent of the specified rate, the structure shall be considered to have successfully passed the test.

10.2.18 Optional Tests

If ENGINEER-IN-CHARGE feels that the materials i.e. cement, sand, coarse aggregates, reinforcement and water are not in accordance with the specifications or if specified concrete strengths are not obtained, he may order tests to be carried out on these materials in laboratory, to be approved by the ENGINEER-IN-CHARGE, as per relevant IS Codes. EMPLOYER shall pay only for the testing of materials supplied by the EMPLOYER; otherwise CONTRACTOR shall have to pay for the tests. Transporting of all material to the laboratory shall however be done by the CONTRACTOR at no extra cost to EMPLOYER.

In the event of any work being suspected of faulty material or workmanship requiring its removal or if the works cubes do not give the stipulated strength, ENGINEER-IN-CHARGE reserves the right to order the CONTRACTOR to take out cores and conduct tests on them or do ultrasonic testing or load testing of structure, as per relevant IS specifications. All these tests shall be carried out by CONTRACTOR at no extra cost to the EMPLOYER. Alternately ENGINEER-IN-CHARGE also reserves the right to ask the CONTRACTOR to dismantle and re-do such unacceptable work at the cost of CONTRACTOR.

If the structure is certified by ENGINEER-IN-CHARGE as having failed, the cost of the test and subsequent dismantling/reconstruction shall be borne by CONTRACTOR.

The quoted unit rates/prices of concrete shall deemed to provide for all tests mentioned above.

10.2.19 Grouting

As directed by ENGINEER-IN-CHARGE.

10.2.20 Quality Control

EMPLOYER / ENGINEER-IN-CHARGE has developed in house quality control formats for concrete works. CONTRACTOR shall note that it required adopting all such formats. A copy of formats shall be furnished to CONTRACTOR by ENGINEER-IN-CHARGE/ EMPLOYER after the contract is awarded.

Alternatively, if CONTRACTOR has his own QC formats he may adopt them subjected to such modifications considered necessary by ENGINEER-IN-CHARGE.

In either case CONTRACTOR shall submit his detailed Quality Assurance Plan along with the bid. This would be reviewed, appropriately modified and approved by CONSULTANT after the award of contract.

10.2.21 Inspection

All materials, workmanship and finished construction shall be subject to continuous inspection and approval of ENGINEER-IN-CHARGE. Materials rejected by ENGINEER-IN-CHARGE shall be expressly removed from site within 3 working days and shall be replaced by CONTRACTOR immediately at no extra cost to EMPLOYER.

10.2.22 Clean-Up

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

10.2.23 Acceptance Criteria

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

a) properties of constituent materials;

b) characteristic compressive strength;

c) specified mix proportions;

d) minimum cement content;

e) maximum free-water/cement ratio;

f) workability;

g) temperature of fresh concrete;

h) density of fully compacted concrete;

i) cover to embedded steel;

j) curing;

k) tolerances in dimensions;

l) tolerances in levels;

m) durability;

n) surface finishes;

o) special requirements such as :

i) water tightness

ii) resistance to aggressive chemicals

iii) resistance to freezing and thawing

iv) very high strength

v) improved fire resistance

vi) wear resistance

vii) resistance to early thermal cracking

ENGINEER-IN-CHARGE's decision as to the acceptability or otherwise of any concrete work shall be final and binding on the CONTRACTOR.

For work not accepted, ENGINEER-IN-CHARGE may review and decide whether remedial measures are feasible so as to render the work acceptable. ENGINEER-IN-CHARGE shall in that case direct the CONTRACTOR to undertake the remedial measures. These shall be expeditiously and effectively implemented by CONTRACTOR. Nothing extra shall become payable to CONTRACTOR by EMPLOYER for executing remedial measures.

10.3 CHAPTER 3 General Civil Works

10.3.1 Applicable Codes And Specifications

The following codes and standards are included in this section.

IS: 110	Ready mixed paint, brushing, grey filler, for enamels for use over primers
IS: 269	Specification for 33 grade ordinary portland cement
IS: 280	Specification for mild steel wire for general engineering purposes
IS: 383	Specification for coarse and fine aggregates from natural sources for concrete
IS: 412	Expanded metal steel sheets for general purposes
IS: 712	Specification for building limes
IS: 730	Specification for hook bolts for corrugated sheet roofing
IS: 733	Wrought aluminium and aluminium alloys, bars, rods and sections
IS: 1077	Specification for common burnt clay building bricks
IS: 1124	Method of test for determination of water absorption, apparent specific gravity and porosity of natural building stones
IS: 1322	Bitumen felts for water proofing and damp proofing
IS: 1397	Specification for Kraft paper
IS: 1398	Specification for packing paper, waterproof, bitumen laminated
IS: 1542	Specification for sand for plaster
IS: 1580	Specification for bituminous compounds for water-proofing and caulking purposes
IS: 1597	Code of practice for construction of stone masonry : Part 1 Rubble stone masonry
IS: 1659	Specification for block boards
IS:1661	Code of practice for application of cement and cement-lime plaster finishes
IS:1834	Specification for hot applied sealing compound for joint in concrete
IS:1838	Specification for preformed fillers for expansion joint in concrete pavements and structures (non extruding and resilient type) : Part 1 Bitumen impregnated fibre
IS:2074	Ready mixed paint, air drying, red oxide- zinc chrome, priming
IS:2098	Asbestos cement building boards
IS:2116	Specification for sand for masonry mortars
IS:2185	Specification for concrete masonry units (Parts 1,2 & 3)
IS:2212	Code of practice for brickwork
IS:2250	Code of practice for preparation and use of masonry mortars
IS:2339	Aluminium paint for general purposes, in dual container

IS:2394	Code of practice for application of lime plaster finish
IS:2395	Code of practice for painting concrete, masonry and plaster surfaces (Parts 1 & 2)
IS:2571	Code of practice for laying in-situ cement concrete flooring
IS:2572	Code of practice for construction of hollow concrete block masonry
IS:2645	Specification of integral cement waterproofing compounds
IS:2690	Specification for burnt clay flat terracing tiles : Part 1 Machine made
IS:2691	Specification for burnt clay facing bricks
IS:2750	Specification for steel scaffoldings
IS:2835	Flat transparent sheet glass
IS:3036	Code of practice for laying lime concrete for a water-proofed roof finish
IS:3068	Specification for broken brick (burnt clay) coarse aggregates for use in lime concrete
IS:3384	Specification for bitumen primer for use in water-proofing and damp-proofing
IS:3495	Method of test for burnt clay building bricks: Part 1 to 4
IS:3696	Safety code of scaffolds and ladders (Parts 1 & 2)
IS:3935	Code of practice for composite construction
IS:4443	Code of practice for use of resin type chemical resistant mortars
IS:4631	Code of practice for laying epoxy resin floor toppings
IS:4832	Specification for chemical resistant mortars (Part II)
IS:4860	Specification for acid resistant bricks
IS:4948	Specification for welded steel wire fabric for general use
IS:5410	Cement paint, colour as required
IS:6041	Code of practice construction of autoclaved cellular concrete block masonry
IS:6042	Code of practice for construction of light weight concrete block masonry
IS:8042	Specification for white portland cement
IS:9862	Specification for ready mixed paint, brushing, bituminous, black, lead-free, acid, alkali, water and chlorine resisting
IS:10005	SI units and recommendations for the use of their multiples and of certain other units.
BS: 476 (Part–20)	Methods for determination of the fire resistance of elements of construction (General Principles)
BS : 476(Part–21)	Methods for determination of the fire resistance of load bearing elements of construction
BS : 476 (Part–22)	Methods for determination of the fire resistance of non-load bearing elements of construction
Part – IV	National Building code of India, 2005

10.3.2 Brickwork

Materials

- Bricks used in the works shall conform to the requirements laid down in IS: 1077. The class of the bricks shall be as specifically indicated in the respective items of work prepared by the CONTRACTOR.
- The nominal size of the modular brick shall be 200mmx100mmx100mm with the permissible tolerances over the actual size of 190mmx90mmx90mm as per IS: 1077. The nominal thickness of one brick and half brick walls using modular bricks shall be considered as 200 mm and 100 mm respectively. In the event of use of traditional bricks of nominal size 230 mmx115mmx75mm with tolerance upto ±3 mm in each dimension, one brick and half brick walls shall be considered as 230 mm and 115 mm respectively.
- Bricks shall be sound, hard, and homogenous in texture, well burnt in kiln without being vitrified, hand/machine moulded, deep red, cherry or copper coloured, of regular shape and size & shall have sharp and square edges with smooth rectangular faces. The bricks shall be free from pores, cracks, flaws and nodules of free lime. 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 and shall have a minimum crushing strength of 7.5N/sq.mm unless otherwise specified in the Items of work.
- The average water absorption shall not be more than 20 percent by weight upto class 12.5 and 15 percent by weight for higher classes. Bricks which do not conform to this requirement shall be rejected. Over or under burnt bricks are not acceptable for use in the works.
- Sample bricks shall be submitted to the ENGINEER-IN-CHARGE for approval and bricks supplied shall conform to approved samples. If demanded by
- ENGINEER-IN-CHARGE, brick samples shall be got tested as per IS: 3495 by CONTRACTOR. Bricks rejected by ENGINEER-IN-CHARGE shall be removed from the site of works within 24 hours.
- Mortar for brick masonry shall consist of cement and sand and shall be prepared as per IS: 2250. Mix shall be in the proportion of 1:5 for brickwork of thickness one brick or above and 1:4 for brickwork of thickness half brick or below, unless otherwise specified in the respective items of work prepared by the CONTRACTOR. Sand for masonry mortar shall conform to IS: 2116. The sand 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 ENGINEER-IN-CHARGE. If so directed by the ENGINEER-IN-CHARGE, sand shall be screened and washed till it satisfies the limits of deleterious materials.

- For preparing cement mortar, the ingredients shall first be mixed thoroughly in dry condition. Water shall then be added and mixing continued to give a uniform mix of required consistency. Mixing shall be done thoroughly in a mechanical mixer, unless hand mixing is specifically permitted by the ENGINEER-IN-CHARGE. 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 to restore 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 shall be removed forthwith from the site. Droppings of mortar shall not be re-used under any circumstances.
- The CONTRACTOR shall arrange for test on mortar samples if so directed by the ENGINEER-IN-CHARGE.
- Workmanship
- Workmanship of brick work shall conform to IS: 2212. All bricks shall be thoroughly soaked in clean 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 200mm/230mm thick and over shall be laid in English Bond unless otherwise specified. 100mm/115mm 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, at least one 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 shall 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 metre. 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 10mm/15mm 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 inclement 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 ENGINEER-IN-CHARGE.
- 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 ENGINEER-IN-CHARGE. 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 x115mm x75mm, 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 layers of 50 micron thick polyethylene sheets.
- RCC/ steel beams resting on masonry wall shall be provided with reinforced concrete bed blocks of 50 mm thickness, projecting 50mm on either sides of the beam, duly finished on top with 2 layers 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 pre-deflect 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 transomes 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 20mm 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.
- Facing bricks of the type specified conforming to IS: 2691 shall be laid in the positions indicated on the Drawings prepared by the CONTRACTOR and all facing brickwork shall be well bonded to the backing bricks/RCC surfaces. The level of execution of the facing brick work shall at any time be lower by at least 600 mm below the level of the backing brickwork.
- Facing bricks shall be laid over 10 mm thick backing of cement mortar. The mortar mix, thickness of joint and the type of pointing to be carried out shall be as specified in the item of works prepared by the CONTRACTOR. The pattern of laying the bricks shall be as specifically indicated in the Drawings prepared by the CONTRACTOR.
- For facing brickwork, double scaffolding shall be used.
- Faced works shall be kept clean and free from damage, discoloration etc., at all times.

10.3.3 Concrete Block Masonry

Materials

Masonry units of hollow and solid concrete blocks shall conform to the requirements of IS: 2185 (Part I).

Masonry units of hollow and solid light-weight concrete blocks shall conform to the requirements of IS: 2185 (Part 3).

Masonry units of autoclaved cellular concrete blocks shall conform to the requirements of IS: 2185 (Part 3).

The height of the concrete masonry units shall not exceed either its length or six times its width.

The nominal dimensions of concrete block shall be as under.

- Length 400, 500 or 600 mm

- Height 100 or 200 mm
- Width 100 to 300 mm in 50 mm increments
- Half blocks shall be in lengths of 200, 250 or 300mm to correspond to the full length blocks. Actual dimensions shall be 10mm short of the nominal dimensions.
- The maximum variation in the length of the units shall not be more than ±5 mm and maximum variation in height or width of the units shall not be more than ± 3mm.
- Concrete blocks shall be either hollow blocks with open or closed cavities or solid blocks.
- Concrete blocks shall be sound, free of cracks, chipping or other defects which impair the strength or performance of the construction. Surface texture shall as specified. The faces of the units shall be flat and rectangular, opposite faces shall be parallel and all arises shall be square. The bedding surfaces shall be at right angles to the faces of the block.
- The concrete mix for the hollow and solid concrete blocks/light weight concrete blocks shall not be richer than one part of cement to six parts of combined aggregates by volume.
- Concrete blocks shall be of approved manufacture, which satisfy the limitations in the values of water absorption, drying shrinkage and moisture movement, as specified for the type of block as per relevant IS code. CONTRACTOR shall furnish the test certificates and also supply the samples for the approval of ENGINEER-IN-CHARGE.

Workmanship

- The type of the concrete block, thickness and grade based on the compressive strength for use in load bearing and/or non-load bearing walls shall be as specified. The minimum nominal thickness of non-load bearing internal walls shall be 100mm. The minimum nominal thickness of external panel walls in framed construction shall be 200 mm.
- The workmanship shall generally conform to the requirements of IS: 2572 for concrete block masonry IS: 6042 for light weight concrete block masonry and IS: 6041 for autoclaved cellular concrete block masonry works.
- From considerations of durability, generally concrete block masonry shall be used in superstructure works above the damp-proof course level.
- Concrete blocks shall be embedded with a mortar which is relatively weaker than the mix of the blocks in order to avoid the formation of cracks. Cement mortar of proportion 1:6 shall be used for the works. Preparation of mortar shall be as specified in clause 18.2.1.

- The thickness of both horizontal and vertical joints shall be 10mm. The first course shall be laid with greater care, ensuring that it is properly aligned, levelled and plumb since this will facilitate in laying succeeding courses to obtain a straight and truly vertical wall. For the horizontal (bedding) joint, mortar shall be spread over the entire top surface of the block including front and rear shells as well as the webs to a uniform layer of 10mm. For vertical joints, the mortar shall be applied on the vertical edges of the front and rear shells of the blocks. The mortar may be applied either to the unit already placed on the wall or on the edges of the succeeding unit when it is standing vertically and then placing it horizontally, well pressed against the previously laid unit to produce a compacted vertical joint. In case of two cell blocks with slight depression on the vertical sides these shall also be filled up with mortar to secure greater lateral rigidity. To assure satisfactory bond, mortar shall not be spread too far ahead of actual laying of the block as the mortar will stiffen and lose its plasticity Mortar while hardening shrinks slightly and thus pulls away from the edges of the block. The mortar shall be pressed against the units with a jointing tool after it has stiffened to effect intimate contact between the mortar and the unit to obtain a weather tight joint. The mortar shall be raked to a depth of 10mm as each course is laid to ensure good bond for the plaster.
- Dimensional stability of hollow concrete blocks is greatly affected by variations of moisture content in the units. Only well dried blocks should be used for the construction. Blocks with moisture content more than 25% of maximum water absorption permissible shall not be used. The blocks should not be wetted before or during laying in the walls. Blocks should be laid dry except slightly moistening their surfaces on which mortar is to be applied to obviate absorption of water from the mortar.
- As per the design requirements and to effectively control cracks in the masonry, RCC bound beams/studs, joint reinforcement shall be provided at suitable locations. Joint reinforcement shall be fabricated either from mild steel wires conforming to IS: 280 or welded wire fabric/high strength deformed basis.
- For jambs of doors, windows and openings, should concrete blocks shall be provided. If hollow units are used, the hollows shall be filled with concrete of mix 1:3:6. Hold fasts of doors/windows should be arranged so that they occur at block course level.
- At intersection of walls, the courses shall laid up at the same time with a true masonry bond between at least 50% of the concrete blocks. The sequence for construction of partition walls and treatment at the top of load bearing walls for the RCC slab shall be as detailed under clause 18.2 for the brick work.
- Curing of the mortar joints shall be carried out for at least 7 days. The walls should only be lightly moistened and shall not be allowed to become excessively wet.

- Double scaffolding shall be adopted for execution of block masonry work.
- Cutting of the units shall be restricted to a minimum. All horizontal and vertical dimensions shall be in respectively, adopting modular co-ordination for walls, opening locations for doors, windows etc.
- Concrete blocks shall be stored at site suitably to avoid any contact with moisture from the ground and covered to protect against wetting.

10.3.4 Rubble Stone Pitching

- Stones for the works shall be of the specified varieties which are hard, durable, fine grained and uniform in colour (for superstructure work) free from veins, flaws and other defects. Quality and work shall conform to the requirements specified in IS: 1597 (Part-1). 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 ENGINEER-IN-CHARGE for approval. Stones shall he laid with its grains horizontal so that the load transmitted is always perpendicular to the natural bed.

  For all works below ground level the masonry shall be random rubble uncoursed with ordinary quarry dressed stones for the hearting and selected quarry dressed stones for the facing.
- Chips and spalls shall be used wherever necessary to avoid toensure that no hollow spaces are left in the pitching. Gravel quarry spells should be laid underneath the ground to level undulations.
- All stones shall be sufficiently wetted before laying to prevent absorption of water from the mortar. However if any part of the pitching is required to be left behind, the wall shall he raked back (and not saw toothed) at an angle not exceeding 45 degree. Stone pitching shall be of 230mm thick of not less than150mm x 150mm size. These shall be

  roughly dressed on sides and surface and the joints filled with small chips on the exposed surface unless otherwise specified.

11. PUMPS

This section of the contract involves the design, supply, installation, testing and commissioning of the complete pumping system complete with all controls and electrical work for domestic water supply, water supply for flushing etc. All submersible drainage and ejector pumps for the project are also included in this contract. It also involves testing and commissioning of the pumping system.

This specification described the particulars of the contract, designs and systems chosen, and mode of operation.

All installation work shall comply with the latest rules and regulations.

The work embraced by this specification covers the design, submission to authorities, supply, and delivery on site, installation, testing, commissioning and maintenance of the pumping system installation of the building in accordance with this specification and associated drawings.

Each unit shall be provided with electronic microprocessors for unit control and all necessary electrical work for the unit.

The pumping system contractor shall guarantee specified pump performance at various pump speeds and pumps must be able to supply at least 2 bar pressure at the highest /farthest fitting.

-Electrical equipment and installation work including the PLC in Control panel.

-Painting and labelling of pipe work and equipment;

-Provision of all hold down bolts, spigots struts and the like required to be built in during construction;

-Provision of all level switches, flow switches and other sensing devices for status indication.

-All interfacing work with other trades.

-Testing & commissioning and balancing of the Pumping system;

-Provision of twenty four (24) months operational maintenance and breakdown services;

-Provisions of operating instructions and maintenance manuals;

-Provision of spare parts;

-Training of the employer's staff for proper operation of the entire systems;

-Liaison with Local Authorities to obtain all necessary certificates and approvals, including the completion of all submission drawings, forms and payment of any fees and charges. All the costs for all the tests required by Local Authorities shall be included. To attend to any Authorities inspection regardless of whether this inspection is carried out after the defect liability period;

-Provisions of the necessary installation which include pumping works, pipe work within the pumping unit up to suction and discharge manifolds, conduit and control wiring, etc. to form a workable system required;

-All other works and systems as specified in the Contract document and or shown on the drawings.

-All cutting, patching, framing up, furring in, chasing and making good associated with the building construction for the passage of pipes, conduits and the like including providing GI pipes sleeves of required size corresponding to pipe dia, wherever pipes crossing fire rated walls and floors and sealing with glass wool in between and fire sealant compound on either end. Details on shop drawings shall also be provided.

All minor items and incidental work, equipment accessories and materials may not be specifically mentioned but are required for the proper completion of the installations in accordance with the true intent and meaning of this Specification.

All necessary safety devices for the protection of personnel against injury and the protection of plant and equipment against damage including relief valves, belt guards, fan inlet and/or discharge guards, safety railing, effective earthing of electrical components, electrical interlocks, warning lights and alarms.

Readily accessible, dust-proof lubricating facilities on all moving parts and equipment including provision for cleaning all lubricating lines and bearings and charging same with the correct lubricants after installation but prior to testing and commissioning.

Clearly visible and robust manufacturer's name-plates permanently fitted each and every item of equipment and showing the manufacturer's name, type and/or model number, serial number, and all essential operating data such as speed, capacity, voltage, current draw, etc.

The Contractor also shall allow provision for the inspection of all plant and equipment by the manufacturer or his licensed representative, at least twice during the course of the installation.

Piping

The pipes and fittings in the domestic Water system shall be GI class `C' (heavy class) conforming to IS: 1239 (Part-I) for pipes and IS:1879 (Part 1 to 10) for malleable cast iron galvanized fittings.

Float less Type Level Switch in Water Tanks

The Contractor shall supply and install float less type switch probes in the water tanks require and shown on the drawings.

Each probe shall be of the correct length for the particular application and tank location. Electrodes shall be of polished stainless steel 20 mm OD. Electrode holders shall be weatherproof in all respect.

The earthing probes shall be connected and wired to the building earth systems of the building.

Each set of electrodes shall be installed inside a 230 mm diameter PVC pipe acting as a wave barrier.

The level switch set shall operate with a stepped down voltage at 24V maximum. Stepped down transformers shall be provided for each set of control probes and shall be installed inside centralised control cubicles inside pump room. All pump seals to be Mechanical seals.

11.1 Pumping System

11.1.1 Section 1

The scope of work shall include design, selection of equipment, supply, inspection & testing at manufacturer’s works, delivery to site, unloading and storage at site, erection and commissioning of the all Electrical-mechanical equipment as listed below & shown in drawings. The Works under this Contract will physically interface with Works under water distribution network and/or other contracts.

This document gives the specification of Electro-Mechanical items for Underground Tank (UGT) water supply pump station. The pumping methodology for UGT to OHT water distribution for buildings shall be as described below.

The below table shows Operation philosophy for pumping system from UGT to OHT applicable for Domestic water and flushing water.

Operational philosophy-I (Hydro Pneumatic)

Operation Philosophy -I Hydro pneumatic	UGT serving 2 or more buildings No. of Pumps 3 (1W+1ASSIST+1S),
Operation Philosophy -II Transfer	UGT serving one no building No. of Pumps 2 (1W+1S)

Operational philosophy –I (Hydro pneumatic Duty +Assist +Standby)

The water shall be pumped to overhead tank of the each building with the help of vertical in line pumps with hydro pneumatic system. There will be 3 nos. of pumps; two pumps(1w+1 Asst) will dedicatedly supply water to all buildings. And there will be one standby pump which will act as standby to other two working pumps.

Control panel of these pumps shall be facilitated with auto cyclic operation for lead lag function of pumps to maintain equal wear and tear.

Pump operation cycle shall be as follows.

	Sequence of operation		
Start-1 initiation from pump panel	Pump-1	Pump-2 (Asst)	Pump-3 standby
Start-2 initiation from pump panel	Pump-2	Pump-3 (Asst)	Pump-1 standby
Start-3 initiation from pump panel	Pump-3	Pump-1 (Asst)	Pump-2 standby
Start-4 & so on initiation from pump panel	Pump-1	Pump-2 (Asst)	Pump-3 standby

The pumping operation has been considered as Automatic. (Auto On & auto off with manual override)

Stand alone level controller will be placed at terrace at OHT to monitor the water level inside OHT. When water reaches low level in OHT , solenoid valve at OHT will open allow water to fill. When solenoid valve opens pressure in the line will drop same will be sensed by pressure sensor at UGT pump room. When pressure drops below preset pressure value UGT hydro pneumatic pumping system starts automatically. Initially lead pump starts filling the OHT if demand exceed lead pump capacity assist pump will start automatically and both pumps will run together. Once domestic tank is full, solenoid valve will close and pressure starts built up in the transfer line same will be sensed by high pressure sensor at UGT pump room. When pressure exceeds high pressure preset value pump stops automatically (first assist pump then lead pump). Pressure vessel will be installed at UGT.

The pump operation is automatic shall be controlled by the hydro pneumatic system control panel. Pump shall have dry run protection (with Float switch in UGT) and same shall be connected to pump control panel. Adequate pressure sensors , Panel and controls to be installed to run pumps automatically (Duty + assist and stand by with lead lag operations).

Electronic Controller

An electronic dedicated pump logic controller shall operate the pumps to maintain the required system pressure while using minimum energy and alternating between pumps to maintain relatively equal pump operating hours.

As flow demand begins, one of the pumps will start at low speed. As demand increases, the pump will speed up until it reaches full RPM. At this point the second pump will start in full speed. The speed of the first pumps will vary until it builds up required system pressure. This sequence will continue for additional working pumps, if demand is not met. Pumps shall changeover automatically to maintain the system pressure depending on demand, time, and fault.

Operational philosophy-II (Transfer pumps)

The water shall be pumped to overhead tank of the one building with the help of vertical in line centrifugal pumps. There will be 2 nos of pump, one pump will dedicatedly supply water to building and there will be one standby pump which will act as standby to other working pump.

Control panel of these pumps shall be facilitated with auto cyclic operation for lead lag function of pumps to maintain equal wear and tear. I.e. During first start initiation from pump panel, pump-1 should be operational and pump-2 should be on standby mode and during second start initiation from pump panel pump-2 should be operational and pump-1 should be on standby mode and in this manner operation cycle should continue

The pumping operation has been considered as Automatic. (Auto On & auto off with manual override)

Float switches (high, Low) will be placed at OHT to monitor the water level inside Over head tank. When water reaches low level pumps at UGT will start automatically and when water reaches to high level pumps will stop automatically.

The pump operation is automatic shall be controlled by float less type level switches & level control panel along with pump control panel. Pump shall have dry run protection (with Level Sensor in UGT) and same shall be connected to pump control panel. Over head tank level sensors will be connected to pump room control panel.

Electronic Controller

An electronic dedicated pump logic controller shall operate the pumps to maintain the required system pressure while using minimum energy and alternating between pumps to maintain relatively equal pump operating hours. Contractor shall provide an automatic level control system to automatically start / stop the

pumps depending on the tank water levels.

When water reaches predetermined low level, an audio-visual automatic alarm shall sound

and the pump started automatically. The alarm shall have a switch, which will enable the

operator to switch it off. When the water rises above the predetermined high level, the pump

shall stop automatically. Water pumps shall stop upon receiving the signal from water level indicator when water level reaches to high level.

11.1.2 SECTION – 2

I) Vertical In Line Pump

General

The pump shall be vertical multistage, centrifugal directly coupled to motor, used for transfer of potable /flushing water from underground tank to overhead tank of the each building or other application. The pump shall be capable of developing the required head at the rated capacity at a power supply frequency of 50 Hz. The pump motors shall be of Class “F” insulation and IP55 rating and shall be provided with built-in thermistors for protection against overheating.

Pumps and drives shall be rated for continuous duty and shall be capable of pumping the flow range specified in the specifications without surging, cavitations or excessive vibration to the limits specified. The pump shall meet maximum allowable shut off head. The pumps shall not overload the motors at any point on the maximum pump speed performance characteristic curve and the pump operating range within the limits of stable pump operation. The total head capacity curve shall be continuously rising towards the shut off as flow decreases throughout the entire curve from run out to shut off head with the highest at shut off.

Its total head capacity curve shall be continuously rising towards shut off with the highest at shut off, and its capacity shall meet to handling sludge volume.

Pumps shall be suitable for single as well as parallel efficient operation at any point in between the maximum and minimum system resistances.

Pumps shall run smooth without undue noise and vibration, cavitations, oil or water leaks over the range of operation. To ensure vibration free operation, all rotating components of pump shall be statically and dynamically balanced to BS 6861/ as per zones A & B of ISO 10816 -1

The pump set shall be suitable for starting with discharge valve open and/or closed.

The pump set shall be capable of withstanding the accidental rotation in reverse direction.

Pumps shall be so selected that the design duty point is within 5% of the maximum efficiency point. Pump minimum efficiency shall not be less than 70% at duty point

The pump casing shall have ample space to take an impeller one size larger than that capable of performing the design duty.

The pump shall have a speed of not more than 1500 rpm.

The pump shall be lubricated in strict accordance with the manufacturer`s instructions and shall be factory aligned prior to shipment.

All pumps shall have mechanical seal

Features of construction

Pump shall be Vertical multi stage, centrifugal, with enclosed, radial impeller. Impeller shall be hydraulically balanced and keyed to shaft. The impeller shall have superior suction eye design to ensure the lower NPSH.

Pump casing shall be of robust construction. Liquid passages shall be finished smooth and designed as to allow smooth flow. The volute tongue shall be filed to a smooth rounded edge.

The vertical shaft shall be of high tensile stainless steel supported by bush bearings shall. The shaft shall be sealed with mechanical seal of DIN 24960 standard.

The bearing shall be radial type bush bearing of tungsten carbide on shaft and ceramic bearing in the diffuser. The bearing shall be self lubricated and highly wear resistant. The motor bearing shall be capable of withstanding the axial thrust. Bearings shall be capable of taking the static weight of the rotating parts and any thrust generated by the operation of the pump. The bearing life shall be minimum 40,000 hrs of operation.

The diffusers shall be made with pressed stainless steel and shall be designed to reduce the internal losses.

Each pump shall be provided with an automatic coupling device for attaching the crane hook to the pump at low level, this automatic coupling device shall easily and automatically couple and uncouple the hoist hook and be complete with necessary accessories.

The materials of construction for Vertical in line pumps shall be as follows:

	Capacity:	Refer GA drawing
	Head	Refer GA drawing
	Shut off head	110% of head
	Efficiency	minimum 70 % at Duty point

Sr. No	Component	Material
	Impeller	AISI 304 stainless steel
	Casing	Cast Iron to IS:210 Gr FG 200 with 1.5 to 2% Nickel
	Shaft	Stainless Steel : BS:970 Gr 316
	Fasteners and Foundation Bolts	Stainless Steel AISI 316
	Motor Stool	Cast Iron
	Drain Plug	Brass
	Seal	Mechanical HQQE: H:O ring cartridge, Q:Silicon carbide, Q:silicon carbide, E: EPDM)

Material test certificates from Government approved metallurgical laboratory shall be furnished by the Contractor

Each pump shall be tested at the manufacturers premises for the full operating range of the pump to BS 5316 Part 1 .Pump performance shall be within the tolerance limits specified in the above said BS.Y-Strainers shall be provided as the suction side of the pump as shown in the drawings

Tests

a) Hydro test pressure on casing shall be 1.5 times maximum discharge head or twice differential head whichever is higher. (Maximum discharge head = shut-off head + maximum suction head). Unless otherwise stated in data sheet A, the hydrostatic tests on the casing shall be conducted for a minimum duration of 30 minutes.

b) The pumps shall be tested as per IS 11346:2004, at rated speed at MANUFACTURER's works to measure capacity, total head, efficiency and power. These tests shall form the basis for acceptance of pumps except for vibration and noise. The pumps shall be tested over the range covering from shut-off head to the maximum flow. The duration of the test shall be minimum one (1) hour. Minimum five (5) readings approximately equidistant shall be taken for plotting the performance curves.

c) After installation, the pumps shall be subjected to performance testing at site also. If the site performance is found not to meet the requirements regarding vibration and noise as specified, the equipment shall be rectified or replaced by the VENDOR, at no extra cost to the PURCHASER.

Inspection

The contractor shall provide facilities for inspection of the components of the pump during all stages of manufacture to check conformity to specification. The following inspection shall be invariably be witnessed by the Employer.

Vertical inline pumps - Casing Hydro test, Performance Testing

II) Motor

All motors shall be suitable for VFD/Constant speed as applicable.

Performance and characteristics

Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under either of the following supply conditions:

- Variation of supply voltage from rated motor voltage ±10%
- Variation in supply frequency from rated frequency ±5%
- Combined voltage and frequency variation ±10%

Motors shall be capable of starting and accelerating the load with the applicable method of starting, without exceeding acceptable winding temperature, when the supply voltage is in the range of 85% of the rated voltage. Starting current of motor shall not exceed 200% of rated full load current.

Motors shall be capable of satisfactory operation at full load at a supply voltage of 80% of the rated voltage for 5 minutes, commencing from hot condition.

Motors shall be capable of developing the rated full load torque even when the supply voltage drops to 70% of the rated voltage. Such operation is envisaged for a period of 1 second. The pull out torque of the motor, to meet this requirement, shall be at least 205% of full load torque.

The locked rotor current of the motors shall not exceed (inclusive of 20% tolerance) 600% of full load current for motors.

Motors shall be capable of giving rated output without reduction in the expected life span when operated continuously under the specified supply conditions.

The locked rotor withstand time under hot conditions at 110% rated voltage shall be more than the starting time at 80% voltage by at least two seconds or 15% of the accelerating time whichever is greater.

Motors when started with the drive imposing its full starting torque under the supply voltage variations specified shall be capable of withstanding at least two successive starts from cold condition and one start from hot condition without injurious heating of windings. The motors shall also be suitable for four equally spread starts per hour under the above referred supply conditions.

Insulation

(i) Any joints in the motor insulation such as at coil connections or between slot and winding sections, shall have strength equivalent to that of slot sections of the coil. The insulation shall be given tropical and fungicidal treatment for successful operation of the motor in hot, humid and tropical climate. The motors shall be provided with Class F insulation with temperature rise limited to that of Class B insulation

Temperature rise

(i) The temperature rises shall not exceed the values given in IS 12802. Under extremes of supply condition, the temperature rise shall not exceed the value indicated in IS by 10^{o}C.

Constructional features

(i) The motor construction shall be suitable for easy disassembly and re-assembly. The enclosure shall be sturdy and shall permit easy removal of any part of the motor for inspection and repair.

(ii) Motors weighing more than 25 kg shall be provided with eyebolts, lugs or other means to facilitate safe lifting.

(iii) The rotor bars shall not be insulated in the slop portion between the iron core laminations for squirrel cage motors.

Bearings

(i) Unless otherwise specified motor bearings shall not be subjected to any external thrust load.

(ii) Unless otherwise specified, motor bearings shall have an estimated life of at least 40,000 hrs.

(iii) The bearings shall permit running of the motor in either direction of rotation.

(iv) It shall be possible to lubricate the bearings without dismantling any part of the motor.

Terminal box

(i) Terminal boxes shall be of weather proof construction designed for outdoor service, to eliminate entry of dust and water, gaskets of neoprene or approved equivalent shall be provided at cover joints and between box and motor frame. The cable terminal box shall be right hand side looking from coupling end.

(ii) The terminal box shall be capable of being turned through 360 deg instead of 90 deg.

(iii) The terminals shall be of the stud type with necessary plain washers, spring washers and check-nuts. Ample phase to phase and phase to ground clearances shall be kept.

(iv) Suitable cable glands and cable lugs shall be supplied along with the motor.

(v) Separate terminal boxes shall be provided for stator leads and space heater.

Paint and finish

(i) All motor parts exposed directly to atmosphere shall be finished and painted to produce a neat and durable surface which would prevent rusting and corrosion. The equipment shall be thoroughly degreased, all rust, sharp edges and scale removed and treated with one coat of primer and finished with two coats of grey enamel paint.

Heating during idle periods

(i) Motors rated above 30 kW shall have space heaters suitable for 240V, single phase, 50 Hz, AC supply. Space heaters shall have adequate capacity to maintain motor internal temperature above dew point to prevent moisture condensation during idle period. The space heaters shall be placed in easily accessible positions in the lowest part of the motor frame.

Accessories

Motors shall have drain plugs so located that they will drain water, resulting from condensation or other cases from all pockets in the motor casing.

The earthing pads shall be of non-corrodible metal welded or brazed at two locations on opposite sides.

Tests

(i) Motor shall be subjected to all the routine tests as per applicable standard in the presence of the PURCHASER'S representative. Copies of test certificates of type and routine tests shall be furnished as specified in the distribution schedule, for the PURCHASER'S approval. The VENDOR

shall ensure to use calibrated test equipment/instruments having valid calibration test certificates from standard laboratories traceable to national/international standards.

(ii) If type tests have not been carried out on similar Motors, or if the type test reports submitted are not found in order, then VENDOR shall carry out these tests without any extra cost to the Purchaser.

Ii) Hydropneumatic System

Scope

The system operation shall be as per Operational philosophy-I for UGT to OHT.

This section of the contract involves the design, supply, installation, testing and commissioning of the complete Hydro-pneumatic pumping system and other pumping systems complete with all controls, control panel (IP 55 enclosure) and electrical work for water supply. Include testing and commissioning of the supply. This specification described the particulars of the contract, designs and systems chosen, and mode of operation. All installation work shall comply with the latest rules and regulations. The work embraced by this specification covers the design, submission to authorities, supply and delivery on site, installation, testing, commissioning and maintenance of the Hydro-pneumatic pumping system, other pumping system installation of the building in accordance with this specification and associated drawings.

The scope of work shall include the following (list is indicative and not exhaustive):

- Vertical inline multistage pump as described in earlier sections.
- Suitably sized food grade quality, non-toxic EPDM diaphragm type Hydro pneumatic pressure vessels complete with necessary interconnections and controls.
- IP 55 Control panel for pump control complete with VFD drive / constant speed starter as shown drawing, circuit breakers, fusses, pressure transmitters, pressure switches etc. complete with all interconnections to pumps and electrical supply panels.
- Pump control units complete with pre-programmed micro-processor chip.
- Pump dry run protection.
- High pressure protection along with pressure relief valve at discharge header
- Pump monitoring units to monitor operation of pumps.
- Pumps cyclic operation system (lead /Lag)

- Each Hydro-pneumatic Pumping unit The system shall be supplied as complete set mounting on common base including suction and discharge common manifolds, non-return valves, isolating valves, flexible couplings, pressure gages, pressure vessel, control panel, pressure switches etc,

_ Each unit shall be provided with electronic microprocessors for unit control and all necessary electrical work for the unit. Hydro-pneumatic pumps must be able to supply at least 1.5 bar pressure at the highest/farthest fitting.

- All the pipe work etc. shown in the system schematic drawings is meant for information only - Electrical equipment and installation work including the PLC in Control panel. - Painting and labelling of pipe work and equipment.

Hydropneumatic Tank

Suitably sized food grade quality, non-toxic EPDM diaphragm type Hydro pneumatic pressure vessels complete with necessary interconnections and controls. The size shall be as shown in the drawings.

The pre charged hydro pneumatic tank shall be used to minimize constant pressure in the system. The tank will be of the vertical, welded-steel type and cylindrical in shape with semi-elliptical heads and a charging valve. The replaceable internal bladder shall be constructed on heavy duty EPDM food grade. A drain valve shall be located in the bottom of the tank. A pressure relief valve shall be located on the water line connection to the tank. Side and top mounted lifting rings shall be provided. The hydro pneumatic tank shall as per IS 15460.

The tank shall be provided with integral factory welded ASME fabricated steel pedestal supports for mounting on the concrete equipment pads. The tank shall be designed for maximum pressure and temperature as per the system requirement.

Tests:

After completion of installation, the hydro pneumatic shall be completely tested to verify compliance with specifications.

The material of construction of the Hydropneumatic tank shall be as follows:

Component	**Material**
Hydro pneumatic tank	MS/Carbon Steel Epoxy powder Coated
Bladder	EPDM (Food grade)
System connection	Malleable iron/SS

Component	Material
Flange	Carbon steel / SS and galvanised

Bidder will furnish all the detail of Hydro pneumatic system including sizing calculation to owner for their approval

III) Transfer pumps:

The system operation shall be as per Operational philosophy-II. Transfer pumping units shall be provided for supply of domestic water/flushing water supply From UGT to OHT. The units shall be selected so as to provide at minimum of 1.5 bar pressure at the OHT.

SCOPE

This section of the contract involves the design, supply, installation, testing and commissioning of the complete transfer pumping system complete with all controls, control panel (IP 55 enclosure) and electrical work for water supply from UGT to OHT. Includes testing and commissioning of water supply system. All installation work shall comply with the latest rules and regulations. The work embraced by this specification covers the design, submission to authorities, supply and delivery on site, installation, testing, commissioning and maintenance of the Transfer pumping system, installation of the building in accordance with this specification and associated drawings.

The scope of work shall include the following (list is indicative and not exhaustive):

- Vertical inline multistage pump as described in earlier section.
- IP 55 Control panel for pump control complete with VFD /constant speed drives as shown in drawings , circuit breakers, fusses, high pressure switch, etc. complete with all interconnections to pumps and electrical supply panels.
- Pump control units complete with pre-programmed micro-processor chip.
- Pump monitoring units to monitor operation of pumps.
- Pump dry run protection.
- High pressure protection along with pressure relief valve at discharge header
- Pumps cyclic operation system (lead /Lag)

- Each Transfer Pumping unit system shall be supplied as complete set mounting on common base including suction and discharge common manifolds, non-return valves, isolating valves, flexible couplings, pressure gages, control panel, High pressure switches etc,

- Each unit shall be provided with electronic microprocessors for unit control and all necessary electrical work for the unit.

Iv) Submersible Dewatering Pumps

General Requirements

Pump shall be vertical foot mounted submersible & non-clog type. Pump shall be suitable for wet pit installation and portable type. Components of identical pumps shall be interchangeable. The pump should be self priming and designed to handle solids up to a size of 25 mm.

These shall be fully submersible with a fully submersible motor. The pumps shall be provided with an automatic level controller and all interconnecting power and control cabling which shall cause the pumps to operate when the water level in the sump rises to a preset level and stop when the preset low level is reached. Pump shall be provided with mechanical seals.

The pumping set shall be for stationary application and shall be provided with pump connector unit. The delivery pipe shall be joined to the pump through a rubber diaphragm, and bend and guide pipe for easy installation. Pump shall be provide with guide rails and lifting chains.

Pump shall be provided with all accessories and devices necessary and required for the pump to make it a complete working system.

Sump pump shall be complete with level controllers, power and control switch gear, Auto/off/Manual switches, pumps priority selections and control and power cabling up to motor and controller/probes etc. (Including earthing).

The system shall be complete with duty/ assist pumps. The pump shall be sub merged in the water and the automatic control panel shall be outside the sump. In the event of excess flow , if the duty pump is unable to cope the sump inflow the standby pump shall be brought on to assist. Therefore the panel design shall allow for two pumps working simultaneously.

The pump motor shall have Class H insulation and be IP 68 protection. Oil filled motors are not acceptable. The stator shall be heat shrunk fitted into the enclosure and shall not use bolts, pins or other fasteners that penetrate through the stator enclosure. The starter shall be equipped with a thermal switch embedded in series in the coils of the stator windings to protect the stator from wheel and capable of sustaining a minimum of 20 starts/stops per hour. Between stator housing and pump, a tandem seal arrangement will be provided with an oil barrier. Both seals run in oil, allowing dry running without seal damage. Both seals shall be of the rubber bellows or metallic bellow type with positive drive between shaft and rotating seal face.

The control panel shall be IP 55 suitable for wall/floor mounting and equipped with anti condensation heater.

Selected duty pump shall operate independently controlled by float level switch when (HOA) switch is in 'Auto' position . Duty selection shall be carried out from the duty selector switch. The stand by pump shall assist as required.

The panel shall have cyclic changeover to maintain equal wear and tear ie led /lag operation changing.

In the event of duty pump failure , standby pump shall automatically operate.

Pump shall be capable of operating independently or simultaneously with HOA switch in " Hand" position and shall override all control circuits (except over load, float switches)

A set of four level switches shall be provide to control the operation as under:

- Low level switch /dry protection : to stop the pump
- Level 1 switch: To start the duty pump
-Level 2 switch: To start the "Duty Assist" pump
- Level 3 switch : To raise a " High level" alarm

Capacity: As per drawings

Head: As per drawings.

Shut off head 110% of working head

Efficiency: Minimum 70 % at duty point

Quantity: 2 (1W+1A/S)

MOC:

Casing : C.I

Impeller : C.I /SS304

Pump shall be C.I. casing and two vane open type with a dynamically balanced impeller connected to a common shaft of the motor. The vane for sewage pump will be open type, while for drainage pump, etc. it will be of semi open type.

Pumps shall be Duty + assist/stand by Dewater pump shall have following logic:

	Sequence of operation	
Start-1 initiation from pump panel	Pump-1	Pump-2 (Asst)/Stand by
Start-2 initiation from pump panel	Pump-2	Pump-1 (Asst)/stand by

V) Booster Systems For Domestic And Flushing (Variable Speed)

Supply, installation, testing and commissioning of Packaged mono block /Multistage centrifugal Booster pump with Control panel , all necessary incomer & outgoing cables configuration with necessary auto change over mechanism, including motor controls safety etc components , earthing of motor , mounting frames , foundations , internal wiring , cables from Booster Panel to Booster pumps with necessary cable tray, any other necessary imports etc . The pump shall have CI body, stainless steel impeller. Pumps shall be provided with mechanical seal. The pump shall be suitable for auto / manual operation. Minimum pump efficiency to be 70% at duty point.

This packaged water booster pump system shall be a standard product of a single pump manufacturer. The packaged water booster pump system shall use advanced variable frequency drive (VSD)
and dedicated electronic pump controller to maintain a constant desirable water pressure of 1.5 Bar at fixtures as indicated in schematics, drawings and schedules to a maximum flow. Minimum supply pressure shall be around minimum 1.5 Bar (Positive Pressure) at fixtures.

A. Pump

The packaged pump system shall have no. of pumps as indicated on schedule. The maximum duty point of each pump shall be as indicated on drawings, schematics and schedules.

Control panel shall be dust and damp proof steel cabinet supplied by the pump manufacturer and shall include a built-in-anti-condensation heater.

The pumps shall be of the vertical in line multi-stage centrifugal design. The pump suction/discharge chamber (base) shall be in CI / SS. Motor stool and pump shaft coupling shall be constructed of cast iron.

The impellers, pump shaft, diffuser chambers, outer discharge sleeve, impeller seal rings, and seal ring retainers shall be constructed of stainless steel. Optional materials for the suction/discharge chamber and motor stool liner shall be stainless steel. Pump base shall be mounted on spring isolators to isolate the vibration.

The pump impellers shall be secured directly to the pump shaft by means of a spline shaft arrangement for model of the lower sizes, and the pump impellers shall be secured to the shaft by a split cone and nut for higher sizes. The shaft journal and chamber bearings shall be Tungsten Carbide and Ceramic/Bronze. All pumps shall be equipped with a high temperature cartridge mechanical seal assembly with Tungsten Carbide/Carbon or Tungsten Carbide seal faces mounted in stainless steel components. The shaft seal shall be of the cartridge design; the larger pumps (with 7.5 Kw and above motors) shall be designed so that the cartridge seal may be replaced without removing the motors.

B. Air Vessel

The closed diaphragm pressure vessel shall be of polyethylene material with a pressure gauge and isolating valve. The interior shall be of non-toxic lining suitable for use with potable water. The vessel shall be manufactured to conform to ASME pressure vessel code/standards.
The system operation will be such that the initial small water demand shall be met by the charged diaphragm pressure vessel. Should the water demand continue the system pressure will dip to a preset pump cut-in point when the lead pump starts to operate at reduced speed through the variable speed drive. However, should the system pressure be still below the preset value, the controller continuously increases pump speed to meet the system demand. When the lead pump is not able to meet the system pressure at full speed, the second pump also starts to operate.

At peak demand all the duty pumps operate, Similarly, if there is a drop in water demand the duty pump speed starts to reduce, then one duty pump cuts-off, followed by stopping of the duty pump.

C. Motor & Variable frequency drive

The motors shall be TEFC type, IF 55, class F insulation, 2 pole, efficiency class “EFF2, should be a NEMA standard motor. Drive-end motor bearings shall be designed to absorb thrust and shall be adequately sized to ensure long motor life. Motor shall be compatible with VFD.
The variable frequency drive enclosure shall include dry-contact fault-output relay contacts along with analog and digital inputs. The motor shall detect/protect itself against under voltage, over voltage, excessive temperature, and set-point signal fault.

D. Electronic Controller

An electronic dedicated pump logic controller shall operate the pumps to maintain the required system pressure while using minimum energy and alternating between pumps to maintain relatively equal pump operating hours.

As flow demand begins, one of the pumps will start at low speed. As demand increases, the pump will speed up until it reaches full RPM. At this point the second pump will start in full speed. The speed of the first pumps will vary until it builds up required system pressure. This sequence will continue for additional working pumps, if demand is not met.
Pumps shall changeover automatically to maintain the system pressure depending on demand, time, and fault.

E. Control Cabinet

The controller shall be mounted in a control cabinet with an IP-55 enclosure of suitable rating (or specified optional cabinet) with the keypad and display screen mounted through the outer door. In addition to the electronic pump controller, the control cabinet shall include circuit breakers for each pump and the control circuit and control relays for alarm functions.
Control cabinet shall include the following, but not be limited to:

1. Motor protection
2. Dry run protection – Float switch / Inlet pressure monitoring device for suction lift condition
3. 320 X 240 pixels VGA display with adjustable backlight
4. Pump Fault Lights – A Red light for fault indications
5. Visual Alarm
6. Pump Elapsed Time Meters
7. Manual Operation
8. Low water
9. Power on
10. Pump on
11. Pump Stop
12. Pump Trip
13. Off / Auto / Duty pump selector

The entire packaged pumping system shall be mounted on a Hot Dipped Galvanized MS or SS fabricated skid. The control cabinet shall be mounted in one of the following ways depending on the size of the cabinet.

1. On a Hot Dipped GI or MS fabricated control cabinet stand attached to the system skid

2. On a Hot Dipped GI or MS fabricated skid, separate from the main system skid

3. Floor mounted control cabinet with plinth.

G. Plumbing

The suction and discharge manifolds shall be fabricated of Hot Dipped Galvanized MS or SS. Both manifolds shall be designed to attach to the system piping at either end of the manifold. Delivery manifold shall include a pressure gauge. The suction manifold shall have as standard a pressure switch or pressure sensor to detect low suction pressure or a float switch to prevent dry running. The discharge manifold shall include a pressure transducer with a 4-20mA output. The pressure transducer shall be factory installed and wired.

Isolation valves shall be installed on the suction and discharge of each pump. A strainer shall be installed on the suction of each pump and check valve shall be installed on the discharge of each pump

The system shall include a diaphragm type pressure tank sized by the system manufacturer. All systems shall be factory tested for performance and hydrostatic tested to at least 1.5 times the maximum system working pressure. The system manufacturer shall provide verified Factory Performance Tests and Witness Factory Performance Tests/Certificates.

11.1.3 SECTION – 3

Technical Schedule

The Bidder shall furnish the following details as a part of technical bid. Bidder shall furnish all relevant catalogues relevant to the equipment.

(A) <u>Vertical In Line Pumps (Domestic Water)</u>

SL.NO.	DESCRIPTION	UNIT	BIDDER TO INDICATE
1.0	<u>GENERAL</u>		
1.1	Make		
1.2	Model		
2.0	<u>PUMP</u>		
2.1	Quantity	Nos	
2.2	Capacity	m^3/ hr.	
2.3	Total head	MWC	
2.4	Shut - off head	MWC	
2.5	Speed	RPM	
2.6	Combined pump and motor efficiency	%	

SL.NO.	DESCRIPTION	UNIT	BIDDER TO INDICATE
2.7	Mechanical Seal Detail		
2.8	Skid Details		
3.0	MOTOR		
3.1	Motor type		
3.2	Motor rating		
3.3	Motor Cooling Arrangement		
3.4	Class of insulation		
3.5	Output of Motor	kW	
3.6	Type of Starter		
4.0	MOC		
4.1	Casing		
4.2	Impeller		
4.3	Type of Impeller		
4.4	Shaft	kg - m^2	

(B) Hydropneumatic System

SL. NO.	DESCRIPTION	UNIT	BIDDER TO INDICATE
1.	**General**		
(a)	Make		
(b)	Model no.		
(c)	Material of construction		

	(Vessel/Bladder)		
(d)	Dimension		
(e)	Overall capacity		
(f)	Cut-in/Cut-out setting		
(g)	Capacity at specified cut-in/cut-out		
(h)	Overall dimension of skid mounted system		
(i)	Weight (Static/Dynamic)		
(j)	Design pressure		
(k)	Design Temperature		
(l)	Working pressure & temperature		
(m)	Internal/External protection		
(n)	Thickness		
(o)	Shell		
(p)	Dish		
(q)	Hydro test pressure		

(C) Sluice Gate Valve

SR. NO.	DESCRIPTION	UNIT	BIDDER TO INDICATE
1	Manufacturer		
2	Type		
3	Model		
4	Service		

5	Number	Nos	
6	Size	mm	
7	Rating	kg/cm2	
8	Test pressure	kg/cm2	
9	Body material		
10	Gate material		
11	Sealing face material		
12	Shaft material		
(13	Flange Drilling standard		

(D) Ultrasonic Level Transmitter

SL.NO.		DESCRIPTION	UNIT	BIDDER TO INDICATE
SERVICE CONDITION	1	Fluid		
	2	Measuring Level Range		
	3	Press. Nor./Max.		
	4	Temp. Min./Max.		
	5	Density		
	6	Vessel Dimensions		
	7	Vessel MOC		
MEASURING ASSEMBLY	8	Principle		
	9	Type		
	10	Process Connection		

	11	Range Limit		
	12	Span Limit		
	13	Blocking Distance		
	14	Frequency		
	15	Bulit-in Temp. Compensation		
	16	Sensor Housing		
	17	Signal Cable between Sensor & Transmitter		
TRANSMITTER	18	Output		
	19	Type of Mounting		
		Maximum Load		
		Power Supply		
		Cable Entry		
		Calibrated Range		
		Enclosure Class		
		Accuracy		
		Adjustable Damping		
		Zero Adjustment		
		Display Type		
		Device Configuration		
		Data Storage Facility		
		Mouting method		
		Max. / Min. Working Temp. oC	^{o}C	

		Relative Humidity	% RH	
LEVEL CONTROLLER		Type		
		Mounting		
		Power Supply		
		Display Type		
		Device Configuration		
		Cable Entry		
		All Wheather Protection Cover		
		Relay Output		
Purchase		Manufacturer / Contry of Origin		
		Model Number		
		Local Agent		

(E) Pressure Switch

SL.NO.	DESCRIPTION	UNIT	BIDDER TO INDICATE
	GENERAL		
1.	Manufacturer		
2.	Model No.		
	TYPE		
3.	Sensor Type		
4.	Mode		
5.	Mounting		
6.	Switch type		

7.	Switch contact rating		
8.	Switch differential		
9.	Switch differential range		
10.	Set differential pressure		
11.	Over-range protection		
12.	Scale		
	FEATURE		
13.	Accuracy		
14.	Case colour		
15.	Enclosure protection		
	MATERIAL OF CONSTRUCTION		
16.	Housing		
17.	Sensing element		
18.	Body		
19.	Diaphragm seal		
	CONNECTION & DIMENSIONS		
20.	Process connection		
21.	Conduit		
22.	Process connection location		
23.	Name plate/ metal tag		

(F) <u>High Pressure Switch</u>

SL.NO.	DESCRIPTION	UNIT	BIDDER TO INDICATE

	GENERAL		
24.	Manufacturer		
25.	Model No.		
	TYPE		
26.	Sensor Type		
27.	Mode		
28.	Mounting		
29.	Switch type		
30.	Switch contact rating		
31.	Switch differential		
32.	Switch differential range		
33.	Set differential pressure		
34.	Over-range protection		
35.	Scale		
36.	Cut in pressure		
37.	Cut out pressure		
38.	Type of contact		
39.	Max. Operating pressure		
	FEATURE		
40.	Accuracy		
41.	Case colour		
42.	Enclosure protection		
	MATERIAL OF CONSTRUCTION		

43.	Housing		
44.	Sensing element		
45.	Body		

(G) Monorail With Chain Pulley Block

SL.NO.	DESCRIPTION	UNIT	BIDDER TO INDICATE
	General		
1.	Designation		CHAIN PULLEY BLOCK FOR PUMPS
2.	Number offered		
3.	Tag numbers		
4.	Capacity	T	
	Chain pulley block		
6.	Manufacturer		
7.	Make		
8.	Model number		
	Trolley		
11.	Manufacturer		
12.	Make		
13.	Model number		
	Dimensions		
15.	Monorail if provided by vendor:		
	Indicate beam size minimum/ maximum	mm	ISMB /ISMB
	Suitable for trolley movement		
16.	Monorail if provided by purchaser:		YES/NO
	Is size specified in data sheet a		IF NO INDICATE SUITABLE
	Suitable for trolley movement		SIZE ISMB
17.	Distance between highest hook		
	Position to bottom of monorail	mm	
18.	If monorail is curved, minimum		
	Radius trolley can negotiate	mm	
	Materials of construction (contd.)		
21.	If chain pulley block is in hazardous		

SL.NO.	DESCRIPTION	UNIT	BIDDER TO INDICATE
	area:		
21.1	Trolley wheels		
21.2	Load chain wheel and main arm		
21.3	Hand chain wheel		
21.4	Gears and pinions		
	Miscellaneous		
24.	Weight of complete chain pulley		
	Block and trolley assembly	Kg	
25.	Weight of chain pulley block	Kg	
26.	Effort required to lift the load	Kg	
27.	Wheel load with impact and without		
	Impact	Kg	/
28.	Preliminary dimensioned general		
	Arrangement drawing of chain pulley		WHETHER FURNISHED
	Block and trolley along with wheel		YES/NO
	Stop details to be furnished		

(H) Dewatering Pumps

SL.NO.	DESCRIPTION	UNIT	BIDDER TO INDICATE
1.0	GENERAL		
1.1	Make		
1.2	Model		
2.0	PUMP		
2.1	Quantity	Nos	
2.2	Capacity	m^3/ hr.	
2.3	Total head	MWC	
2.4	Shut - off head	MWC	
2.5	Speed	RPM	

SL.NO.	DESCRIPTION	UNIT	BIDDER TO INDICATE
2.6	Combined pump and motor efficiency	%	
2.7	Mechanical Seal Detail		
2.8	Skid Details		
3.0	MOTOR		
3.1	Motor type		
3.2	Motor rating		
3.3	Motor Cooling Arrangement		
3.4	Class of insulation		
3.5	Output of Motor	kW	
3.6	Type of Starter		
4.0	MOC		
4.1	Casing		
4.2	Impeller		
4.3	Type of Impeller		
4.4	Shaft	kg - m^2	

12. COMMISSIONING & GUARANTEE

Scope

Work under this section shall be executed without any additional cost. The rates quoted in this tender shall be inclusive of the works given in this section.

Contractor shall provide all tools, equipment, metering and testing devices required for the purpose.

On award of work, Contractor shall submit a detailed proposal giving methods of testing and gauging the performance of the equipment to be supplied and installed under this contract.

All tests shall be made in the presence of the Architect or his representative or any inspecting authority. At least five working days notice in writing shall be given to the inspecting parties before performing any test.

Water flow rates of all equipment and in pipe lines through valves shall be adjusted to design conditions. Complete results of adjustments shall be recorded and submitted.

Contractor shall ensure proper balancing of the hydraulic system and for the pipes / valves installed in his scope of work by regulating the flow rates in the pipe line by valve operation. The contractor shall also provide permanent Tee connection (with plug) in water supply lines for ease of installing pressure gauge, temperature gauge & rota meters. Contractor shall also supply all required pressure gauge, temperature gauge & rotameter for system commissioning and balancing. The balancing shall be to the satisfaction of Consultant / Project Manager.

Three copies of all test results shall be submitted to the Engineer in A4 size sheet paper within two weeks after completion of the tests.

Pre commissioning

On completion of the installation of all pumps, piping, valves, pipe connections, insulation etc. the Contractor shall proceed as follows:

a. Prior to start-up and hydraulic testing, the Contractor shall clean the entire installation including all fitments and pipe work and the like after installation and keep them in a new condition. All pumping systems shall be flushed and drained at least once through to get rid of contaminating materials. All pipes shall be rodded to ensure clearance of debris, cleaning and flushing shall be carried out in sections as the installation becomes completed.

b. All strainers shall be inspected and cleaned out or replaced.

c. When the entire systems are reasonably clean, a pre-treatment chemical shall be introduced and circulated for at least 8 hours. Warning signs shall be provided at all outlets during pre-treatment. The pre-treatment chemical shall:

· Remove oil, grease and foreign residue from the pipe work and fittings;

· Pre-condition the metal surfaces to resist reaction with water or air.

. Establish an initial protective film;

- After pre-treatment, the system shall be drained and refilled with fresh water and left until the system is put into operation.

- Details and procedures of the pre-treatment shall be submitted to the Architect for approval.

d. Check all clamps, supports and hangers provided for the pipes.

e. Check all the equipment, piping and valves coming under hot water system and operate each and every valve on the system to see if the valves are functioning properly. Thereafter conduct & hydro test of the system as for (b) above.

f. Fill up pipes with water and apply hydrostatic pressure to the system as given in the relevant section of the specification. If any leakage is found, rectify the same and retest the pipes.

Statutory Authorities' Tests And Inspections

As and when notified in writing or instructed by the Architect, the Contractor shall submit shop drawing and attend all tests and inspections carried out by Local Fire Authorities, Water Authority and other Statutory Authorities, and shall forthwith execute free of charge any rectification work ordered by the Architect as a result of such tests and inspections where these indicate non-compliance with Statutory Regulations. Some of these tests may take place after the issue of Practical Completion of the Main Contract and the Contractor shall make all allowances in this respect.

The Contractor shall be responsible for the submission of all necessary forms and shop drawings to the Statutory Authorities which shall conform in layout to the latest architectural plans submitted to and kept by these Authorities.

The submission shall comply with the requirements set forth in the current Codes of Practice and circular letters of the Statutory Authorities. The shop drawings to be submitted shall be forwarded to the Architect for checking before submission.

The Contractor shall allow for at least two submissions of complete sets of shop drawings to the Authorities, one to be made within six months after the award of the Contract but not less than six weeks before the inspection. The Architect may at his discretion instruct the Contractor for additional submissions to the Local Authorities whenever necessary.

The Contractor shall notify the Architect at least seven days in advance of his application for local Authority tests and inspections. On receipt of a confirmed date for test and inspection the Contractor shall inform the Architect without delay.

Final Acceptance Tests

Following commissioning and inspection of the entire installation, and prior to issue of the

Completion Certificate, the Contractor shall carry out final acceptance tests in accordance with a programme to be agreed with the Architect.

Should the results of the acceptance tests show that plant, systems and/or equipment fail to perform to the efficiencies or other performance figures as given in this Specification, the Contractor shall adjust, modify and if necessary replace the equipment without further payment in order that the required performance is obtained.

Where acceptance tests are required by the relevant Authorities having jurisdiction, these tests shall be carried out by the Contractor prior to the issue of Completion Certificate to the acceptance of the Authorities.

Rejection Of Installation / Plant

Any item of plant or system or component which fails to comply with the requirements of this Specification in any respect whatsoever at any stage of manufacture, test, erection or on completion at site may be rejected by the Architect either in whole or in part as he considers necessary/appropriate. Adjustment and/or modification work as required by the Architect so as to comply with the Authority's requirements and the intent of the Specification shall be carried out by the Contractor at his own expense and to the satisfaction of the Authority/Architect.

After works have been accepted, the Contractor may be required to carry out assist in carrying out additional performance tests as reasonably required by the Architect/Employer.

Warranty And Handover

The Contractor shall warrant that all plant, materials and equipment supplied and all workmanship performed by him to be free from defects of whatsoever nature before handover to the Owner.

Handing Over Of Documents

All testing and commissioning shall be done by the Contractor to the entire satisfaction of the Owner's site representative and all testing and commissioning documents shall be handed over to the Owner's site representative.

The Contractor shall also hand over all maintenance and operation manuals, all certificates and all other documentation as per the terms of the contract to the Owner's site representative.

Pipe Colour Code:

S. No	Services/Equipments	Ground Colour	First Colour Band	Second Colour Band	Band (mm)	
					Width	Spacing
A.	WATER					
1.	Fire water	Fire Red	Crimson Red	-	25	1500
2.	Municipal Raw water	Sea Green	-	-	-	-
3.	Treated Domestic water	Sea Green	Light Orange	-	25	1500
4.	Drinking water	Sea Green	French blue	Signal Red	25	1500
5.	Cold water down takes from Overhead storage tanks	Sea Green	French blue	Canary Yellow	25	1500
6.	Domestic Hot water from localised heaters	Sea Green	Light Grey	-	25	1500

7.	Centralised heating below 60^0C	Sea Green	Canary Yellow	-	25	1500
8.	Soft water	Sea Green	Light Brown	Signal Red	25	1500
9.	Recycled treated water for Flushing	Sea Green	Light Brown	-	25	1500
10.	Boiler feed water	Sea Green	Gulf Red	-	25	1500
11.	Condensate	Sea Green	Light Brown	-	25	1500
12.	Landscape sprinkle and hydrant water	Sea Green	White	Signal Red	25	1500
B.	DRAINAGE					
1.	Soil	Black	-	-	-	-
2.	Waste	Black	White	-	25	1500
3.	Vent	Black	White	-	25	1500
4.	Rain water	Black	-	-	25	1500
C.	Natural Gas	Light Brown	White & Blue	-	25	1500
D.	Equipments and others					
1.	Pumps and Motors	Canary Yellow	-	-	-	-
2.	Pipe supports	Black or as directed	-	-	-	-
3.	Electric panels	Steel Grey	-	-	-	-

Notes: All colours and code refer to Synthetic Enamel colours. The painting shall be with synthetic enamel paint unless otherwise specified.

Identification

The system of colour coding shall consist of a ground colour and colour bands superimposed on it.

Ground Colours

The ground colour shall identifies the basic nature of the fluid carried (see Fig.1) and also distinguishes one fluid from another. The various ground colours are indicated in Table above.

Ground colour shall be applied throughout the entire length for un-insulated pipes, for insulated pipes, on the metal cladding or on the pipes of material such as non-ferrous metals, austenitic stainless steel, plastic, etc., ground colour coating of minimum 2m length or of adequate length, not to be mistaken as colour band, shall be applied.

Colour Bands

Colour bands shall be superimposed on the ground colour.

Wherever the ground colour is not applied throughout the entire length, it shall be applied near valves, junctions, joints, service appliances, bulkheads, walls, etc. (see Fig. 3)

They shall be superimposed on ground colour at the following location:

a) At battery limit points;
b) Intersection points and change of direction points in piping ways;
c) Other points such as midway of each piping way, near valves, junction joints of service appliances, walls, on either side of pipe culverts;
d) For long stretch yard piping at 50m interval; and
e) At start and terminating points.

The relative proportional widths of the first colour band to the subsequent bands shall be 4:1

Minimum width of colour band shall confirm to the following Table;

Nominal Pipe Size	Width L (mm)
80 NB and below	25
Over 100 NB upto 150 NB	50
Over 200 NB upto 300 NB	75
Over 350 NB	100

For insulated pipes nominal pipe size means the outside diameter of insulation.

Valves shall be painted with the same colour as the main pipelines except when the pipeline has been provided with the safety colour, the valves shall be painted red, for fire fighting; yellow, with black diagonal stripes, for warning of danger; and French blue in conjunction with the green basic colour, to denote pipes carrying fresh water, either potable or non-potable.

14. LIST OF BUREAU OF INDIAN STANDARDS CODES

All equipment, supply, erection, testing and commissioning shall comply with the requirements of Indian Standards and code of practices given below as amended upto 30th April, 2002. All equipment and material being supplied by the contractor shall meet the requirements of IS. Tarrif advisory committee's regulation (fire insurance), electrical inspectorate and Indian Electricity rules and other Codes / Publications as given below:

1.0 Pipes and Fittings

IS : 458	Specification for precast concrete pipes (with and without reinforcement)
IS : 651	Salat glazed stone ware pipes and fittins.
IS : 1239 (Part 1)	Mild steel, tubes, tubulars and other wrought steel fittings : Part 1 Mild Steel tubes.
IS : 1239 (Part 2)	Mild Steel tubes, tubulars and other wrought steel fittings : Part 2 Mild Steel tubulars and other wrought steel pipe fittings.
IS : 1536	Centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
IS : 1537	Vertically cast iron pressure pipes for water, gas and sewage.
IS : 1538	Cast Iron fittings for pressure pipes for water, gas and sewage.
IS : 1729	Sand Cast iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS : 1879	Malleable cast iron pipe fittings.
IS : 1978	Line pipe
IS : 1979	High test line pipe.
IS : 2501	Copper tubes for general engineering purposes
IS : 2643 (Part 1)	Dimensions for pipe threads for fasterning purposes : Part 1 Basic profile and dimensions.
IS : 2643 (Part 2)	Dimensions for pipe threads for fastening purposes : Part 2 Tolerances.
IS : 2643 (Part 3)	Dimensions for pipe threads for fastening purposes : Part 3 Limits of sizes.
IS : 3468	Pipe nuts.
IS : 3589	Seamless or electrically welded steel pipes for water, gas and sewage (168.3 mm to 2032 mm outside diameter).
IS : 3989	Centrifugally cast (sun) iron spigot and socket soil, waste and ventilating pipes, fittings and accessories.
IS : 4346	Specifications for washers for use with fittings for water services.

IS : 4711	Methods for sampling steel pipes, tubes and fittings.
IS: 4985	uPVC pipes
IS:7834	uPVC fittings
IS:13592	uPVC pipes
IS:15328	Underground uPVC brown pipes
ISO:21138-3	HDPE double wall corrugated pipes
IS : 6392	Steel pipe flanges
IS : 6418	Cast iron and malleable cast iron flanges for general engineering purposes.
IS : 7181	Specification for horizontally cast iron double flanged pipe for water, gas and sewage.
DIN :4102	PP Silent pipes

2.0 <u>Valves</u>

IS : 778	Specification for copper alloy gage, globe and check valves for water works purposes.
IS : 780	Specification for sluice valves for water works purposes (50 mm to 300 mm size).
IS : 1703	Specification copper alloy float valves (horizontal plunger type) for water supply fittings.
IS : 2906	Specification for sluice valves for water works purposes (350 mm to 1200 mm size)
IS : 3950	Specification for surface boxes for sluice valves.
IS : 5312 (Part 1)	Specification for swing check type reflux (non return) valves : part 2 Multi door pattern.
IS : 5312 (Part 2)	Specification for swing check type reflux (non return) valves : part 2 Multi door pattern.
IS : 12992 (Part 1)	Safety relief valves, spring loaded : Design
IS : 13095	Butterfly valves for general purposes.

3.0 <u>Sanitary Fittings</u>

IS : 771 (Part 1 to 3)	Specification for glazed fire clay sanitary appliances.
IS : 774	Specification for flushing cistern for water closets and urinals (other than plastic cistern)
IS : 775	Specification for cast iron brackets and supports for wash basins and sinks
IS : 781	Specification for cast copper alloy screw down bib taps and stop valves for water services.
IS : 1700	Specification for drinking fountains.

IS : 2548 (Part 2)	Specification for plastic seats and covers for water closets : Part 1 Thermoset seats and covers.
IS : 2556 (Part 1)	Specification for vitreous sanitary appliances (Vitreous china) Part 1 General requirement.
IS : 2556 (Part 2)	Specification for vitreous sanitary appliances (vitreous china) Part 2 Specific requirements of wash-down water closets.
IS : 2556 (Part 3)	Specification for vitreous sanitary appliances (vitreous china) Part 3 Specific requirements of squatting pans.
IS : 2556 (Part 4)	Specification for vitreous sanitary appliances (vitreous china) part 4 specific requirements of wash basins.
IS : 2556 (Part 6 Sec 2)	Specification for vitreous sanitary appliances (vitreous china) part 6 Specific requirements of urinals, section 2 half stall urinals.
IS : 2556 (Part 6 Sec 4)	Specification for vitreous sanitary appliances (vitreous china) Part 6 specific requirements of urinals, section 4 partition slabs.
IS : 2556 (Part 6 Sec 5)	Specification for vitreous sanitary appliances (vitreous china) Part 6 Specific requirements of urinals, section 5 waste fittings.
IS : 2556 (Part 6 Sec 6)	Specification for vitreous sanitary appliances (vitreous china) Part 6 Specific requirements of urinals, section 6 water spreaders for half stall urinals.
IS : 2556 (Part 7)	Specification for vitreous sanitary appliances (vitreous china) Part 7 Specific requirements of half round channels.
IS : 2556 (Part 8)	Specification for vitreous sanitary appliances (vitreous china) Part 8 Specific requirements of siphoning wash down water closets.
IS : 2556 (Part 11)	Specification for vitreous sanitary appliances (vitreous china):Part 11 Specific requirements for shower rose.
IS : 2556 (Part 12)	Specification for vitreous sanitary appliances (vitreous china) : Part 12 Specific requirements of floor traps.
IS : 2556 (Part 15)	Specification for vitreous sanitary appliances (vitreous china) : Part 15 Specific requirements of universal water closets.
IS : 2692	Specification for ferrule for water services
IS : 2717	Glossary of terms relating to vitreous enamelware and ceramic metal systems
IS : 2963	Specifications for waste plug and its accessories for sinks and wash basins.
IS : 3311	Specification for waste plug and its accessories for sinks and wash basins.
IS : 5961	Specification for cast iron gratings for drainage purposes.
IS : 6249	Specification for gel-coated glass fibre reinforced polyester resin

	bath tubs.
IS : 6411	Specification for gel-coated glass fibre reinforced polyester resin bath tubes.
IS : 8931	Specification for copper alloy fancy single taps, combination tap assembly and stop valves for water services.
IS : 9758	Specification for flush valves and fitting for water closets and urinals.

4.0 Water Quality Tolerance

IS : 3025 (Parts 1 to 44)	Method of sampling and test (physical and chemical) for water and waste water.
IS : 4764	Tolerance limits for sewage effluents discharged into inland surface waters.
IS : 10500	Drinking Water

5.0 Pumps & Vessels

IS : 1520	Specification for horizontal centrifugal pumps for clear cold fresh water.
IS : 2002	Steel plates for pressure vessels for intermediate and high temperature service including boilers.
IS : 2825	Code for unfired pressure vessels.
IS : 4648 (Part 1)	Code of practice for lining of vessels and equipment for chemical processes Part 1 : Rubber lining.
IS : 5600	Specification for sewage and drainage pumps
IS : 8034	Specification for submersible pump sets for clear, cold, fresh water.
IS : 8418	Specification for horizontal centrifugal self priming pumps.

6.0 General

SP : 6 (1)	Structural Steel Sections
IS : 325	Three Phase Induction Motors
IS : 554	Dimensions for pipe threads where pressure tight joints are required on the threads.
IS : 694	PVC insulated cables for working voltages upto & including 1100 V.
IS : 779	Specification for water meters (domestic type).
IS : 782	Specification for caulking load.
IS : 800	Code of practice for general construction in steel
IS : 1068	Electroplated coatings of nickel plus chromium and copper plus nickel plus chromium.

IS : 1172	Code of Basic requirements for water supply drainage and sanitation.
IS : 1367 (Part 1)	Technical supply conditions for threaded steel fasteners : Part 1 introduction and general information.
IS : 1367 (Part 2)	Technical supply conditions for threaded steel fasteners : Part 2 product grades and tolerances.
IS : 1554 (Part 1)	PVC insulated (heavy duty) electric cables : Part 1 for working voltages upto and including 1100 V.
IS : 1554 (Part 2)	PVC insulated (heavy duty) electric cables : Part 2 for working voltages from 3.3 KV upto and including 11 KV.
IS : 1726	Specification for cast iron manhole covers and frames.
IS : 1742	Code of practice for building drainage.
IS : 2064	Selection, installation and maintenance of sanitary appliance code of practice.
IS : 2065	Code of practice for water supply in buildings.
IS : 2104	Specification for water meter for boxes (domestic type)
IS : 2373	Specification for eater meter (bulk type)
IS : 2379	Colour code for identification of pipe lines.
IS : 2527	Code of practice for fixing rainwater gutters and down pipes for roof drainage.
IS : 2629	Recommended practice for hot dip galvanizing on iron and Steel.
IS : 3114	Code of practice for laying of cast iron pipes
IS : 4111 (Part 1)	Code of practice for ancillary structures in sewerage system : Part 1 manholes.
IS : 4127	Code of practice for laying glazed stoneware pipes.
IS : 4853	Recommended practice for radiographic inspection of fusion welded butt joints in steel pipes.
IS : 5329	Code of practice for sanitary pipe work above ground for buildings.
IS : 5455	Cast iron steps for manholes.
IS : 6159	Recommended practice for design and fabrication of material, prior to galvanizing.
IS : 7558	Code of practice for domestic hot water installations.
IS : 8321	Glossary of terms applicable to plumbing work.
IS : 8419 (Part 1)	Requirements for water filtration equipment : Part 1 Filteration medium sand and gravel.
IS : 8419 (Part 2)	Requirements for water filtration equipment : Part 2 under drainage system.

IS : 9668	Code of practice for provision and maintenance of water supplies and fire fighting.
IS : 9842	Preformed fibrous pipe insulation.
IS : 9912	Coal tar based coating materials and suitable primers for protecting iron and steel pipe lines.
IS : 10221	Code of practice for coating and wrapping of underground mild steel pipelines.
IS : 10446	Glossary of terms relating to water supply and sanitation.
IS : 11149	Rubber Gaskets
IS : 11790	Code of practice for preparation of butt-welding ends for pipes, valves, flanges and fittings..
IS : 12183 (Part 1)	Code of practice for plumbing in multistoried buildings : Part 1 water supply.
IS : 12251	Code of practice for drainage of building basements.
IS : 5572	Code of practice for sanitary pipe work.
BS : 6700	Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their cartilages.
BS : 8301	Code of practice for building drainage.
BSEN : 274	Sanitary tap were, waste fittings for basins, bidets and baths. General technical specifications.

15. ELECTRICAL SYSTEM

1. Scope

Work shall be carried out in accordance with the accompanying specifications and shall comply with the latest relevant Indian Standards and Electricity Rules and Regulations.

The configuration of the MCC shall be designed to suit the requirements of the process". The necessary Single Line diagrams/ Schematic drawings shall be furnished for approval by Consultant/ Owner.

All motor control centres shall be CPRI approved and shall be suitable for operation on 3 phase/single phase 415/230 volts, 50 cycles power supply

This specification covers the specific requirements including complete manufacture, supply, delivery to site, storage at site, transportation from place of storage to erection site, erection, wiring, earthing testing, commissioning and handing over of Floor/ Wall Mounted Pumping MCC Panel required for pumping system.

The control panel shall be of adequate size with a provision of 25% spare space to accommodate possible future breakers. Breakers shall be arranged in multi-tier. Knockout holes of appropriate size and number shall be provided in the Motor Control Centre in conformity with the location of cable/conduit connections. Removable sheet steel plates shall be provided at the top to make holes for additional cable entry at site if required.

Every cabinet shall be provided with Trifoliate or engraved metal name plates. All panels shall be provided with circuit diagram mounted on inside of door shutter protected with Hylam sheet. All live accessible connections shall be shrouded and shall be finger touch proof and minimum clearance between phase and earth shall be 20 mm and phase to phase shall be 25 mm.

All equipment and components shall be new and supplied by approved manufactures. Equipment & Components requiring specialised maintenance or operation shall be avoided as far as possible. All equipment shall be complete with all necessary weather and anticorrosion protection including tropicalization to prevent damage/deterioration due to climate.

The detailed parameters of the MCC Panel with associated switch-gears shall be as be as per the actual requirement for its satisfactory working, however for ease of understand Contractor can refer the power distribution strategy shown in the SLD only for reference.

2. System Design Parameter

All equipment shall be designed to operate satisfactorily and meet the requirements specified in this specification under all site conditions where the equipment is proposed to be installed. The design ambient shall be 45 deg. C for all equipment.

The equipment shall be designed and manufactured in accordance with the best engineering practices and shall be suitable for the intended purpose.

Following System Parameter to be adopted for system design.

Nominal (Rated) System Voltage 3Ph / 1Ph	:	0.415kV / 0.230kV
Highest System Voltage	:	1.1kV
Lightning Impulse Withstand Voltage (1.2/ 50 microsecond)	:	-
Power Frequency Withstand Voltage for 1 minute	:	3 kV rms
System Neutral Earthing	:	Solidly Earthed
Continuous current rating of Main Busbar	:	Refer SLD
Continuous current rating of Feeders	:	
Fault Level of System	:	10kA for 1sec.
Frequency	:	50 Hz
Minimum Phase-Earth Clearance	:	15.8 mm
Minimum Clearance between Phases	:	19.05 mm

3. Panel Boards

Separate, segregated metal clad compartments shall be provided for main and auxiliary bus bars, each feeder and cable alleys. Metal clad cubicles/modules shall be provided with hinged doors in the front, with facility for padlocking door handles. More than one module may be arranged in the same vertical section. It shall be possible to extend the switchboard on both sides. Construction of the panel shall be minimum form 3B.

In case of circuit breaker compartments, suitable barriers shall be provided between breaker and all control, protective and indication circuit equipment including instrument transformers. External cable connections shall be through separate cable compartments for power and control cables.

The fixed type module shall have all the circuit components mounted in the compartment, with bolted type power and control connections. It shall be possible to remove all circuit components after removing the connections and the component fixing bolts.

Instruments, relays and control devices shall be mounted flush on hinged door of the cubicles. Switchboard shall be complete with inter-panel wiring.

Each switchboard shall also be fitted with a label indicating its title. Each cubicle shall be fitted with a label on the front and rear of the cubicle. Each relay, instrument, switch, fuse, contactor and MCCB/MCBMPCB shall be provided with a separate label.

One metal sheet shall be provided between two adjacent vertical sections running to the full height of the switchboard except for the horizontal busbar compartment. However, each shipping sections shall have metal sheets at both ends.

After isolation of the power and control connections of a circuit, it shall be possible to carry out maintenance in a compartment safely, with the busbars and adjacent circuits alive.

The current rating of outgoing feeders of any switchboard shall not be less than 10% of that of the incoming feeder. Deviation from this requirement shall be subject to the approval.

Panels shall comprise of Phase indicating lights, on, off, trip indication lights for incomers and for all outgoings auto manual selector switch with on and trip status indicators.

All logical circuitry shall be done to suit intended operational philosophy.

Panel shall be minimum IP54 Rating for the indoor application and IP65 for the outdoor application

Bus bars (In Panel Boards)

The phase and neutral bus bars shall be of rating indicated in the corresponding one line diagram. Bus bars shall be of copper for up to current rating of 100A and above 100A it shall be Aluminium bus bars and shall be provided with minimum clearances as per relevant IS/IEE standards.

All busbars and bus taps shall be insulated with close fitting sleeve of hard, smooth, dust and dirt free, heat shrunk PVC insulation of high dielectric strength, to provide a permanent non-ageing and non-tracking protection, impervious to water, tropical conditions and fungi. The insulation shall be non-inflammable and self extinguishing type and in fast colours to indicate phases. The dielectric strength and properties shall hold good for the temperature range of 0 to 95 degree centigrade. If the insulating sleeve is not colored, bus bars shall be colour coded with colored PVC tape at suitable intervals.

Bus bar joints shall be of the bolted type. Spring washers shall be provided to ensure good contact at the joints. Busbars shall be thoroughly cleaned at the joints and suitable contact grease shall be applied just before making a joint.

Direct access to, or accidental contact with busbars and primary connections shall not be possible. All apertures and slots shall be protected by baffles to prevent accidental shorting of busbars due to insertion of maintenance tools.

Sequence of red, yellow and blue phases and neutral for four-pole equipment shall be left to right and top to bottom, for horizontal and vertical layouts respectively.

4. Motor starters

4.1 Technical requirement

The type of starter to be used shall be as follows (to be read in conjunction with MEP equipment schedules.

Type of Motor Staring Method

a) Constant Speed motors upto and including 7.5kW: Automatic Direct on Line starters.

b) Constant Speed motors of above 7.5Kw : Automatic Star/Delta Starters

c) Two Speed Motors Automatic : Star/Delta Starters

d) Variable frequency drive (VFDs)

The starting current of the motors shall be limited by using the above mentioned starters, as required.

Where individual starters and controls are grouped together, the Contractor shall provide a panel for mounting this equipment.

Starter feeders shall be equipped with but not limited to:

a). Main MPCB/MCCB with door interlocked rotary handle.(lockable in the off position).

b). Contactors for direct on-line starting or star-delta starting as noted in the contract documentation

c.) Thermal overload relay with built in single phasing prevention feature.

d). Hand-Off-Auto control switch.

e). Common duty selector switch.

f). Thermister relay.

g). RUN/TRIP lamps.

h). Auto changeover arrangement.

4.2 Star Delta And Direct On Line Type

Motor starters shall be in accordance with respective codes as specified above. The starters shall be totally enclosed, metal clad, dust and vermin proof construction. The starters shall be of continuous

rating and shall be of automatic type. All starters shall be suitable for 415 volts, 3 phase, 50 HZ, A.C. supply.

Provide starters incorporating over current protection for motors starters.

Contactors shall have the number of poles as required for appropriate duty. The making capacity of the contactors shall be as per AC23 of ISS.

Unless other specified, all starters shall have integral start/stop push buttons. Start push buttons shall be coloured green and shall be shrouded to prevent inadvertent operation. Stop push buttons shall have mushroom heads and shall be coloured red. All push buttons operated contractors shall be provided with a hold-on/running contact.

All remote control circuit connected to be starters shall operate at 230 volts or lower voltage.

Motor starters shall be provided with thermal overload relay with adjustable settings, one each phase for three phase motors. Single phasing preventers shall be provided for all three phase motors.

Terminal block with integral insulating barriers shall be provided for each starter.

All the starter shall be provided with a schematic diagram on a durable material fixed permanently within each lid or cover.

Starters shall be provided with sufficient extra N/O contacts for interlocks, indicating lamps, etc.

Automatic Star/Delta starters shall be provided with adjustable timers.

Starters for wound rotor motors shall be rotor resistance type and shall be oil/air immersed, metal clad construction with combination of drum type rotor resistance starter and starter switch. Rotor starter shall be used for starting only. The starter switch shall be of heavy duty, with trip free mechanism. The tripping mechanism shall not reset until the starter handle is in "OFF' position.

For Star//Delta starters incorporate adjustable time delay contactor relays, to control star delta changeover, ensuring electrical endurance compatible with starter contactors. Ensure starting sequence activated on voltage restoration.

All motor starters will be provided with Type 2 Co-ordination such that under short circuit conditions, the contactor or starter shall cause no danger to persons or installation and shall be suitable for further use. The risk of contact welding is recognized, in which case the manufacture shall indicate the measures to be taken in regards to equipment maintenance

4.3 Soft Starters

Provide soft-start starters as noted in Tender Documentation.

Soft start starters shall be provided for the specified service. Soft start starters shall consist of a main disconnect switch, a mechanical contactor, a six-SCR full wave bridge solid state reduced voltage starter, a thermal overload relay factory assembled in a single enclosure, with ratings, features and accessories as specified below. The soft start shall be capable of controlling the starting inrush of a NEMA design B motor, and to reduce water hammer effects of the pumps when the motor is stopped.

Ratings and features:

a. Starter voltage as noted on electrical SLD.
b. Enclosure type, NEMA 1 ventilated.
c. Main AC line fused disconnects or circuit breaker mounted and wired, with a door interlock mechanism and padlocking means.
d. Starter shall include a full NEMA style, HP sized and rated series contactor, including contacts and coils, ahead of the solid state electronics. Contactor shall open on normal stop command, and if a shorted SCR is detected.
e. Starter shall be rated for a minimum of 350 present current for 30 seconds.
f. Starter shall include adjustable thermal overload protection.
g. Starter shall include maintained contact H-O-A selector switch and red running pilot light.
h. Starter shall include an integral 230V control circuit transformer with primary and secondary fusing.
i. Starter shall be rated for full current operation at 40 degrees C ambient temperature.
j. In addition to the interlock & switches specified above each soft start starter shall be provided with (4) four additional spare sets of auxiliary contacts, (2) two normally open & (2) two normally closed.

Protective features and adjustments:

a. SCR's shall be rated 1600 PIV minimum.
b. Instantaneous over current trip shall be included if current exceeds 900 percent FLA.
c. Metal Oxide Varistor (MOV) suppressors shall be provided.
d. Heat sink over temperature switch shall be provided.
e. Starter shall include shorted SCR detection and lockout.
f. Starter shall not start if a phase loss condition is present.
g. Diagnostics shall include LED indicators for:

1.phase power present

2. Shorted SCR detected

3. Motor overload

4. Instantaneous overcurrent

5. Starter ready

6. Starter on

7. Power supply failure

h. A fault relay shall be included to trip the series contactor in the event of motor thermal overload, instantaneous overcurrent, of presence of a shorted SCR.

i. Adjustments shall include ramp time, current limit, jog voltage, jog time, and deceleration time.

Operational Features:

a. On starting, the starter shall be capable of applying an adjustable "jog" voltage to the motor for an adjustable time to magnetize the motor, then automatically switch to a controlled current ramp mode to accelerate the load.

b. On stopping, the starter shall include an "anti-water hammer" circuit which is capable of accepting a 0-10V DC signal proportional to flow from the building automation system and controlling the voltage to the motor to obtain a smooth reduction in flow without excessive pipe movement or water hammer. As a backup, a linear voltage ramp deceleration mode shall be available.

Field Start-up and Service:

a. Soft starter supplier shall provide authorized factory trained service personnel to do on-site start-up and adjustment for each soft start starter.

4.4 Variable Frequency Drive

VFD Description:

Variable-frequency drive (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and over current and overload protection; as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

a. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

Unit Operating Requirements:

a. Input AC Voltage Tolerance: Plus ± 6percent of VFD input voltage rating.

b. Input AC Voltage Unbalance: Not exceeding 3 percent.

c. Input Frequency Tolerance: Plus or minus 3 percent of VFD frequency rating.

d. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.

e. Minimum Short-Circuit Current (Withstand) Rating: 25 kA.

f. Vibration Withstand: Comply with IEC 60068-2-6.

g. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
h. Starting Torque: Minimum 100 percent of rated torque from 3 to 50 Hz.
i. Speed Regulation: Plus or minus 5 percent.
j. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
k. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

Internal Adjustability Capabilities:

a. Minimum Speed: 5 to 25 percent of maximum rpm.
b. Maximum Speed: 80 to 100 percent of maximum rpm.
c. Acceleration: 0.1 to 999.9 seconds.
d. Deceleration: 0.1 to 999.9 seconds.
e. Current Limit: 30 to minimum of 150 percent of maximum rating.

Self-Protection and Reliability Features:

a. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
b. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
c. Under- and overvoltage trips.
d. Inverter over current trips.
e. VFD and Motor Overload / Over temperature Protection: Microprocessor-based thermal protection system for monitoring VFD's and motor thermal characteristics, and for providing VFD over temperature and motor overload alarm and trip; settings selectable via the keypad.
f. Critical frequency rejection, with three selectable, adjustable dead bands.
g. Instantaneous line-to-line and line-to-ground over current trips.
h. Loss-of-phase protection.
i. Reverse-phase protection.
j. Short-circuit protection.
k. Motor over temperature fault.

Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Auto speed Search" feature is available and engaged.

Bidirectional Auto speed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

Integral Input Disconnecting Means and OCPD: NEMA KS 1, fusible switch with pad lockable, door-mounted handle mechanism.

a. Disconnect Rating: Not less than 115 percent of VFD input current rating.
b. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.
c. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
d. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
e. NC or NO alarm contact that operates only when circuit breaker has tripped.

Emergency Start/ Stop Push Button (Near The Motor)

a. Shall be provided with 2 No positive action N/C contacts.
b. Shall be provide with 1 No N/O contacts.
c. Housing material shall be Plastic.
d. Enclosure rating shall be IP 65.
e. Connection type (contacts) shall be Screw connection.
f. Mounting diameter shall be a minimum of 22 mm.
g. Mechanical life shall be a minimum of 50.000 switching cycles.
h. Ambient operating temperature shall be from–40 °C to +70 °C.
i. Protection class II.
j. Usage category shall comply with IEC
k. Rated insulation voltage Ui 600 V.
l. Minimum switching voltage 5 V DC.
m. Minimum switching current 1 mA.
n. Connection type (contacts) Screw connection.
o. Maximum connection cable cross-section 2.5 mm².
p. LED indicator lamps shall be provided.
q. Emergency Start / Stop button to be coloured ‘RED’

4.5 Starter components

MCCB

MCCBs shall be of the air break, quick make, quick break and trip free type and shall be totally enclosed in a heat resistant, moulded, insulating material housing.

MCCBs shall have an ultimate short circuit capacity not less than the prospective short circuit current at the point of installation.

MCCBs shall have a service short circuit breaking capacity equal to the ultimate short-circuits capacity.

Each pole of MCCB shall be fitted with a bi-metallic thermal element for inverse time delay protection and a magnetic element for short circuit protection. Alternatively, they shall be fitted with a solid state protection system. Such a protection system shall be fully self-contained, needing no separate power supply to operate the circuit breaker tripping mechanism. Thermal element shall be adjustable. Adjustments shall be made simultaneously on all poles from a common facility. Thermal elements shall be ambient temperature compensated.

The MCCBs shall be provided with the following features.

- Common trip bar for simultaneous tripping of all poles
- Shrouded terminals
- Time for clearing short circuit current of 20 msec.
- NO + 2 NC auxiliary contacts.

Motor Protection Circuit Breaker (MPCB)

MPCB shall be hand operated, air break, quick make, quick break type.

Operating mechanisms shall be mechanically trip-free from the operating knob to prevent the contacts being held closed under overload or short-circuit conditions.

Each pole shall be fitted with a bi-metallic element for overload protection and a magnetic element for short-circuit protection. Multiple pole MPCBs shall be mechanically linked such that tripping of one pole simultaneously trips all the other poles. The magnetic element tripping current classification shall be of the type suitable for the connected load.

The short circuit rating shall be not less than that of the system to which they are connected.

MPCB shall be all inclusive of contactor, timer, bi metallic relay as included in starters.

Contactors

The power contactors used in the switchboard shall be of, air break, single throw, triple pole, electromagnetic type. Contactors shall be suitable for uninterrupted duty and rated for Class AC3 duty in accordance with the latest edition of IS 13947.

Operating coils of all contactors shall be suitable for operation on 240 V, single phase, 50 Hz supply.

Contactors shall be provided with at least two pairs of NO and NC auxiliary contacts.

Contactors shall not drop out at voltages down to 70 % of coil rated voltage.

Contactors shall be provided with a three element, positive acting, ambient temperature compensated, time lagged, hand reset type thermal overload relay with adjustable settings. The hand reset button shall be flush with the front door of the control module, and shall be suitable for resetting the overload relay with the module door closed. Relays shall be either direct connected or CT operated. Overload relay and reset button shall be independent of the "Start" and "Stop" push buttons. All contactor shall all be provided with single phasing preventer (SPP).

Motor starters shall be complete with auxiliary relays, timers and necessary indications.

Instrument Transformers

Current transformer (CT) shall have polarity markings indelibly marked on each transformer and at the lead terminations at the associated terminal block.

CT shall be able to withstand the thermal and mechanical stresses resulting from the maximum short circuit current.

CT core laminations shall be of high grade silicon steel.

Secondary winding of voltage transformer (VT) shall be rated for a three phase line to line voltage of 110 V.

Identification labels giving type, ratio, output and serial numbers shall be provided.

All CT's shall be of class-1 accuracy

Relays

a. Main protective relays shall be Numerical / Static type.
b. All relays shall be enclosed in rectangular shaped, dustproof cases and shall be suitable for flush mounting.
c. All relays shall be accessible from the front for setting and resetting. Access to setting devices shall be possible only after the front covers of the relays are removed. Resetting facilities shall however be accessible external to the relay case.
d. All protective relays shall be of the draw-out type and shall be provided with operation indicators visible from the front.
e. Auxiliary relays and timers shall be rated to operate satisfactorily between 70 % and 110 % of the rated voltage.

Thermal overload relay

Thermal over load relay shall have built in phase failure sensitive tripping mechanism to prevent against single phasing as well as on overloading. The relay shall operate on the differential system of protection to safeguard against three phase overload, single phasing and unbalanced voltage conditions.

Auto-manual conversion facility shall be provided to convert from auto-reset mode to manual-reset mode and vice-versa at site. Ambient temperature compensation shall be provided for variation in ambient temperature from -5° C to +55°C.

All overload relays shall be of three element, positive acting ambient temperature compensated time lagged thermal over load relays with adjustable setting. Relays shall be directly connected for motors up to 35 HP capacity. C.T. operated relays shall be provided for motors above 35 HP capacity. Heater circuit contactors may not be provided with overload relays.

Time delay relays

Time delay relays shall be adjustable type with time delay adjustment from 0-180 seconds and shall have one set of auxiliary contacts for indicating lamp connection

Control and Selector Switches

Control and selector switches shall be of the rotary type, having enclosed contacts, which are accessible by the removal of the cover. Control and selector switches for instruments shall be flush mounted on the front of the panels and desks.

All control switches shall be of the spring return to normal type and shall have momentary contacts. Selector switches shall be of the stay-put, maintained contact typ

Indicating Instruments & Meters

Electrical indicating instruments shall be 110 mm square with 240 deg scale. Taut band type of instruments is preferred. Taut band moving coil instruments for use on AC systems shall incorporate built-in transducers.

Instrument dials shall be white with black numbers and lettering.

Normal maximum meter reading shall be of the order of 60 % normal full scale deflection.

Ammeters for motor feeders shall have suppressed scale to show current from full load up to six times the full load current.

Watt hour meters shall be of the induction type and shall be provided with reverse running stops.

Instruments shall have an accuracy of Class 1.0.

Indicating lamps

Indicating lamps shall be of the cluster LED type, with low watt consumption. Indicating lamp shall be of the double contact, bayonet cap type rated for operation at either 240 V AC or at the specified DC system voltage as applicable. Lamps shall be provided with translucent lamp covers.

Bulbs and lenses shall be interchangeable and easily replaceable from the front.

Push Buttons

"Start" and "Stop" push buttons shall be coloured green and red respectively. Stop Push Button shall be lockable stay-put type with Mushroom head.

Space Heaters

Adequately rated anti-condensation space heaters shall be provided, one for each control panel, for each switchboard and for each marshalling kiosk.

Space heater shall be of the industrial strip continuous duty type, rated for operation on a 240 V, 1 phase, 50 Hz, AC system.

Each space heater shall be provided with a single pole MCB with overload and short circuit release, a neutral link and a control thermostat to cut off the heaters at 40 degree.

Cubicle Lighting/Receptacle

Each control panel, control cabinet, marshalling box, etc. shall be provided with interior lighting by means of a 20 W fluorescent tube lighting fixture. A MCB shall be provided for the lighting circuit. The lighting fixture shall be suitable for operation from a 240 V, 1 ph, 50 Hz, AC supply.

A 240 V, 1 phase, AC receptacle (socket) plug point shall be provided in the interior of each panel with a MCB for connection of hand lamp.

Safety Arrangements

All terminals, connections and other components, which may be “live” when front access door is open, shall be adequately screened. It shall not be possible to obtain access to an adjacent cubicle or module when any door is opened.

Components within the cubicles shall be labelled to facilitate testing.

Power and Control Cable Terminations

Equipment terminal blocks for power connections shall be complete with adequate phase segregating insulating barriers, shrouds and suitable crimping type of lugs for terminating the cables. Double compression type cable glands shall be provided for all power and control cables.

Earthing connectors between cable armour and earth shall be routed outside the cable gland in an approved manner. Gland insulation shall be capable of withstanding a high voltage test of 3000 V for one minute.

Wiring for Control and Protective Circuits

All wiring for control, protection and indication circuits shall be carried out with 650 V grade, PVC insulated cable with stranded, tinned copper conductor of minimum 1.5 sq. mm size. The size of conductor for CT circuits shall be minimum 2.5 sq. mm.

All wiring shall be run on the sides of panels and shall be neatly bunched and cleated without affecting access to equipment mounted in the panel. All wiring shall be taken to terminal blocks without joints or tees in their runs.

All wiring shall be colour coded as given below.

Instrument Transformer : Red, Yellow or Blue determined by the circuit phase with which the wire is associated

A C phase wire : White

A C neutral : Black

D C circuits : Grey

Earth connections : Green

Engraved core identification ferrules, marked to correspond with the wiring diagram, shall be fitted to each wire and each core of multicore cables terminated on the panels. Ferrules shall fit tightly on wires, without falling off when the wire is removed. Ferrules shall be of yellow colour with black lettering.

All wires forming part of a tripping circuit shall be provided with an additional red ferrule marked 'T'. Each wire shall be identified by a letter to denote its function followed by a number to denote its identity, at both ends. Unused core of multicore cables shall be ferruled U1, U2 etc., at both ends, and connected to spare terminals.

Spare auxiliary contacts of electrical equipment shall be wired to terminal blocks

Control Wiring Terminal Blocks

Terminal blocks shall be of the 650 V grade and stud type. Brass stud of at least 6 mm dia. with fine threads shall be used and securely locked within the mounting base to prevent turning. Each terminal shall comprise two threaded studs, with a link between them, washers, and matching nuts and locknuts for each stud. Connections to the terminals shall be at the front.

Terminals shall be numbered for identification, grouped according to function. Engraved ‘black on-white’ labels shall be provided on the terminal blocks describing the function of the circuit.

Terminals for circuits with voltage exceeding 110 V shall be shrouded. Terminal blocks at different voltages shall be segregated into groups and distinctively labelled.

Terminals used for connecting current transformer secondary leads shall be 'disconnecting and shorting' type with a facility grounding the secondary.

Terminal blocks shall be arranged with 100 mm clearance, between any two sets.

Separate terminal stems shall be provided for internal and external wiring respectively.

All wiring shall be terminated on terminal blocks, using crimping type lugs or claw type of terminations.

Test Terminal Blocks

Test terminal blocks, if any, shall be provided for secondary injection and testing of relays. A suitable metering block shall be provided where specified for the connection of a portable precision instrument to be operated when required for specific plant testing purposes.

Earthing of Switchboards/Panels

Each switchboard, control panel, etc. shall be provided with an earth busbar running along its entire length. The earth busbar shall be located at the bottom of the board/panel.

Earth busbars shall be of Aluminium and shall be rated to carry the rated symmetrical short circuit current of the associated board/panel for one second, unless otherwise specified. Earth busbars shall be properly supported to withstand stresses induced by the momentary short circuit current of value equal to the momentary short circuit rating of the associated switchboard/panel.

Positive connection of the frames of all the equipment mounted in the switchboard to the earth busbar shall be maintained through insulated conductors of size equal to the earth busbar or the load current carrying conductor, whichever is smaller.

All instrument and relay cases shall be connected to earth busbar by means of 650 V grade, green coloured, PVC insulated, stranded, tinned copper, 2.5 sq. mm conductor looped through the case earth terminals.

Motor earthing

Earthing shall be provided in accordance with relevant BIS Codes and shall be copper strips /wires .The main panel shall be connected to main earthing system of the power supply. All single phase metal clad switches and control panels be earthed with minimum 3 mm diameter copper conductor wire. All 3 phase motors and equipment shall be earthed with 2 numbers distinct and independent copper wires / GI tapes of minimum sizes as follows:

i.	Motor upto and including 10 HP rating.	2 Nos. 6 mm dia copper wires.
ii.	Motor 12.5 HP to 40 HP capacity	2 Nos. 6 mm dia copper wires

iii.	Motor 50 to 75 HP capacity.	2 Nos. 6 mm dia copper
iv.	Motor above 75 HP.	2 Nos. 50 mm x 6 mm GI tapes.

Above sizes are the minimum sizes to be provided. The contractor shall do a check for expected fault current at the motor end and shall provide a higher size conductor if necessary in order to withstand the fault current for 1sec.

4.6 Applicable Standards

The following standards and codes of practice shall be applicable. These shall be the latest editions including all official amendments and revisions. The standards referred to therein shall also be applicable.

Air break switches, MCCBs, etc. for voltage not exceeding 1000 V AC or 1200 V DC	:	IS 13947
Current transformer	:	IS 2705 / IEC 60044
Voltage transformer	:	IS 3156 / IEC 44, 60186
Electrical Relays	:	IS 3231, 3842 / IEC 60255
Contactors for voltage not exceeding 1000 V AC	:	IS 13947 / IEC 60947
Control Switches	:	IS 6875 / IEC 60947
High Voltage Fuses	:	IS 9385 / IEC 60282
Low voltage Fuse	:	IS 13703 / IEC 60269
Electrical direct acting indicating instruments	:	IS 1248 / IEC60051
AC electricity meters of of induction type for voltage greater than 1000 volts	:	IS 722, 8530 / IEC 60145, IEC 60211
Porcelain post insulators for system with nominal voltages greater than 1000 volts	:	IS 2544
Specification for copper rods and bars for electrical purposes	:	IS 613
Specification for low voltage	:	IS 13947 / IEC 60947

switchgear and control gear		
Degree of protection provided by enclosures for low voltage switchgear and control gear	:	IS 13947 / IEC 60947
Marking and arrangement for switchgear, busbars, main connections and auxiliary wiring	:	IS 5578 / IS 11353
Code of practice for selection, installation and maintenance of switchgear and control gear	:	IS 10118
Miniature Circuit Breakers	:	IS 8828 / IEC 60898
Control Switches/ Push buttons	:	IS 6875

4.7 <u>Specific Technical Particulars:</u>

Sr. No.	Description	Particulars
1	Rated voltage, Phases and Frequency	415 V, 3 Ph, 50 Hz
2	Type of Construction	Single front, fixed type with IP54.
3	Maximum system voltage	476 V
4	One minute Power Frequency withstand voltage	
a)	Power circuit	3000 V (rms)
b)	Control Circuit	2000 V (rms)
c)	Auxiliary circuit connection to secondary of CTs	2000 V (rms)
5	Current rating of busbars over design ambient temperature of 40 Degree C	As per SLD.
6	Short circuit withstand for main and auxiliary busbars (1 sec.)	As per SLD.
7	Maximum temperature of main and auxiliary busbars at continuous rated current rating under site design ambient temperature of 45 Degree C	85
8	Colour finish shade as per IS:5	

Sr. No.	Description	Particulars
a)	Interior	Glossy white
b)	Exterior	Light grey, semi-glossy, shade 631 of IS 5
9	Earthing bus material and size	Aluminium, 25 x 6 mm
10	Clearances in air of live parts	25.4 mm
11	Power contactors	
a)	Contactor rated duty	AC3
b)	Utilisation category	Uninterrupted
12	Motor Starters	For motor < 5 kW – DOL For motor > 5 kW – Star-Delta up to 250kW **(EXCEPT FOR FIRE LOADS).**
13	Type of Mounting	Wall/ Floor.
14	Cable Entry	Top
Note: For starters, all switch-gear selection to be as per the respective vendor specified 'Type-2 Co-ordination Chart'.		

4.8 Tests And Reports

Type test reports for the switchgear and circuit breakers shall be furnished along with the tender and subsequently.

The switchgear, circuit breakers and all associated equipment shall be tested in accordance with relevant standards. All routine tests shall be carried out. Type tests shall also be carried out if not tested previously.

Type and routine test report shall be submitted for the PURCHASER's approval before the equipment is dispatched. Bound copies of test reports shall be furnished along with the switchgear.

All meters and other reference devices used for testing shall have valid calibration from reputed national laboratories/institutes. Inspection by Purchaser/ Engineer will not be carried out unless the vendor confirms that calibrated equipments are ready for proceeding with the tests.

Equipment shall not be dispatched unless the test certificates are duly approved by the PURCHASER/ ENGINEER.

5 Conduits

Conduits and Accessories shall conform to relevant Indian Standards. Wall thickness shall be 16 gauge up to 32 mm dia and 14 gauge above 32 mm dia conduit. Screwed G.I. Conduits shall be used. Joints between conduits and accessories shall be securely made, to ensure earth continuity. All conduit accessories shall be threaded type only. All raw metal shall be painted with bitumastic paint.

Only approved make of conduits and accessories shall be used.

Conduits shall be delivered to the site of construction in original bundles and each length of conduit shall bear the label of the manufacturer.

Maximum permissible number of 650/1100 volt grade PVC insulated wires that may be drawn into rigid non metallic or GI Conduits are given below :

Size of wires Nominal Cross section Area (Sq. mm.)	**Maximum number of wires within conduit size(mm)**				
	20	**25**	**32**	**40**	**50**
1.5	5	10	14	--	--
2.5	5	8	12	--	--
4	3	7	10	--	--
6	2	5	8	--	--
10	--	3	5	6	--
16	--	2	3	--	6
25	--	--	2	4	6
35	--	--	--	3	5

6 Cables & cable sizes

1100V grade Cables of sizes 25 sq. mm. and above shall be XLPE FRLS insulated aluminium conductor armoured type and PVC insulated Copper conductor armoured cables for sizes 16 sq. mm. and below. All cables shall be conforming to IS Codes. Cables shall be suitable for laying in trenches, ducts, and on cable trays as required. Cables shall be termite resistant. Cable glands shall be heavy duty double compression brass glands. Control cables and indicating panel cables shall be multi core PVC insulated copper conductor and armoured cables.

1100V grade Cables shall be with FRLS grade outer sheath PVC insulation and armoured conforming to IS Codes. Cables shall be suitable for laying in trenches, ducts, and on cable trays as required. 1100V grade Cables shall be termite resistant. Cable glands shall be double compression glands. Control cables and indicating panel ables shall be multi core PVC insulated copper conductor and armoured cables.

The equipment inside plant room shall be connected to the control panel by means of suitable cables of adequate size. An isolator shall be provided near each motor/equipment (mounted within 10 ~ 15 mtr distance on nearest wall or self supported on floor) wherever the motor/equipment is separated from the supply panel through a partition barrier or through ceiling construction. PVC insulated copper conductor wires shall be used inside the control panel for connecting different components and all the wires inside the control panel shall be neatly dressed and plastic beads shall be provided at both the ends for easy identification of control wiring.

Contractor shall select suitable rating and type of starter for the motors as per directions and approval from relevant authorities. Power cabling shall be suitable for selected rating and type of starter selected. Power cabling shall be of the following sizes:

Sl No.	Motor Rating in HP	Starter	Line Current in A	Panel to Starter Cable size (Armoured cable)	Panel to Starter Cable current	Starter Current in A	Starter to Motor cable size (Armoured cable)	Panel to Starter Cable current
1.	<= 10	DOL	13.5	4Cx25 Al.	75.2	13.5	3Cx25 Al.	75.2
2.	11 to 15	S/D	20.0	4Cx25 Al.	75.2	11.55	2 x 3Cx25 Al.	75.2
3.	16 to 25	S/D	33.5	4Cx25 Al.	75.2	19.34	2 x 3Cx25 Al.	75.2
4.	30 to 35	S/D	47.0	4Cx25 Al.	75.2	27.14	2 x 3Cx25 Al.	75.2
5.	40 to 50	S/D	67.0	4Cx25 Al.	75.2	38.68	2 x 3Cx25 Al.	75.2
6.	60 to 75	S/D	100.7	4Cx50 Al.	106.4	58.14	2 x 3Cx25 Al.	75.2
7.	100	S/D	134.0	4Cx95 Al.	156.8	77.36	2 x 3Cx35 Al.	90.4
8.	125	S/D	167.8	4Cx120 Al.	178.4	96.88	2 x 3Cx50 Al.	106.4
9.	150	S/D	201.4	4Cx185 Al.	225.6	116.28	2 x 3Cx70 Al.	131.2
10.	200	S/D	268.6	4Cx300 Al.	293.6	155.08	2 x 3Cx95 Al.	156.8

7 Wiring for illumination:

General: Wiring shall include switches, small power receptacles, lighting distribution boards, complete with junction boxes, pull boxes, terminal blocks, glands, conduits & accessories and supporting & anchoring materials. All materials, fittings and appliances used in the installation shall conform to the relevant IS specification and shall be suitable for application in Sewage treatment plant areas.

Type: Wiring is to be done in the looping system without any jointing. Phase wires shall be looped in switch control points and neutral shall be looped at outlet points. For recess conduit system MS conduit and for surface conduit system GI conduit shall be used. Recess conduit system shall be used in office, laboratory, control room etc.

Point wiring: Point wiring shall include all works necessary to complete wiring of a switch circuit of any length from the tapping point on the distribution circuit to the following via switch with

- Ceiling rose and connector: for ceiling / exhaust fan points
- Back plate: for fluorescent fittings with down rods etc.,
- Socket outlet: for socket outlet points
- Lamp holder: for wall brackets, bulk head and similar fittings.
- The following shall be included in point wiring:
- Switch board
- Ceiling rose or connectors as required
- Any special or suitable round block for neatly housing the connector and covering the fan hook in case of fan point.
- Wooden box, bushed conduit, porcelain tubing where cable passes through wall etc.,
- Metallic covering on conduit upto 1.5 m from floor.
- Earth wire from six pin socket outlet point/fan regulator/fixture to common conduit earth wire system.
- All wood or metal blocks, boards and boxes, sunk or surface type for mounting fan regulator etc.
- All fixing accessories such as clips, rails, screws, pin plugs, wooden plugs etc., as required.
- Connection to ceiling rose, connectors, socket outlet, lamp holders, switch and fan regulator etc.,
- Looping the same switch board and inter connections between points on the same circuit
- Providing fish wire in conduits for recessed conduit works.

Load on Circuit: Lighting circuits and small power circuits for sockets, exhaust fans/axial flow fans shall be separate. Each circuit shall not be loaded more than 60% of MCB rating. It shall, however, be ensured that in one switchboard, wiring of one circuit is only provided.

Size of Conductor: The smallest copper conductor to be used for lighting circuits shall be 1.5 mm2 and for power circuits 2.5 mm2. Neutral conductor and earth continuity wire shall be brought to each switchboard situated in rooms and halls. These shall be terminated inside the switchboards with suitable connectors. The switchboard shall be of adequate size to accommodate one number 5 amps socket outlet and required nos. of piano key type control switches with spares for future use.

Conduit capacity: PVC insulated cables conforming to IS: 694 - 1977 drawn in one conduit shall not occupy more than 60% of conduit capacity.

Rigid Steel Surface Conduit: Rigid conduits shall be solid drawn on ERW, finished with galvanised surface. No conduit less than 16 SWG for 32 mm diameter and below and 14 SWG for above 32 mm diameter shall be used. Minimum diameter of steel conduit shall be 20 mm. The conduit wiring shall be complete in all respect including accessories. Conduit shall conform to IS: 9537. Conduit pipes shall be joined by means of screwed couplers and screwed accessories only. In long distance straight run of conduit, inspection type couplers at reasonable intervals or as directed by the Engineer for easy maintenance, shall be provided. Thread of all conduits shall be between 13 mm to 19 mm long, sufficient to accommodate pipes to full threaded portion of coupler accessories.

The layout of conduit shall be such that any condensation or sweating inside the conduit is drained out. Suitable precautions shall be taken to prevent entry of insects inside the conduits.

The outer surface of conduit including all accessories forming part of conduit system shall be protected against rust when such system is exposed to weather by being painted with two coats of oxide paint, before they are installed. After installation, all accessible surfaces of conduit, pipes, fittings, etc., shall be painted with approved finish colour.

Suitable junction inspection boxes according to requirements shall be provided to permit periodical inspection and to facilitate replacement of wires. If necessary, the boxes shall be mounted flush with the wall of ceiling. Minimum 65 mm depth junction boxes shall be used in roof slabs and depth of boxes in other places shall be as per IS: 2667 - 1977.

Primary wiring shall be from main lighting distribution board to individual switch boards. And secondary wiring shall be from individual switchboards to the light fixtures.

8 Earthing System

Treated earthing pit with perforated earth pipe made from GI Pipe 40 mm. Dia., 3 mtrs. long including all accessories and providing masonry enclosure with cover plate and watering pipe with funnel complete with alternate layers of salt and charcoal as per IS :3043 and connecting it to earth grid conductor in the ground as per IS shall be provided with all complete works.

9 Lighting System

Lighting Fixtures with all accessories shall be with necessary supporting arrangement (the indicated price to be inclusive of the light fixture) - Rates quoted for Installation of lighting fixtures shall inclusive of the supporting steel structures, clamps / connectors and all other accessories required for proper fixing of the lighting fittings. Supply of flexible metal conduit from JB to Fixture control gear box and upto fixture is included in the scope. All necessary wiring 2.5 sq mm PVC insulated wire from JB to Fixture control gear box and up to fixture, assembly of fixture & integral wiring of fixture is included in the scope.

For Pump room for following fixture shall be used:

- 1/2 x 28w FTL (T5) Type Ceiling Mounted with Electronic Ballast or equivalents
- 1 x 18w Ceiling Type with electronic Ballast or equivalents

Lighting-Power panel shall be as specified in drawing.

For further information refer the respective tender drawing

10 Specific Requirement of 1.1kv LV Cables:

Scope of supply includes XLPE insulated 1.1kV grade, stranded Aluminium/ copper conductor, extruded PVC inner and outer sheathed, GI/ Aluminium flat/Round wire armoured multi-core and single core LV Power / Control / DC cables.

a) The conductors shall be electrolytic grade high conductivity annealed Copper or electrolytic grade Aluminium.

b) Galvanised steel Round wire / Flat strip armour shall be provided as specified for multi-core cables. Galvanised steel round wire armouring shall be provided for cables upto 16 sq.mm. Whereas Flat strip armouring shall be provided for all 1.1KV LV cables above 16 sq.mm.

c) The insulation over the individual conductor core will be colour coded. Core identification shall be as follows;

a) Single core: Red, Yellow, Blue, Black or Natural.

b) Two core: Red, Black.

c) Three core: Red, Yellow and Blue.

d) Four core: Red, Yellow, Blue and Black.

e) Five core: Red, Yellow, Blue, Black and Grey.

f) For core exceeding five cores – two adjacent cores (Counting core and Direction core) in the each layer are coloured Blue and Yellow respectively and the remaining cores are Grey with numerals. Printed numerals shall be provided at every 50mm on each core.

g) For 3.5 core cables three main cores shall be Red, Yellow and Blue and the reduced core shall be Black.

d) All multi-core cables shall be laid up as per the colour scheme indicated above with thermoplastic fillers in the centre and the interstices wherever applicable in order to make the cable circular. Top layer of the laid up shall be always with right hand direction.

e) For XLPE insulated cables – The PVC Type ST 2 compound for insulation on conductor and for inner and outer sheath as well as the XLPE insulating compound extruded on the PVC outer sheath shall be suitable for maximum rated conductor temperature of 90 deg C.

f) The construction, performance and testing of cables shall comply with IS 7098 Part I for LT XLPE cables and IS1554-Part-I for PVC cables. Conductor construction shall be as per IS: 8130. All galvanised steel round wire armour shall conform to requirements of IS 3975 - 1979.

g) Testing of cables:

- For XLPE insulated cables - The construction, performance and testing of the cable shall comply with IS 7098 - Part.
- Cables shall be subjected to routine and acceptance tests in accordance with standards specified. Test methods shall conform to IS 10810 (Methods of Test for Cables). Type tests and optional tests according to applicable standards shall be conducted on cables as specified below.

Cabling:

The cables will be laid in pre fabricated galvanised steel, Ladder /perforated cable trays, suitably supported by painted mild steel cable tray supports.

All cable trays will be earthed at minimum two places by GI flats to main earthing system earth conductor. The distance between the two earthing points will generally not exceed 10 metres.

Cable Termination- The rate shall be inclusive of stripping of cable insulation, supplying and fixing of Aluminium lugs for aluminium cables & tinned plated copper lugs for copper cables and crimping the same to the conductor, supply and fixing of double compression cable glands including all labour supply and consumable material required for jointing/termination. The rate shall also include the laying of cable in ground / in cable trays, etc

Cable Lugs

a. Cable lugs shall be of tinned copper, solder less crimping type for cu cables & AL lugs for the AL cables.

b. The current rating of the lugs shall be same as that of the respective cable conductors.

c. Ring type cable terminations shall be used.

d. Insulated lugs are not acceptable for any cable terminations.

e. Bi-metal strip/ Bi-metallic lug shall be used whenever two different metals are to be connected together.

f. Double hole extended neck (long barrel neck) type lugs shall be used in case of cables above 185 sq. mm.

g. Fork terminals shall be used for luminaires & decorative switch/ socket. Pin terminals may be acceptable during execution only in case other terminals/ lugs cannot be accommodated.

h. Reducer / wire pin terminals shall be avoided for MCB terminations. MCB terminations shall be with 'long palm terminals.

i. All terminations in DBs / enclosure for earthing & neutral busbars / terminals shall be with ring type terminals.

j. All earthing terminations shall be with ring type lugs only.

k. All control & interlock cable terminations shall be with ring type lugs.

l. Anticorrosion/ anti-oxidation compounds shall be used for crimping lugs (This shall especially be ensured for Al cable terminations & any bimetallic terminations (Cu cable termination using tinned copper lugs)).

m. If termination is done with crimping tool employing crimping die then forming dies shall be used to make the sector shaped conductor into a round conductor before crimping the lugs on the conductor. The lug must not be crimped directly on the sector conductor. Before crimping the lug, the conductor shall be thoroughly cleaned and special jelly applied over it to prevent further oxidation.

Cable Glands

a. Double compression type cable glands shall be used. Cable glands shall be brass casting, machine finished and Nickel-plated to avoid corrosion and oxidation. Rubber components used in cable gland shall be of neoprene.

b. For single core cables, gland shall be with brass ring.

c. Cable glands shall be with metric threads.

d. Cable glands shall be conical (& not flange type).

Where ever applicable, supply & installation provision of bimetallic strip for connection between Al to Cu strip & GI to CU strip shall be the scope of Bidder.

Installation contractor has to ensure reference of an arrow and suitable accompanying wording which shall be stencilled on the sides of the drums indicating which way it should be rolled. The number on each drum shall be either branded at the end of the drum or stamped on the metal attached to an end of the drum. The cable shall be placed on the drum in such a manner that it will be protected from injury during transit. Each end of the cable shall be firmly and properly secured to the drum. The drum shall be securely blocked in position so that the cable will not be displaced during transit.

It shall be the CONTRACTOR's responsibility to prepare the drum cutting schedule so that cable wastage is minimum while cutting.

Every effort shall be made by the CONTRACTOR to minimise wastage of material. The total wastage for each item of material on account of normal cutting wastage, cable splicing, CONTRACTOR's mistake in erection, laying and termination, material failure, accidents, thefts, damage, fire, mishandling, misplacement, etc. shall not exceed Two percentage (2%) of the quantity entrusted. In case the CONTRACTOR fails to account for 98.0% of the material (as actually installed plus left over unused plus usable cut lengths having length of 15m or more returned), the

OWNER shall recover the cost of the deficiency from the CONTRACTOR. Cable lengths shall be measured terminal to terminal after installation, for this purpose

Cable trays

- Cable trays of prefabricated perforated and ladder types and associated accessories such as coupler plates, tees, elbow etc. fabricated from 14SWG MS sheet and then hot dip galvanised (2.0 mm thick) sheet steel. 50mm side flanges for perforated tray and 75 mm side flange for ladder tray shall be provided on both sides of the tray. All the cable trays shall be hot dip galvanised (Min. 100 micron thickness) after fabrication.
- All the cable trays running on floor shall be provided with covers. Cable tray covers shall be fabricated from 16 gauge perforated (1.60 mm thick) M.S. sheets. Shall be epoxy powder coated with paint shade RAL 7032 Siemens grey pebble grey with minimum thickness 100 microns. Salt spray test report shall be furnished for minimum duration of 1000 Hrs.
- Cable trays shall be in standard length of 2500 mm and clear inside width of trays shall be as shown in drawings
- Perforated type trays : 50, 75, 100, 150, 300, 450
- Only Pre-Fabricated bends, joints and reducers shall be used. The quoted price of trays shall be inclusive of these accessories.
- Two lengths of Cable trays shall be fixed with twin coupler plates (inner & outer) at each joint. Erection with just one coupler plate shall result in rejection of the entire installation.
- Hardware (esp. bolts) for Joining of two lengths of cable trays shall be installed such that, not to damage the cables under any condition.
- Cable tray constructional features shall be as per attached standard drawing however material & thickness / size shall be as specified in the write up.
- Earthing strip shall be provided all along the cable trays, which in turn shall be connected to the main earthing grid.
- 2 nos. of earth strips shall run through each cable tray. In case of multi-tier cable trays, 2 nos. of earthing strips shall run only through one of the cable trays. The balance cable trays of the multi-tier cable trays shall be connected with these earth strips at a distance not more than 10 meter.
- All cable trays shall be earthed at minimum two places by 25 x ~~665 x 10~~mm GI strip welded along the tray and shall be interconnected to earthing grid.
- For all the pipe sleeves used by Electrical Contractor, FM approved Fire sealant of Minimum 2 hours continuous fire rating shall be applied.
- The BIDDER shall ensure that for all vertical drops no cable shall be seen uncovered.

11 Rubber Mat

Rubber mat shall be provided in front to cover the full length of all panels. Where back space is provided for working from the rear of the panel, rubber mat shall also be provided to cover the full length of panel on the rear also.

12 Programmable Logical Controller

An electronic dedicated pump logic controller shall be a Grundfos Hydro MPC (Multi Pump Controller) or approved equal. The controller shall operate the pumps to maintain the required system pressure while using minimum energy and alternating between pumps to maintain relatively equal pump operating hours.

As flow demand begins, one of the pumps will start at low speed. As demand increases, the pump will speed up until it reaches full RPM. At this point the second pump will start in full speed. The speed of the first pumps will vary until it builds up required system pressure. This sequence will continue for additional working pumps, if demand is not met.

Pumps shall changeover automatically to maintain the system pressure depending on demand, time, and fault.

Electronic controller should perform a flow estimation every 2 minutes so as to minimize or utilize the number of duty pumps and stop all pumps in an event of no demand, thereby the performance and energy consumption of the system is optimized.
If the system includes an optional standby pump, the controller shall exercise the standby pump as a part of the system and equally run the pump as other pumps in the system.

The controller shall accept a low-suction pressure or other suction fault input to shut down the system.

The controller shall have a keypad and a graphical user interface display with Installation wizard for easy commissioning of the system.

Drawings And Data

The following shall be furnished as part of the tender:

General arrangement showing plan, elevation and typical sectional views.

Foundation plan showing location of fixing channels, floor openings etc.

Schematic wiring drawings for each cubicle.

Technical literature on the equipment offered.

All drawings and data sheets shall be annotated in English.

Quality Assurance Plan.

Schedule of Technical Data

Sr. No.	Description	Particulars
1	Rated voltage, Phases and Frequency	
2	Type of Construction	
3	Maximum system voltage	
4	One minute Power Frequency withstand voltage	
a)	Power circuit	
b)	Control Circuit	

c)	Auxiliary circuit connection to secondary of CTs	
5	Current rating of busbars over design ambient temperature of 40 Degree C	
6	Short circuit withstand for main and auxiliary busbars (1 sec.)	
7	Maximum temperature of main and auxiliary busbars at continuous rated current rating under site design ambient temperature of 45 Degree C	
8	Colour finish shade as per IS:5	
a)	Interior	
b)	Exterior	
9	Earthing bus material and size	
10	Clearances in air of live parts	
11	Power contactors	
a)	Contactor rated duty	
b)	Utilisation category	
12	Motor Starters	
13	Type of Mounting	
14	Cable Entry	

LIST OF APPROVED MAKES

Sr.NO.	DESCRIPTION	MAKES
1	MPCB/MCCB	Legrand/Siemens/ Merlin-Gerin / L&T/ Schneider Electric/ ABB
2	Control Fuses	Siemens/ GE
3	Terminal Block	Elmex/ Connectwell
4	Selector switches	Kaycee/ Siemens
5	LED Indicating Lamps	Teknic/ Vaishno/ Siemens
6	MCC Panel	Schneider Electric/ ABB/. Siemens/ GE/ L&T/. Arrow Engineers/. Zenith Engineering
7	Push Buttons	KayCee /L&T/GE Power Control/ Siemens/ Schneider/ Teknic/Vaishno
8	Contactors	L&T/GE Power Control/ Siemens/ Schneider/ ABB/ Telemecanique
9	Cable Trays	Indiana / Patni / Reliance / Sadhana
10	LT Power Cables and Wires	Universal Cables / Polycab / Ravin/ KEI
11	LT Cable Lugs	Dowells/ Jainson / Comet
12	LT Cable Glands	Braco / Dowells/ Hex / Comet
13	Switches , Plugs, Sockets	Legrand/ Havells/ Anchor/ Schneider/ ABB
14	Lighting Fixtures and Accessories	Philips/ Havells/ Crompton Greaves Limited/ Wipro/ Bajaj Electricals
15	LDB's, PDB's, MCB's, MCCBs	Legrand/ L&T / Siemens/ Schneider
16	Conduits	M/s AKG/ M/s Precision