TECHNICAL SPECIFICATION

PLUMBING SYSTEM

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1. INTERNAL WATER DISTRIBUTION (DOMESTIC, GREY, HOT WATER)

1.1 Pipes :- Product Description

General Note: -
All fittings should be capable of withstanding pressure which is 1.5 x the design pressure in the pipes in that relevant segment of the building. While selecting the pipes/fittings, appropriate derating factor w.r.t temperature to be taken care of. 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.

Contractor shall provide one compensator joint / expansion joints in every 50 meter in the risers, however contractor to calculate, verify and provide necessary fittings/accessories as required to compensate thermal expansion/contraction of pipes, building sway movement and column shortening. Contractor to obtain the approval from Client/Engineer prior to ordering of the material. Above shall be in compliance with manufacturer / supplier recommendations / requirements.

A. .uPVC Pipes & Fittings (Water Supply – Non Exposed):

Pipes: - Un plasticized polyvinyl chloride water supply pipes schedule- 40 / 80 at a working pressure not less than 150 PSI at 23 deg C meeting minimum requirements as per IS 4985: 2000. Also confirming to ASTM – D 1785

Fittings:- Un plasticized polyvinyl chloride water supply pipe fittings schedule- 40 / 80 at a working pressure not less than 150 PSI at 23 deg C i.e. Tees, Elbows, Couplers, Unions, Reducers, brushings etc. including transition fittings connection between UPVC & metal pipe/GI/CI i.e. Brass Adaptors (both Male & Female threaded) meeting minimum requirements as per IS 7834 for Moulded fittings and IS 10124 fabricated fittings. Also conforming to ASTM D-2466 -13 and ASTM D2467

Joint: - Solvent Weld. PVC solvent cement, conforming to ASTM D 2564 for schedule 40 and schedule 80.

B. uPVC Pipes & Fittings (Water Supply – Exposed):

Pipes : - Un plasticized polyvinyl chloride water supply pipes UV treated schedule- 40 / 80 at a working pressure not less than 150 PSI at 23 deg C meeting minimum requirements as per IS 4985: 2000. Also confirming to ASTM – D 1785. 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.

Fittings:- Un plasticized polyvinyl chloride water supply pipe fittings UV treated schedule- 40 / 80 at a working pressure not less than 150 PSI at 23 deg C i.e. Tees, Elbows, Couplers, Unions, Reducers, brushings etc. including transition fittings connection between UPVC & metal pipe/GI/CI i.e. Brass Adaptors (both Male & Female threaded) meeting minimum requirements as per IS 7834 for Moulded fittings and IS 10124 fabricated fittings. Also conforming to ASTM D-2466 -13 and ASTM D2467

Joint: - Solvent Weld. PVC solvent cement, conforming to ASTM D 2564 for schedule 40 and 80

C. CPVC Pipes and fittings :

Pipes: - The pipes shall be CPVC (Chlorinated Poly Vinyl Chloride) material for hot & cold water supply piping system up to 50mm dia SDR.11, CTS, as per IS 15778/D2846, and 50mm dia above CPVC schedule 40 ASTM F441,IPS. The pipes shall meet the minimum requirements as per IS 15778.

The piping works shall be supported with proper metal/CPVC clamps, Tee holders, elbow holder 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
All exposed pipes to be painted with one coat of desired shade of enamel paint as per architect/client representative requirement

Fittings:- Solvent welded CPVC fittings i.e. Tees, Elbows, Couples, Unions, Reducers, Brushing etc. including transition fittings (connection between CPVC &Metal pipes / GI) i.e. PPSU adaptors (both male female) etc. conforming to ASTM F438 for Schedule 40 and ASTM F 439 for Schedule 80. Fittings up to 50mm dia SDR.11 ASTM D2846.

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

Joint: - Solvent Weld. CPVC solvent cement, conforming to ASTM F493 for schedule 40 and 80

D. PB pipes and Fittings:

Pipes: - Polybutylene thermoplastic piping system (PB) with pipes in accordance with BS-7291 and EN-ISO 15876-2 2003 or DIN 16986/69 for Hot and Cold and flush water application with 10 bar service pressure (PN-10).

Fittings:- Hot fusion welded / push fit Polybutylene (PB) fittings like Tee's, Elbows, Sockets, Reducers, Unions, PPSU adaptors (both male female) etc. conforming to BS 864 and EN-ISO 15876-2 2003 for Hot and Cold and flush water application with 10 bar service pressure (PN-10)..

Joint: - Hot fusion welded / push fit in compliance with EN-ISO 15876-2 2003.

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

Pipes: - 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 o f an aluminum 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.

Joint:- Pressed Coupling.

F. Galvanized Iron Pipes with Fittings

Pipes: - G.I. Seamless pipes meeting minimum requirement as per IS: 1239 / IS 3589 and confirming to ASTM A53 / A53M and B.S. 1387/1775 cut to required lengths.

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.

Fittings: - All fittings shall be malleable iron galvanized grooved fittings of approved make. All fittings shall be malleable iron galvanized grooved 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 Cast Iron fittings confirming IS-1879-2000 shall be used for pipes up to 40mm diameter & for 50mm & above diameter pipes welded joints shall be used.

Joint: - Welded/Grooved as indicated in schematic/ specified elsewhere in other part of this tender. All the transfer pipe line in the vertical risers shall be joined using flexible grooved fittings. Horizontal fittings shall be normal rigid grooved couplings. -

G. Grooved Fittings

a. References and Standards

i. American Society for Testing Materials (ASTM)

- ASTM A-53 – Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.
- ASTM A-183 – Carbon Steel Track Bolts and Nuts
- ASTM A-234 – Standard Specification For Piping Fittings or Wrought Carbon Steel and Alloy Steel.
- ASTM A-449 – Quenched and Tempered Steel Bolts and Studs
- ASTM A-536 – Ductile Iron Castings
- ASTM F-1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications

ii. American Society of Mechanical Engineers

- ASME B16.9 – Factory Made Wrought Butt Welded Fittings
- ASME B31.1 – Chemical Plant and Petroleum Refining Piping
- ASME B31.9 – Building Services Piping

iii. American Water Works Association

- AWWA C-606 – Grooved and Shouldered Joints

b. Quality Assurance

i. To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by original manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components.

ii. Pipe/Grooved (Standard/Light wall): Carbon Steel, A-53B/A-106B - Roll or cut grooved-ends as appropriate to pipe material, wall thickness, pressures, size and method of joining. Pipe ends to be grooved in accordance with manufactures specified listed standards conforming to ANSI/AWWA C-606

c. Standard Mechanical Couplings (2 inch through 12 inch):

Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12.Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. (Gaskets used for potable water applications shall be UL classified in accordance with ANSI/NSF-61 for potable water service.) Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183, minimum tensile strength 110,000 psi (758450 kPa) as provided standard.

i. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9, and NFPA 13.

ii. 2” through 6”: “Installation Ready” for direct stab installation without field disassembly.

iii. 2” through 12”:

iv. Flexible Type:-Coupling key shall be designed to fit into the wedge shaped groove and allow for linear and angular movement, vibration attenuation, and stress relief. Support requirements defined in the tender

v. Flange Adapters: For use with grooved end pipe and fittings, flat faced, for mating to ANSI Class 125 / 150 flanges. For direct connection to ANSI Class 300 flanges use.

vi. Grooved couplings shall meet the requirements of ASTM F-1476.

vii. Gasket: Synthetic rubber conforming to steel pipe outside diameter and coupling housing, manufactured of elastomers as designated in ASTM D-2000.

Note: - Reference shall always be made to the manufacturers guide for proper gasket selection for the intended service.

d. Mechanical Couplings (14 inch through 24 inch):

Couplings shall consist of two ASTM A-536 ductile iron housing segments, a wide elastomer pressure responsive gasket, and zinc electroplated carbon steel track head bolts and nuts conforming to the physical and chemical requirements of ASTM A-449 and the physical requirements of ASTM A-183.

i. Coupling housings designed with the wedge-shaped key profile to engage the mating pipe(s)/component(s) wedge-shaped grooves. Housings include lead-in chamfer to accommodate a wider acceptable range of initial pipe positions. Housings shall be coated with orange enamel or galvanized.
ii. Gasket: Synthetic rubber, wide width, conforming to steel pipe outside diameter and coupling housing, manufactured of elastomers as designated in ASTM D-2000.

Note: -Reference shall always be made to the manufacturers guide for proper gasket selection for the intended service.

iii. Coupling Types:

- Rigid Coupling: Coupling key shall be designed to fill the wedge shaped groove to provide a rigid joint that corresponds with support spacing's as defined by ASME B31.1 and B31.9. Systems incorporating rigid couplings require the calculated thermal growth/contraction of the piping system to be fully compensated for in the design of the piping system through use of adequate flexible components.
- Flexible Coupling: Coupling key shall be designed to fit into the wedge shaped groove and allow for linear and angular movement, vibration attenuation, and stress relief. Support requirements defined in the tender

e. Grooved End Fittings:

Standard fittings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, forged steel conforming to ASTM A-234, Grade WPB 0.375" wall (9,53 mm wall), or fabricated from Std. Wt. Carbon Steel pipe conforming to ASTM A-53, Type F, E or S, Grade B. Fittings provided with an alkyd enamel finish or hot dip galvanized to ASTM A-153. Zinc electroplated fittings and couplings conform to ASTM B633.

Fittings shall be supplied with factory grooved ends, for use with couplings and flange adapter. Fittings shall be manufactured of ductile iron conforming to ASTM A-536, forged carbon steel conforming to ASTM A-234, or factory fabricated from carbon steel pipe conforming to ASTM A-53. Fittings shall be manufactured to the dimensional standards ASME B16.9. Orange enamel coated or galvanized.

f. Flexible & Rigid Coupling – General Requirements.

i. Flexible coupling shall provide a water or airtight joint between pipe segments or pipes and fittings and shall be UL/FM approved.
ii. Flexible pipe couplings are expected to exhibit a service life at least equal to the other pipe fittings used in a fire protection system.
iii. The dimensions of a flexible pipe coupling shall allot its use with standard pipe schedules used in fire protection systems. The minimum wall thickness for 8 inches and larger pipes for use with couplings requiring rolled-groove pipe ends shall be 0.188 inches.
iv. All Flexible pipe couplings shall be designed for a rated working pressure of minimum 16 bar or greater.
v. The coupling shall be able to withstand a temperature of 800 ˚C in both wet and dry conditions so that the coupling shall maintain the integrity of the pipe.

vi. Gasket materials shall be suitable for continuous water and sir service in the temperature range of -40 to 148.9˚C.They shall be pliable, smooth and free of obvious surface porosity and mold flash.

vii. When required by the given design, flexible pipe coupling halves shall mesh together with no interferences.

viii. The coupling shall be resistant to corrosion by salt spray and it shall be tested as per BS 2011: Part 2

ix. Couplings Hydrostatically pressurized to their maximum rated working pressure shall not leak or otherwise fail when subjected to the required bending moments listed below in the table.

x. Flexible pipe couplings 12 inches(304.8 mm) and smaller shall be closed by blind test nipples . The assembly shall then be filled with water and mounted spanning two supports 0.6 meters apart. The assembly shall then be hydrostatically pressurized to the maximum rated working pressure of the coupling and held at that pressure throughout the test. Load shall be vertically applied at the center of the coupling until the maximum required bending movement as listed in the table below is reached. With this test configuration, the moment arm is 0.3 mts and the load which must be applied to the coupling is numerically equal to twice the required moment. No leakage shall occur at the maximum bending moment.

xi. Contractor to submit the detailed calculation for Engineer's / Client's approval for numbers & location of couplings.

Sl.no	Coupling Size(mm)	Required Bending Moment(N.m)
1	25.4	624
2	31.8	895
3	38.1	1105
4	50.8	1566
5	63.5	2339
6	76.2	3295
7	88.9	4115
8	101.6	5003
9	127	7159
10	152.4	9674
11	203.2	15409
12	254.0	20256
13	304.8	30051

g. Hole-Cut Branch Outlets:

i. Bolted Branch Outlet: Branch reductions on 2"(DN50) through 8"(DN200) header piping. Bolted branch outlets shall be manufactured from ductile iron conforming to ASTM A-536, Grade 65-45-12, with synthetic rubber gasket, and heat treated carbon steel zinc plated bolts and nuts conforming to physical properties of ASTM A-183.

ii. Strapless Outlet: 1/2"(DN15) or 3/4"(DN20) NPT outlet on 4" (DN100) and larger header sizes rated for 300 PSI (2065 kPa).

iii. Strapless Thermometer Outlet: To accommodate industrial glass bulb thermometers with standard 1-1/4"-18 NEF 2B extra fine thread and 6" (152mm) nominal bulb length on 4" (DN100) and larger header sizes rated for 300 PSI (2065 kPa).

H. Water Supply- MOC

Refer to the schematic drawings

1.2 Pipes and Fittings Execution

A. Piping System Installation General (Internal)

Work under this section consists of furnishing all equipment, appliances, materials, labor necessary and required to install, test and commission internal service water distribution piping as required by the drawings, specified hereinafter and given in the Bill of Quantities.

The work shall include but not limited to:

Water distribution system in all parts of the building including supporting, chasing of walls for pipes, making holes in walls/ floors, making good the opening. It is not allowed to make hole in the structural wall; all the holes shall be identified in the builder work drawings and provided at the time of casting itself. Any chasing carried out on the site shall be made good to the satisfaction of the Employers representative. Connection to RC tanks with purpose made pipe inserts/ sleeves. Minimum working pressure available at all the fixture shall be around 1.5 Bar.

a. All piping shall be arranged and aligned in accordance with the approved shop drawings. Elevations wherever shown must be strictly adhered to unless otherwise directed. All dimensions shall be field checked before fabricating the piping.

b. Piping shall be installed as straight and direct as possible forming right angles with or running parallel with the walls, floors or other adjacent piping. Branch pipes from service lines shall be taken from top, bottom or side of main using crossover fittings as may be required by structural or installation conditions.

c. Pipes and fittings shall be fixed truly vertical, horizontal or in slopes as required in a neat workman like manner.

d. Wherever required, bends shall be used on all main pipe lines as far as possible and use of elbows shall be restricted for short connections only. All bends shall be formed by means of a hydraulic pipe bending machine for pipes up to 65mm dia.

e. Installation of piping shall be co-ordinate with other work and/ or existing facilities, to avoid blocking building openings, lighting fixture etc. Piping shall not interface with access to valves, ductwork, and equipment and shall not obstruct passageways. Piping shall be installed to provide working clearance for operation and maintenance.

f. Pipes shall be securely fixed to wall and ceiling by suitable clamps/ hangers brackets at intervals as specified or directed by the Employers representative. Pipe connections to various fixtures shall be as below:

Sl No	Description	Hot	Cold
1	Janitor Sink		15mm
2	Bath Tub	15mm	15mm
3	Shower	15mm	15mm
4	Water -Purifier	-	15mm
5	Water Closet (Flush Tank)	-	15mm
6	Water Closet (Flush Valve)	-	32mm
7	Bib Tap / Hose Bib	-	15mm
8	Hot tub	-	15mm
9	WC Hand Spray	-	15mm
10	Wash Basin	15 mm	15mm
11	Dish Washer	-	15 mm
12	Washing Machine	-	15 mm

g. Modifications to the arrangement of piping may be required at site to suit structural conditions or to avoid interference with work of other trades. Contractor shall furnish all offsets, additional fittings etc. as required to meet installation conditions whether detailed on the drawings or not.

h. Piping shall be installed to provide a minimum clearance of at least 25mm in tight situations and 50 mm in lenient situations between extreme projections of piping, flanges, fittings, valves after allowing for insulation and pipe expansions. For internal work the pipes & fittings shall run on the surface of the walls or on brackets fixed to walls or ceiling or hangers fixed to the ceiling unless otherwise specified. The fixing shall be done by means of standard pattern holder bat clamps, keeping the pipes about 15 mm clear of the wall. Pipes running along ceiling shall be supported on hangers. When it is found necessary to conceal the pipes, chasing may be adopted or pipes fixed in the ducts or recess etc., provided there is sufficient space to work on the pipes with usual tools. The pipes shall not be buried in walls or floors.

i. Where unavoidable pipes may be buried for short distance, provided adequate protection is given against damage. Joints shall not be buried. Sleeves shall be fixed at places where the pipe passes through a wall or floor, for protection of the pipe & to allow freedom for expansion & contraction & other movements.

j. In case the pipe is embedded in wall or floor, it should be painted with two coats of anti-corrosive bitumastic paint of approved quality, covered with one layer of fiber glass tissue or Hessian cloth and finally painted with one coat of bitumen paint. The pipe should not come in contact with lime mortar or lime concrete. Under the floor pipes shall be laid in layer of sand filling.

k. Clamps shall be embedded in brick work in cement mortar 1:3 & shall be spaced at regular intervals in straight lengths.

l. The hangers/ clamps shall be fixed at shorter lengths near the fittings or as directed by the Employers representative.

m. Pipes shall be supported at each floor level with a mid-story guide on vertical runs and at 90 cm (up to 25mm and below) or 120 cm (32mm and above) on horizontal runs.

n. For pipes 15mm to 25 mm dia. the holes in the walls shall be made by drilling, with chisel or jumper & not by dismantling the brick work. However, for bigger dimension pipes the holes shall be carefully made of the smallest size as directed by the Employers representative. After fixing the pipes the holes shall be made good with cement mortar 1:3 and properly finished to match the adjacent surface.

o. Allowances shall be made throughout for expansion and contraction of pipe. Branch connections from mains shall be made with ample swing or offset to avoid undue strain on fittings.

p. Piping system shall be complete with connection to fixtures and other terminal use points. Unions or flanges shall be used at all piping connections to equipment and as generally required to disconnect piping without disturbing either the piping or equipment.

q. Access panels shall be provided in false ceiling, walls, shafts, partitions etc. for all concealed valves, controls or any item requiring inspection or maintenance. Access panels shall be of sufficient size and so located that the concealed items may be serviced and maintained or completely removed and replaced.

B. Piping System Installation General (External & Riser)

Work under this section consists of furnishing all equipment, materials, appliances and labor necessary and required to install, test and commission external and riser water supply (Domestic & Grey) piping as required specified hereinafter and given in the Bill of Quantities.

a. The work shall include but not limited to
   i. External & Risers water supply system to buildings including main water supply pipe shall be of GI ERW material.
   ii. Risers will have grooved flexible joints.
   iii. Valve chambers and other ancillary items.
   iv. Connections to tanks, pumps etc.

v. Excavation and refilling of pipe trenches.
vi. External wrapping and coating.
vii. General Requirements:
viii. Pipes shall be installed in accordance with these specifications unless recommendations of the manufacturers are more stringent.
ix. Pipes shall be stored so that they are fully supported throughout their whole length on level ground free from loose stones.
x. Pipes shall be handled so as to ensure delivery to the trench in sound undamaged condition.
xi. Cutting of pipes shall be done in the best workmanship manner. Cutting shall be square and all burrs shall be removed.
xii. Maximum allowable deflection from a straight line or grade on vertical/ horizontal lines shall be 5%.
xiii. The bottoms of the trenches shall be carefully prepared so as to ensure that the barrels of the pipes when laid are well bedded for their entire length on firm surface true to line and gradient. Please define the bedding thickness and refilling thickness. Please also provide the requirement for the warning tapes.
xiv. During refilling pipes shall be surrounded with fine selected material, well watered and rammed so as to resist subsequent movement of pipes. No stones shall be in contact with the pipe and when the excavation is in rock, the bottom shall be cut deep enough to permit the pipes to be bedded on a layer of fine selected material or concrete.
xv. Except where necessary in making connection with other lines, pipes shall be laid with the bells facing the direction of lying.
xvi. Pipes shall not be laid in water or when trench conditions are unsuitable for the work.
xvii. When work is not in progress, open ends of pipes, fittings and valves shall be securely closed.
xviii. Pipe ends left for future connections shall be valve, plugged or capped and anchored as directed.
xix. Depth of cover over the crown of pipe from the existing ground surface or the indicated finished grade shall be a minimum of 500mm unless otherwise shown or indicated.
xx. Pipes passing through walls of concrete valve pits and structures shall be provided with sleeves.
xxi. Where location of water pipe is not clearly defined on the drawings, the water pipe shall not be laid horizontally closer than 1800mm from a sewer provided the water pipe is at least 300mm above the top of sewer.
xxii. Where water lines cross gravity sewers the sewer pipe shall be fully encased in concrete for a distance of 3000mm each side of the crossing.
xxiii. Water lines shall not be laid in the same trench with sewer lines, gas lines, fuel lines or electrical cabling.
xxiv. Pipes & fittings shall be laid in trenches. The widths & depths of the trenches for different diameters of the pipes shall be as given below:

Sl No	Dia Of the Pipe	Width of the Trench	Depth of the Trench
1	15mm to 50mm	30 cm	up to 60 cm
2	65mm to 100mm	45 cm	up to 75 cm
3	150mm to 200mm	60 cm	up to 90 cm

xxv. At joints the trench width shall be widened wherever necessary. The work of excavation & refilling shall be in the scope of the Contractor and shall be done true to line & gradient.
xxvi. Tees and crosses for future connections shall be installed where shown on drawings or as directed.
xxvii. All external piping below ground shall be coated and wrapped as per IS 10221. In case of metallic pipes, the pipes below ground shall be protected against corrosion by the application of one layer of Hessian based bitumen felt Type 3, Grade I or polyethylene tape.
xxviii. The felt / polyethylene shall be applied over a layer of cold bitumen paint. Final surface shall be similarly finished with one additional layer of cold bitumen.

xxix. The pipes shall be laid on a layer of 100 mm sand/selected sieved soil and filled up to 150 mm above the pipes. The remaining portion of the trench shall then be filled with excavated earth. The surplus earth shall be disposed off as directed.

xxx. For pipes 80mm diameter and larger having high internal pressure, thrust blocks of cement concrete 1:2:4: shall be constructed on al l bends to transmit the hydraulic thrust without impairing the ground & spreading it over a sufficient area.

C. Underground pipe installation

a. Excavation for underground pipe lines shall be as shown on the drawings or as required at site. Pipe lines shall be buried to a minimum depth of 1000 mm. The type of soil to be considered is soft soil.

b. Wherever required, Contractor shall support all trenches of adjoining structures with adequate timber supports.

a. 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.

b. On completion of testing and coating & wrapping trenches shall be refilled and compacted with excavated earth in 15 cms. Layers and consolidated to restore ground condition to original status. Prior to excavation contractor shall ensure that no adjoining structure or pipeline is affected / damaged.

D. uPVC pipes and fittings.

uPVC pipes and fittings shall be installed 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.

Contractor shall responsible to coordinate with Interior Design (ID) drawings/vendor for termination/connection of plumbing &drainage lines and installation of sanitary fittings.

Contractor shall submit calculation (including but not limited to) for thermal expansion, thrust support, vertical supports etc. for Engineer's/Client's approval.

Pipe Support:-

All piping should be supported with an approved hanger at intervals sufficiently close to maintain correct pipe alignment and to prevent sagging . Pipe should also be supported at all branch ends and at all changes of direction.

Support traps arms as close as possible to the trap. In keeping with good plumbing practices support and brace all closet bends and fasten closet flanges.

a. Concentrated loads should be supported directly so as to eliminate high stress concentrations. Should this be impractical then the pipe must be supported immediately adjacent to the load.

b. In systems where large fluctuations in temperature occur ,allowances must be made for expansion and contraction of the piping system. Since changes in direction in the system are usually sufficient to allow for expansion and contraction

c. Hangers must be placed so as not to restrict this movement.

d. Since plastic pipe expands or contracts approximately five times greater than those of steel, hangers should not restrict this movement.

e. Hangers should provide as much bearing surface as possible. T o prevent damage to the pipe, file smooth any sharp edges or burrs on the hangers or supports.

f. Support spacing for horizontal piping systems is determined by the maximum operating temperature the system will encounter . The piping should be supported on uniform centers with supports that do not restrict the axial movement.

g. For vertical lines, contractor should design the vertical supports according to the vertical load involved and should submit for Engineer/Clients approval.

h. Thrust blocks shall be provided as indicated the drawings and in all direction changes in the main riser. Calculations shall be submitted for client / engineer review.

Recommended Support Spacing:-

Schedule - 40
Recommended Support spacing (in feet)

Nom. Pipe Size		Temperature°C				
(In.)	(mm)	15.5	26.6	37.7	48.8	60
½	15	4½	4½	4	2½	2½
¾	20	5	4½	4	2½	2½
1	25	5½	5	4½	3	2½
1¼	32	5½	5½	5	3	3
1½	40	6	5½	5	3½	3
2	50	6	5½	5	3½	3
2½	65	6½	6	5½	4	3
3	80	7	7	6	4	3½
4	100	7½	7	6½	4½	4
6	150	8½	8	7½	5	4½
8	200	9½	9	8½	5½	5
10	250	10½	9½	9	6½	5½
12	300	12	10½	9½	7	6

Schedule - 80
Recommended Support spacing (in feet)

Nom. Pipe Size		Temperature°C				
(In.)	(mm)	15.5	26.6	37.7	48.8	60
½	15	5	4½	4½	3	2½
¾	20	5½	5	4½	3	2½
1	25	6	5½	5	3½	3
1¼	32	6	6	5½	3½	3
1½	40	6½	6	5½	3½	3½
2	50	7	6½	6	4	3½
2½	65	7½	7½	6½	4½	4
3	80	8	7½	7	4½	4
4	100	9	8½	7½	5	4½
6	150	10	9½	8½	6½	5½
8	200	11	10	9½	7½	6
10	250	12½	11	10½	8	7
12	300	13	12	10½	7½	6½

Joint Set & Curing Time:-

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

E. CPVC pipes and fittings.

CPVC pipes and fittings shall be installed 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

Solvent Jointing:-

a. 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.

b. The end of the pipes is visually inspected before making the joint. Use of a chamfering tool will help identify any crack.

c. There are several methods to quickly and efficiently cut pipes. wheel type plastic tubing cutters are preferred. Ratchet type cutter of fine tooth saw is another option. However, when using the ratchet cutter be certain to score the exterior wall by rotating the cutter blade in circular motion around the pipe. Do this before applying significant downward pressure to finalize the cut. This step leads to a square cut in addition, make sure ratchet cutter blades are sharp. Square cutting of tubes provides optimal bonding area within a joint.

d. Burrs and filings can prevent proper contact between the tube and fittings during the assembly, and should be removed from the outside and inside of the tube. A chamfering tool is preferred, but a pocket knife of file is also suitable for this purpose.

Joint Curing;-

JOINT CURING :

Recommended initial set times.

Temperature Range	Pipe Size ½" to 1¼" 15 mm to 32 mm	Pipe Size 1½" to 3" 40 mm to 80 mm	Pipe Size 4"to 8" 100 mm to 200 mm	Pipe Size 10" to 12" 250 mm to 300 mm
15.5°C - 37.7°C	15 min	30 min	1 hrs.	2 hrs.
4.4°C - 15.5°C	1 hrs.	2 hrs.	4 hrs.	8 hrs.

Recommended initial cure times.

Temperature Range	Pipe Size ½" to 1¼" 15 mm to 32 mm	Pipe Size 1½" to 3" 40 mm to 80 mm	Pipe Size 4"to 8" 100 mm to 200 mm	Pipe Size 10" to 12" 250 mm to 300 mm
15.5°C - 37.7°C	6 hrs.	12 hrs.	24 hrs.	48 hrs.
4.4°C - 15.5°C	12 hrs.	24 hrs.	48 hrs.	96 hrs.

Supports

Horizontal and Vertical support									
Spacing									
Nominal Pipe Size		21°C (70° F)		49°C (120° F)		71°C (160° F)		82°C (180° F)	
Inch	mm	FT	(cm)	FT	(cm)	FT	(cm)	FT	(cm)
1/2	15	5.5	167.70	4.5	137.16	3.0	91.44	2.5	76.20
3/4	20	5.5	167.70	5.0	152.40	3.0	91.44	2.5	76.20
1	25	6.0	182.88	5.5	167.70	3.5	106.68	3.5	91.44
1¼	32	6.5	198.12	6.0	182.88	3.5	106.88	3.5	106.68
1½	40	7.0	213.36	6.0	182.88	3.5	106.88	3.5	106.68
2	50	7.0	213.36	6.5	198.12	4.0	121.92	3.5	106.68

★ **When the system is to be concealed, it should be pressure tested before concealment.**

F. PB pipes and Fittings

Installation guidelines should be strictly followed as per the manufacturer's technical literature. and BS 5955: Part 8: 1990 (1995) Specification for the installation of thermoplastics pipes and associated fittings for use in domestic hot and cold water services and heating systems, and BS 6700:1997 Specification for design, installation, testing and maintenance of services supplying water for domestic use within buildings and their cartilages

Further all termination points should be PPSU fittings only for connection to the faucets. Apartment piping shall be laid and clamped in dry wall chase. Inside riser piping shall be along with necessary manifolds along with the fittings. Manifold shall be from the same supplier as of piping. If a joint beneath the floor is required, a compression fitting complying with the requirements of I.S. EN 1254 Part 3: 1998 must be used for the purpose

As all plastics materials expand & contract with temperature change, due allowance in pipe runs shall be made on installation to accommodate expansion & contraction of the pipe.

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

Installation guidelines should be strictly followed as per the manufacturer's technical literature and shall be approve by Engineer/Client.

H. Galvanized Iron Pipes.

a. Laying and Fixing

i. Where pipes have to be cut or re-threaded, ends shall be carefully filed so that no obstruction to the bore occurs.
ii. For internal work, all pipes and fittings shall be fixed truly vertical and horizontal, either by means of standard pattern holder bat clamps keeping the pipes 1/2" (12mm) clear of the wall everywhere or concealed as directed.
iii. For external work, GI ERW pipes and fittings shall be laid in trenches. The width of the trench shall be the minimum width required for working.
iv. Pipes laid underground shall be not less than 60cm. from the finished ground level and a minimum horizontal distance of 600 mm shall be maintained between other services lines.

b. Cleaning

i. Pipe surfaces shall be thoroughly cleaned mechanically and dried before tape is applied and shall be free of dirt, grease and rust scale or other foreign matter.

ii. Oil and grease, if present on the pipe surface shall be removed by using a suitable solvent and clean rag.
iii. The use of dirty, oily rags will not be permitted.

c. Field Application of Tape

i. Tape shall be wrapped in accordance with the manufacturers' recommendations in a manner that shall meet the adhesion requirement..
ii. During application, care shall be taken to ensure that there are no air pockets or bubbles beneath the tape. Tape shall be wrapped with an overlap of 50% for TEES.
iii. The first wrapping shall be done individually. Tape shall be cut if required to suit the profile.
iv. There shall be two layers of tape wrappings. The first layer shall be wrapped on the pipe directly after cleaning the pipe surface. The second layer shall be applied over the first layer. The second layer should also be wrapped with 50% overlap.

1.3 VALVES AND ACCESSARIES

A. General

I. 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.

II. All valves supplied shall be suitable for the working pressure and test pressure of the various water supply systems.

III. All valves other than automatic control valves shall be full line size.

IV. 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.

V. Furnish all valves and accessory material necessary in the piping whether or not shown on drawings as follows.

VI. 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.

VII. Where possible locate all valves at convenient positions of operation from the floor with valve stems upright.

VIII. Valves that are flanged shall have flanges comply with BS 4504 as for pipe work.

IX. Provide valves of the same manufacturer throughout, where possible.

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

XI. Valves shall be selected for the working pressure required.

XII. 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.

XIII. All valves (Gate, Butterfly, Ball, Auto balancing, globe, PRV, Check, and safety) and strainers shall be of suitable class as indicated in drawings & schematics and suitable for the particular service as specified.

All valves shall be capable of withstanding pressure which is 1.5 x the design pressure in the pipes in that relevant segment of the building...

Sl No.	Type of Valve	Size	Body Construction	Ends
1	Isolating Valve (Ball Valves)	Up to 50 mm	Brass	Screwed
2	Isolation Valve (Butterfly Valve)	50 mm & above	Cast Iron	Flanged
3	Y Strainers	Up to 50mm 50 mm & above	Brass cast iron	Flanged
4	Pressure Relief valve	All sizes.	Gun Metal	Screwed
5	Pressure reducing valve	50mm and less	Bronze	Screwed /Flanged
6	Pressure reducing valve	Above 50 mm	Ductile iron	Flanged
6	Foot Valve	Up to 50mm 50 mm & above	Brass Cast Iron	Flanged
7	Non return valve	Up to 50mm 50 mm & above	Brass Cast Iron	Flanged
8	Water Hammer Arrestor		Gun Metal	Screwed/Flanged

I. All valves and strainers shall be of the particular duty and design as specified. Valves and strainers shall either be of screwed type or flanged type, as specified, with suitable flanges and non-corrosive bolts and gaskets.

II. Tail pieces as required shall be supplied along with valves. Gate, Butterfly, Ball, Balancing shall conform to Indian Standard IS: 778 and PRV shall conform to Indian Standard IS: 9739 and non-return valves and swing check type reflux to IS: 5312.

III. All valves PN rating shall be 1.5 times of system working pressure

B. Valves & Controls - Specifications

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.

C. Gate Valves

a. Gates valves used in high pressure (head) piping shall be made of Stainless Steel 316 / Brass/ GM/ C.I and of suitable class as indicated in specifications, drawings & schematics or higher if required.

b. Supplying, fixing and testing shall correspond to IS: 778-1984, Specifications for Copper Alloy Gate, Globe and Check Valves for Water Works.

c. It shall be hand wheel (Cast iron) operated and high quality lubricated gland packing..

d. Valves shall be tagged with permanent label under hand wheel indicating type or duty.

e. All valves shall have manufacturer's test certificate indicating the date of shop test and other quality control tests with the material used for the same.

D. Ball Valves

a. Ball valves (according sizes as specified in Table Point A) shall be of high pressure type and shall be of sizes as specified in the BOQ. Normal size of a ball valve shall be that, corresponding to the size of the pipe to which it is fixed.

b. Ball valves shall be full bore, two piece designs.

c. Ball valves shall have body & bonnet of brass material.

d. 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.

e. Ball and the stem shall be of Brass confirming to IS 6912 respectively. Ball shall be hard chrome plated.

f. Handle shall be of M.S

g. Seat and gland packing shall be of PTFE.

h. 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.

i. 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.

E. Equilibrium float valve (For Storage Tanks)

a. Equilibrium Gun Metal float valves with ball floats to be fixed in storage tanks shall consist of hot pressed brass valve body(up to 50mm dia) and Cast iron (above 50mm dia), Stainless steel lever arm, and copper balls (26 SWG) screwed to the arm integrally.

b. The ball float shall be round and of Copper material. It shall have bronze welded seams. The closing/opening mechanism incorporating the piston and cylinder shall be non-corrosive metal and include washers.

c. The size, construction and weight of Float valves and ball float shall be suitable for desired working pressure operating the supply system.

d. Float valves shall generally conform to IS specification No.1703-1977. Weight of ball float and its size shall be as per IS specification.

F. Foot Valves

a. Foot valves (according sizes as specified in Table, Point G) shall be Brass/ cast iron body, with epoxy coating), brass disc and strainer of approved quality as specified in BOQ. The foot valves shall be conform to IS : 10805 – 1986.

b. Foot valves shall be spring loaded of stainless steel depending on the requirement.

c. Foot valves seal shall be EPDM.

d. Valves shall be tested physically for free operation before being mounted or assembled to the pipeline.

G. Butterfly Valves – Lever Operated

a. Butterfly valves (according sizes as specified in Table, Point B) used in high pressure (head) piping shall be made of C.I material of suitable class as indicated in specifications, drawings & schematics or higher as required.

b. Butterfly valves shall be slim seal, short wafer type with standard finish. Valves shall be suitable for mounting between flanges drilled to ANSI 125.

c. Valve shall consist of disc pivot and driving stem shall be in one piece centrally located. Disc shall move in bearings on both ends with 'O' ring to prevent leakage.

d. Seat shall be stainless steel/ductile iron based on working pressure classification and moulded with EPDM and shall line the whole body. Spindle shall be AISI 41 steel.

e. Valve for normal application shall be suitable for a working pressure to suit the application and service and shall be complete with flow control lever and notches, factory machined companion flanges and bolts and nuts.

f. Valves shall conform to BS EN 593, BS 5155 and IS 13095 with electro steel nickel coated SG Iron (N) and seat material EPDM.

g. 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.

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

i. 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.

j. 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.

k. 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.

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

m. The disc shall be of SS plate

H. Check Valves (Non Return Valves)

a. Horizontal / vertical Check valves (NRV) (according sizes as specified in Table, Point H) used in high pressure (head) piping shall be made of Brass/cast iron and of suitable class as indicated in specifications, drawings & schematics or higher as required.

b. Check valves shall be of Dual Plate with Brass/cast iron body, bronze/S.S plate, SS 316 hinge pins and springs and Buna-N seals to ANSI series 125.

c. Body ring shall be made of EPDM.

d. Valves shall conform to IS 778-1984 - Specifications for Copper Alloy Gate, Globe and Check Valves for Water Works.

I. Motorized Valve

The motorized valve shall be Butterfly type valve

a. Butterfly valves used in high pressure (head) piping shall be made of C.I material of suitable class as indicated in specifications, drawings & schematics or higher as required.

b. Butterfly valves shall be slim seal, short wafer type with standard finish. Valves shall be suitable for mounting between flanges drilled to ANSI 125.

c. Valve shall consist of disc pivot and driving stem shall be in one piece centrally located. Disc shall move in bearings on both ends with ‘O’ ring to prevent leakage.

d. Seat shall be Stainless steel / Ductile iron based on pressure classification and moulded with EPDM and shall line the whole body. Spindle shall be AISI41 steel.

e. Valve for normal application shall be suitable for a working pressure to suit the application and service and shall be complete with flow control lever and notches, factory machined companion flanges and bolts and nuts.

f. Valves shall conform to BS 5155 with electro steel nickel coated SG Iron (N) and seat material EPDM.

g. The leakage rate shall be A (as per EN 12266-1)

h. Control panel shall be designed as per the logic of pump operation.

Actuator

i. The feedback shall be modulating type 4-20 mA or 0(2)-10 V selected by DIP switch

j. The input shall be modulating type 4-20 mA or 0(2)-10 V selected by DIP switch

k. The enclosure shall be IP 67 water proof

l. The indicator shall be of continuous indicating type

m. The travel angle shall be 90˚C± 5 ˚C

n. The worm gear shall be permanently lubricating and self locking type

o. The manual override shall be Non-clutch design

p. The running time at an Pressure differential of 10 bar shall not be more than 15 seconds

Installation

a) Operate the valve manually to fully open or fully closed before the actuator is mounted in the valve

b) Operate the actuator and the valve stem to a fully open or closed position
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.

J. Strainers.

a. "Y" strainers (according sizes as specified in Table, Point D) shall be of Brass/ Cast iron body and of suitable class as indicated in drawings & schematics or higher as required.

b. Strainers shall incorporate removable stainless steel screen with 3.175 mm (1/8") perforations and permanent magnet.

c. Strainers shall be provided with flanges at both inlet and outlet.

d. Strainers shall be designed to enable blowing out of accumulated dirt and replacement of the screen without disconnection of the main pipe.

e. Strainers shall be provided with equal size isolating butterfly valves of approved brands as shown in drawings so that the strainer may be cleaned without draining the system.

K. Pressure reducing valve**.**

a. Valves shall maintain a constant downstream pressure regardless of fluctuations in demand and shall also prevent a pressure rise when demand is zero. Valve shall be suitable for horizontal or vertical installation.

b. No separate chambers shall be allowed between the main valve cover and body. Valve body and cover shall be of ductile iron. Ductile Iron is standard and other materials shall be available.

c. The valve shall contain a resilient, synthetic rubber disc, with a rectangular cross-Section contained on three and one-half sides by a disc retainer and forming a tight seal against a single removable seat insert. No O-ring type discs (circular, square, or quad type) shall be permitted as the seating surface. The disc guide shall be of the contoured type to permit smooth transition of flow and shall hold the disc firmly in place. The disc retainer shall be of a sturdy one-piece design capable of withstanding opening and closing shocks. It must have straight edge sides and a radius at the top edge to prevent excessive diaphragm wear as the diaphragm flexes across this surface. No hourglass-shaped disc retainers shall be permitted and no V-type or slotted type disc guides shall be used.

d. The diaphragm assembly containing a non-magnetic 303 stainless steel stem of Sufficient diameter to withstand high hydraulic pressures, shall be fully guided at both ends by a bearing in the valve cover and an integral bearing in the valve seat. The seat shall be a solid, one-piece design and shall have a minimum of a five-degree taper on the seating surface for a positive, drip-tight shut off. No centre guides shall be permitted. The stem shall be drilled and tapped in the cover end to receive and affix such accessories as may be deemed necessary. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating operating pressure from line pressure.

e. The flexible, non-wicking, FDA approved diaphragm shall consist of nylon fabric bonded with synthetic rubber compatible with the operating fluid. The centre hole for the main valve stem must be sealed by the vulcanized process or a rubber grommet sealing the centre stem hole from the operating pressure. The diaphragm must withstand a Mullins Burst Test of a minimum of 600 psi per layer of nylon fabric and shall be cycle tested 100,000 times to insure longevity. The diaphragm shall not be used as the seating surface. The diaphragm shall be fully supported in the valve body and cover by machined surfaces which support no less than one-half of the total surface area of the diaphragm in either the fully opened or fully closed position.

f. The main valve seat and the stem bearing in the valve cover shall be removable. The cover bearing and seat in 6" and smaller size valves shall be threaded into the cover and body. Valve seat in 8" and larger size valves shall be retained by flat head machine screws for ease of maintenance. The lower bearing of the valve stem shall be contained concentrically within the seat and shall be exposed to the flow on all sides to avoid deposits. To insure proper alignment of the valve stem, the valve body and cover shall be machined with a locating lip. No "pinned" covers to the valve body shall be permitted. Cover bearing, disc retainer, and seat shall be made of the same material. All necessary repairs and/or modifications other than replacement of the main valve body shall be possible without removing the valve from the pipeline. Packing glands and/or stuffing boxes shall not be permitted and components including cast material shall be of approved manufacture.

g. The valve manufacturer shall warrant the valve to be free of defects in materia1 and workmanship for a period of three years from date of shipment, provided the valve is installed and used in accordance with all applicable instructions.

h. The valve manufacturer shall be able to supply a complete line of equipment from 1 1/4" through 24" sizes and a complete selection of complementary equipment. The valve manufacturer shall also provide a computerized cavitations chart which show flow rate, differential pressure, percentage of valve opening, Cv factor, system velocity, and if there will be cavitations damage.

i. Valves shall be single-seated, hydraulically - operated. Valve body and cover shall be Ductile Iron Class 150/Class 300, flanged. Trim shall be bronze. Valve seat shall be replaceable. There shall be no external packing glands.

j. Valves shall have integral low flow by-pass line.

k. Main valve and all trim shall be factory- assembled into one unit.

l. PRV shall be complete with strainer in suction , and isolation valve, pressure gauge before after PRV

m. PRV station shall have bypass line with isolation valve as shown in the detailed layout.

L. Pressure Relief Valve

a. Pressure relief valves shall be provided to keep the pressure in the line below a given value within the reasonable limits in the downstream side of the pipeline when the pressure builds up beyond the design value.

b. Pressure relief valves shall be of high pressure type of specified sizes.

c. Valves shall be suitable for mounting between flanges and threading connections.

d. Valve body shall be of gun metal and of suitable class as indicated in drawings & schematics or higher as required.

e. Valves shall be of spring loaded, direct operation, metallic diaphragm type, as required for the particular usage.

M. Brass Bib Cocks & Stop Cocks

a. Bib cocks (bib tap) and stop cocks (stop tap) shall be of specified size & shall be of screw down type with hose connector.

b. The closing device should work by means of a disc carrying a renewable non-metallic washer, which shuts against water pressure on a seating at right angles to the threaded spindle, which operates it.

c. The handle shall be either crutch or butterfly type securely fixed to the spindle. Valve shall be of the loose leather seated pattern. The cocks (taps) shall open in anti-clockwise direction.

d. The bibcock & stopcock shall be polished bright. The minimum finished weights of the bib tap (cock) & stop tap (cock) as given in the IS specifications are reproduced below:

e. Bib cocks or stop cocks are required to be chromium plated, the chromium plating shall be of grade B type conforming to IS: 1068-1958.

f. The chromium shall never be deposited brass unless coating of nickel is interposed. In case these are required to be nickel plated, the plating shall be of first quality with a good thick deposit of silvery whiteness capable of taking high polish which will not easily tarnish or scale.

g. In finish & appearance, the plated articles, when inspected shall be free from plating defects such as blisters, pits, and roughness.

h. Hose Bib taps with lock type arrangement for car wash purpose.

i. The brass hose bib tap shall be provided at parking levels. The bib tap shall be with lock type arrangement with hose connector.

N. Test Plugs

a. Provision: Measurement of temperature and pressure. At inlet and outlet of all equipment.

b. Description: Self sealing, complete with captive cap for sealing when not in use. Ensure test plugs are suitable for system operation temperature and pressure. Provide one thermometer and pressure gauge for each range of conditions, for use with test plugs.

c. Material: Brass for Hot, Grey and domestic water usage.

O. Level Sensors

a. Level sensors shall consist of control unit, preamplifier and one full insulated probe-mounted vertically or two part insulated probe mounted from tanks side wall adjustable switching system for pump control application. The same shall be housed in stove enamel painted cast aluminum weatherproof enclosure.

b. Enclosure of probes shall be manufactured with SS316 material. The least count of the central unit with amplifier should be +/- 0.10mm for response value of 30 seconds.

c. Capacitive Sensor
   i. Threaded and flanged process connections

ii. Corrosion resistant construction and 316L stainless steel wetted parts
iii. 5 m (16.4 ft) maximum insertion length for rod versions and 25 m (82 ft) maximum insertion length for cable versions
iv. Rugged shear and abrasion resistant probe
v. Fully adjustable range: level, damping, diagnostics, etc.
vi. Field adjustable insertion length for cable probes without PFA insulation
vii. Probe input ESD protected
viii. Field proven and patented Active-Shield technology and variable frequency

Oscillator Specification

Power

- Supply voltage 12-30 V DC any polarity, 2-wire current loop circuit,

  max. resistance value 550 □ @ 24 V DC
- Measurement signal 4 – 20 mA or 20 – 4 mA

Environmental requirements

- location indoor/outdoor
- Altitude 2000 m max.
- ambient temperature general purpose applications: – 40 to +85 °C (– 40 to +185 °F)
- relative humidity suitable for outdoors (Type 4/NEMA 4/IP65 enclosure, IP68 optional)
-

Performance

- Measurement range 1.66 pF to 3300 pF
- Minimum span 3.3 pF
- Accuracy < 0.5% of actual measurement value
- Non-linearity and reproducibility< 0.4% full scale and actual measurement value
- Temperature stability max. temperature drift of 0.25% of actual capacitance value
- Safety current signalling signal 3.8 to 20.5, fault 3.6 or 21 mA (22 mA)
- Probe input ESD protected
- Inputs/outputs fully galvanic ally isolated
- Polarity-insensitive current loop

P. Flanges and Unions

a. Sufficient number of flanges and unions shall be provided of same material as the pipe required facilitating the maintenance work after the piping is installed.

b. Flanges shall be connected to the pipeline by screwing or welding depending on the requirement.

c. Flanges shall conform to the relevant ASTM standards for the particular material used for its manufacture. Flanges can also conform to relevant IS standards.

d. Pressure Rating and type shall suit service & application. It shall be ensured that the mating flanges are of similar rating and thickness.

e. Gasket shall be of suitable for intended service and given a thin uniform coat of lubricant in accordance with the manufacturer's recommendations and WRAS(water regulation and advisory scheme

Q. Automatic Air Vent

a. Brass body with non-ferrous float and internal working parts. Construction shall be take apart type for easy maintenance. Outlet shall be tapped for connection to drain line.

R. Vacuum Breakers or Backflow Preventers

b. Vacuum breakers shall be provided for cold as well as hot water supply piping wherever shown on the drawings or as directed.

c. Vacuum breakers shall have brass or bonze body with bronze or corrosion resisting steel parts and suitable discs. Vacuum breakers shall be of make approved by the Consultant.

S. Pressure Gauges

a. Pressure gauges shall be provided wherever shown on the drawings or as directed.

b. Pressure gauges shall not be installed until the piping systems are cleaned.

c. The pressure gauge shall be constructed of die cast aluminium and stove enamelled. It shall be weather proof with an IP 55 enclosure.

d. It shall be a stainless steel Bourdon tube type pressure gauge with a scale range from 0 to 25Kg / sq cm and shall be constructed as per. IS 3624

e. Each pressure gauge shall have a siphon tube connection. The shut off arrangement shall be by Ball Valve.

f. Dial gauges shall have adequate response for the pressures encountered within the specified (Range 0-25Kg/sq.cm).

g. Pressure gauges shall be of Bourdon tube and spring type accurate within 1% with minimum 115 mm dia. dial and with recalibrating screws.

h. Gauges shall have plain cases with close rings, white dial and shall be finished in black enamel.

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

j. Pressure gauges shall be of make approved by the Consultant.

T. Temperature Gauges

a. Use temperature gauges with pocket and provide with gland attachment on thermometer stem.

b. Provide gauges with a dial graduation in degrees Celsius marked on a logarithmic scale. Ensure pointer movement is clockwise for increase in temperature.

c. Use separable type pockets, screwed 15/19 mm BSP and manufactured from stainless steel (316L).

d. Screw pockets into tapped bosses or stools set in pipelines or vessels. Fill pockets with oil to BS 631 to ensure contact with thermometer bulb.

e. Provide sensing elements for Hot water system (solar system), where indicated, and fix to provide airtight joints.

f. Provide with metal shielding around sensing element to prevent effects of local radiation.

g. Provide temperature gauges at inlet and outlets of hot water equipment (solar system) as shown on drawings.

h. Thermometer shall be dual type adjustable angle, bimetallic helix actuated with silicone fluid damping, white with black marking and blank pointer hermetically sealed lens, stainless steel stem 75mm diameter dial, clear lens, 1% accuracy calibrated in both degrees F and degrees C.

i. Shall be suitable for hot water supply systems(solar system)

U. Thrust Block, Thrust Supports/Anchor Supports.

a. In case of bigger pipes (80 mm dia and above), 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 as directed by the Owner's site representative.

b. Thrust Supports or anchor supports indicated on drawing/schematic are for indication only, contractor to calculate the actual number, size and location of thrust Thrust Supports or anchor supports and submit for engineer's/client's approval.

V. 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.

W. Water Meter

a. 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 & outlet and cost shall be inclusive for the same). The meter shall comply to ISO 4064 standard, feasible for class B or Class A installation.

b. Water meters of approved make and design shall be supplied for installation at location as shown. The water meters shall meet with the requirement and approval of local water supply authorities. Suitable valves and chambers or wall meter box to house the meters shall also be provided along with the meters. Installation shall be as per the authority requirements

c. The water meters shall be provided with straight reading, dry dial, hermetically sealed register, and magnetic drive. The rotation of the turbine is directly transmitted to be register, and magnetic drive. The meters shall have tantalization of flow volume in cubic meter (cum). The meter shall conform to local municipal authority, and shall be suitable for connection to the remote monitoring/reading.

d. The meters shall conform to Indian Standard IS:779 and IS:2373. Where called for, the water meters shall be located in masonry chambers of appropriate size.

e. 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.

f. Water Meter has to be approved by local authority

g. 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.

X. Water Hammer Arrestors

a. Effective fluid hammer which results in breaking of pipe line caused due to hydraulic shock shall be arrested by means of water hammer arrestor.

b. The arrestor shall be capable of withstanding pressures upto 40kg/cm2 and temperatures in the rangeof (–)40Fto212F(0Cto+100C).

c. It shall be maintenance free with a companion flange to suit in the pipeline.

d. Following materials shall be used for its manufacture
   i. Barrel – Type ‘K’ hard drawn copper.
   ii. Cap-Standard wrought copper fittings attached to barrel with 95-5 solder
   iii. Piston & Thread Adaptor – Machined of free turning brass.
   iv. Seals – “O” rings of Parker spec.EP-5778-80

v. Seal Lubricant – Dow-corning silicone compound#111, FF&DA Listed for use in portable watersystem.

Installation of Water hammer arrestor

i. Flush lines thoroughly prior to installation.
ii. The WHA shall be located as close to the source of shock as possible. Use only Teflon tapes to seal the pipe threads
iii. To insure proper performance, the WHA should be installed so that there is an unobstructed path to the arrestor.

Y. Sluice Gate valves

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.

Z. Ball float valve

Ball valves with floats to be fixed in storage tanks shall consist of cast brass lever arm having copper balls (26 SWG) screwed to the arm integrally. The copper ball shall have bronze welded seams. The closing/opening mechanism incorporating the position 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.

1.4 TESTING AND COMMISSIONING OF WATER SUPPLY SYSTEM

A. Water Supply System testing general

a. The entire works included in this Contract shall be fully tested in stages as the work proceeds and on completion of work as applicable.

b. The Contractor shall provide all necessary labour, instruments, equipment, materials, fuel, power and manufacturer's representatives to carry out such tests as may be necessary to satisfy the client / consultant that the installation meets the requirement and intent of the Specification as well as such tests required by Local Authorities.

c. All tests shall be made in the presence of the client / consultant or his representative or any inspecting authority. At least seven working days notice in writing shall be given to the inspecting parties before performing any test.

d. Three copies of all test results shall be submitted to the client on paper within two weeks after completion of the tests. All test reports shall form a part of commissioning manual.

e. Tests described hereinafter and including all tests prescribed by the Authority having jurisdiction shall be carried out. Any tests proved unsatisfactory shall be repeated to the satisfaction of the inspecting parties.

f. Testing shall be done in accordance with IS: 12183 except as may be modified herein under and manufacturer’s recommendations.

g. Entire 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.

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

i. Before use at site all 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.

j. 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.

k. 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.

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

m. 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.

n. While doing concealed bathroom work, it is advised to make the required network on floor by proper measurement of different pipe lengths. To avoid misalignment, guiding marks on pipes and fittings should be referred.

o. If any pump fails in or before testing of commissioning. The same shall be replaced without any extra cost to the client.

B. **Water supply System Cleaning & Flushing**

a. The entire piping system after satisfactory testing shall be thoroughly cleaned and flushed by purging with clean domestic water until clear flow is obtained from each outlet.

b. If any faucet, valve or outlet is found not flowing full, the cause for the same shall be determined and necessary corrections made.

c. All parts removed during the flushing operation such as strainer screens etc. shall be replaced and the system put into operating condition.

C. **Disinfection of Domestic Water lines**

a. After flushing of all the Hot and Cold Water service piping, all the fresh water supply pipe work and water tanks shall be disinfected using a chlorine solution.

b. System to be disinfected shall include
   ix. Domestic fresh water tanks.
   x. Fire water tanks.
   xi. Distribution pipe work

c. All pipe work systems receiving suction from the above mentioned tanks apart from the fire systems.

d. Nipples and valves as required to introduce the disinfectant solution, to vent air and to drain the system shall be provided.

e. Sufficient chemical shall be added to the storage tanks so as to obtain a solution containing 50ppm available chlorine.

f. Distribution systems shall be filled with the disinfecting solution and taps shall be opened successively, working progressively away from the storage tank, and closed when the water discharge smells of chlorine. The storage tank shall finally be topped up with disinfecting solution of the above concentration.

g. Disinfectant solution shall be held in the system for a period of 24 hrs and a test for residual chlorine made. If no residual chlorine is found, the system shall be drained and the disinfection procedure repeated. When positive residual chlorine test is accomplished the system shall be flushed with potable water and put into operation.

h. Before handover of the system, copies of the certification and laboratory report (if required) shall be submitted to the Consultant.

i. Under no circumstances the use of any portion of the fresh water system until it is properly flushed disinfected and certified shall be permitted.

j. During disinfection work the contractor shall take all necessary precautions to prevent site staff from drinking the system water. Such precautions shall include locking doors to 'Wet' areas and providing warning signs in English and Hindi.

1.5 Connections to Various systems & mechanical equipment Supplied By Other Agencies

A. All inlets, outlets, valves, piping and other incidental work connected with installation of systems, mechanical equipment supplied by other agencies will be carried out by the contractor in accordance with the drawings, requirements for proper performance of equipment, manufacturer's instructions and the directions of the Owner's site representative / Architect.
B. The equipments to be supplied by the other agencies consist mainly for Kitchen, Back-of-the-House, STP area and other similar areas.
C. The work of connections to the various equipments shall be effected through proper unions and isolating valves.
D. The work of effecting connections shall be executed in consultation with and according to the requirement of equipment suppliers, under the directions of the Owner's site representative / Architect.
E. The various aspects of connection work shall be executed in a similar way to the work of respective trade mentioned elsewhere in these specifications.

2. SOLAR WATER HEATING SYSTEM

2.1 Scope:

Work under this section shall include Design, Engineering, Manufacture, Fabrication,Supply of Electro-Mechanical components, Erection, Testing and Commissioning of theSolar Water Heating (SWH) System in all respects.

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.

2.2 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.

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.

Collector size shall be as per the site conditions to accommodate the capacity indicated in the drawing.. 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.

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.

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.

2.3 Tanks :

Solar hot water tanks shall be fabricated from heavy gauge M.S. plates of minimum 5 mm thickness for shell and 8 mm thickness for dished ends. Tanks shall be internally lined with 1.6 mm thick 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.

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

2.4 Pumps

A. 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.

B. 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.

C. 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.

2.5 Piping

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

2.6 Process Block Diagram : Refer Schematic

2.7 Insulation and Wrapping

A. All hot water supply and solar hot water system tanks shall be insulated in the manner specified hereinafter
B. 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.
C. Elastomeric foam insulation shall be installed under supervision.
D. Insulation supplier shall provide thickness calculations. The minimum thickness shall be 19mm. The thickness calculation shall minimize heat loss and prevent condensation.

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.

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.

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.

3. INTERNAL DRAINAGE (Waste, Sanitary , Vent & Rain Water).

3.1 Pipes :- Product Description

General Note: -

All fittings should be capable of withstanding pressure which is 1.5 x the design pressure in the pipes in that relevant segment of the building. While selecting the pipes/fittings, appropriate derating factor w.r.t temperature to be taken care of.

Contractor shall provide one compensator joint / expansion joints in every 50 meter in the risers, however contractor to calculate, verify and provide necessary fittings/accessories as required to compensate thermal expansion/contraction of pipes, building sway movement and column shortening. Contractor to obtain the approval from Client/Engineer prior to ordering of the material. Above shall be in compliance with manufacturer / supplier recommendations / requirements.

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.

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.

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 thickrubber insertion packing and when closed and bolted shall be air and water tight.

A. UPVC Pipes&Fittings :- Imported

Pipes – The waste & sanitary pipes and fittings shall be color as specified by the Architect / owner's representative, unplasticized PVC, manufactured in accordance with EN 1329-1 for above ground and EN 1401-1 for below ground application. Pipes shall, where appropriate, bear the British Standard Kite Mark.

Joint:- The method of jointing to be employed shall be that of solvent cement joints using the manufacturer's approved cleaner and cement or ring / push fit.

a. Pressure for the pipes up to dia. 80 mm is 2 bar

b. Pressure for the pipes up to dia. 150 mm is 4 bar

c. Pressure for the pipes above dia. 150 mm is 6 bar

Seal ring fittings shall be used where necessary to accommodate thermal movement or where the manufacturers recommend. 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 as shown on the drawings and in accordance with the Building Regulations and BS EN 12056-2.

B. UPVC Pipes and Fittings :- Indian Make

Pipes :- The waste & sanitary pipes and fittings shall be color as specified by the Architect / owner's representative, unplasticized PVC, manufactured in accordance with - IS 4985 & pressure class shall be as specified in MOC table.

Fittings: - Fittings shall unplasticized PVC, manufactured in accordance with IS 7834

Joint:- The method of jointing to be employed shall be that of solvent cement joints using the manufacturer's approved cleaner and cement.

Horizontal and vertical pipe work shall include allowance for thermal expansion, building sway movement 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, oralternatively 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 as shown on the drawings and in accordance with the Building Regulations and BS EN 12056-2.

C. UPVC SWR pipes and fittings :

Pipes – The waste & sanitary pipes and fittings shall be colour as specified by the Architect / owner's representative, unplasticized PVC, manufactured in accordance with IS 13592, & type A/B shall be as specified in MOC table.

Fittings: - Fittings shall be unplasticized PVC SWR, manufactured in accordance with IS 14735 -99 & type shall be as specified in MOC table.

Joint:- The method of jointing to be employed shall be that of solvent cement joints or ring/push fit using the manufacturer's approved cleaner and cement.

Seal ring fittings shall be used where necessary to accommodate thermal movement or where the manufacturers recommend. 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 IS 5382. 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 as shown on the drawings and in accordance with the Building Regulations and BS EN 12056-2

D. PP Pipes & Fittings (Silent poly-propylene):

Pipes:- Low noise (26 DB) type Polypropylene pipes manufactured accordance to BS EN 1451-1/BS 7874/BS EN 681-1 /BS EN 682-2, DIN 4109, The Pipe shall be Mineral Reinforced material with density not less than 0.95 kg/cm3. For above 200 mm Dia. use HDPE pipe as specified. Pressure class shall be as specified in MOC table.

Fittings: - The door access fittings (elbow, tee) & P- Traps shall also be Mineral Reinforced material with density not less than 0.95 Kg/cm3.

Joint: - Push Fit.

Table 15066-1

Physical Property and Pipe Performance Requirements

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 (Type IV 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	110,000
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
Property	**Method**	**Days to Failure**	**Minimum Values**
Impact Strength			
(IZOD) (0.125-inch thick)	ASTM D256	in-lb/in	
	(Method A)	Notch	42
Linear Thermal			
Expansion Coef	ASTM D696	in/in/°F	1.2 x 10-4
Thermal Conductivity	ASTM C177	BTU, in/	2.7
		Ft2/hrs/°F	
Brittleness Temp	ASTM D746	°F	<-180
Vicat Soft. Temp	ASTM D1525	°F	+257
NSF Listing	Standard 61	---	Listed

E. HDPE pipes & Fittings (silent db20)

Pipes: - Mineral wool reinforced HDPE pipe (Silent dB 20) with butt fusion jointing method. Manufactured as per IS-4984, ISO-4427, DIN8074, ASTM D 3035 and BS-6437 standards in PE-63, PE-80 and PE-100 grade

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

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

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

Fittings used to connect with dissimilar pipe materials shall be provided as per Section 15062 "Ductile Iron Pipe and Fittings."

Joint:- Butt fusion joint.

F. HDPE Pipes and Fittings

1. Material

a) The pipes shall be round and shall be supplied in straight lengths with plain ends.

b) 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.

c) Pipes and fittings shall be manufactured according to IS-14333 for Indian make.

d) Pipes and fittings shall be manufactured according to latest European EN 1519 – 1 for imported make.

e) All materials shall be manufactured under a BS 5750/ISO 9000 approved scheme. All component parts of the system shall be covered by manufacturer's warranty.

f) Pipe fittings and accessories: HDPE carrying a current BBA Certificate No. 92/2729

2. Joints

a) All pipe and fitting joints including the joint to the outlet shall be fusion welded either electro sleeve coupling or butt weld as per IS-7634 Part-2.

b) Expansion joints shall be provided in accordance with manufacture's recommended intervals and / or changes in direction more than a meter apart unless clipping are positioned to allow movement.

c) Intermediate sliding supports shall be provided in accordance with manufacture's recommendation. Intermediate sliding supports to fasten the pipe to the rail shall be at the following intervals:

Pipe 40mm to 75mm diameter	-	0.8m.
Pipe 90mm diameter and above	-	10 x overall pipe diameter.

G. Cast iron pipes & Fittings

Non Pressure Pipe (Spun Pipe): - Cast iron pipes are conforming to IS: 3989 suitable for Soil, waste and sanitary application & making proper connections to equipments including all necessary fittings. Pipe type and application shall be as specified in MOC table.

Pressure Pipes: - Cast iron pressure pipes (Class LA/A/B) conforming to IS1536 suitable for Soil, waste and sanitary application & making proper connections to equipments including all necessary fittings. Pipe pressure class and application shall be as specified in MOC table.

Cast Iron pipes – Imported Make: - Cast iron pipes conforming to BSEN 877 suitable for Soil, waste and sanitary application & making proper connections to equipments including all necessary fittings. Pipe pressure class and application shall be as specified in MOC table

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.

The pipes and fittings shall be of uniform material throughout and shall be free from all manufacturing defects.

Fittings:- Fiitngs shall be manufactured in accordance to IS 14329/IS 1538/IS3989/BSEN 877/ ASTM 564.

Joint: - Coupling Joints/Socket and Spigot joint with Drip seal/EPDM Rubber joint.

Drip seal PJS-43 (pipe joint sealant) shall be used for joining various diameters of C.I. pipes and specials. This sealant replaces the standard Drip seal caulked joints.

The compression gasket is a precision moulded one-piece gasket that is made of an elastomer that meets the requirements of ASTM C-564. The physical characteristics of this elastomer ensure that the gasket will not decay or deteriorate from contact with the materials flowing in the pipe or chemicals in the soil or air around the pipe

H. Drainage – MOC

Please refer to the schematic drawings

3.2 Pipes :- Execution

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

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

A. General

c. Soil, waste and vent pipes in shafts, ducts and in concealed areas i.e. false ceilings etc. shall as specified in earlier sections.

d. Pipe's are made and supplied in nominal lengths of 6 m with plain ends to be used with hot fusion welding or electro-fusion jointing process.

e. All drainage pipes to conform to DIN 19535, DIN19537 or

f. The soil pipes shall be with a minimum diameter of 100mm. All bends, branches, swan neck and other parts shall conform to the requirement and standards as described for the pipes.

g. Pipes shall be rested against the walls on suitable wooden cradles. Local authority regulations applicable to the installations shall be strictly followed.

h. 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.

i. Soil pipes shall be painted as provided under `painting'. The soil pipes shall be covered on top with terminal outlets as directed and approved.

j. All vertical soil pipes shall be firmly fixed to the walls with properly fixed clamps, and shall as far as possible is kept 50mm clear of wall.

k. Pipes shall be fixed, jointed and painted as described in installation of soil, waste & vent pipes.

l. Every waste pipe shall discharge above the grating of properly trapped gully. The contractor will ensure that this requirement is adequately met with.

m. 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.

n. Ventilating pipes shall conform to the requirements laid down earlier. Anti-siphon vent pipes/relief vent pipes where called for on the drawings shall be as specified. The pipes shall be of the diameter shown on the drawings.

o. 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.

p. 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.

q. All the fittings used for connections between soil, waste and ventilation pipes and branch pipes shall be made by using pipe fittings with rodding eye for cleaning.

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

s. Head (starting point) of drains and sewage / waste water sumps (as and where applicable) having a length of greater than 4 m up to it connection to the main drain or manhole shall be provided with a 80 / 100 mm vent pipe.

B. Installation of Sanitary, Waste, Vent Pipes & Rain Water Pipes

a. All Horizontal pipes running below the slab and along the ceiling shall be fixed on structural adjustable clamps, sturdy hangers with neoprene lining of the design as called for in the drawings. The pipes shall be laid in uniform slope and proper levels. All vertical pipes shall be truly vertical fixed by means of stout clamps with neoprene lining in two sections, bolted together, built into the walls, wedged and neatly jointed.

b. 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.

c. The joint shall not be covered till the pipe line has been tested under pressure. Rest of pipe line shall be covered so as to prevent the expansion and contraction due to variation in temperature.

d. Vent Pipe Terminations

a) Vent system conforming to IS : 13592 - Type B 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 pushfit rubber ring jointing technique in general. Solvent cement joints may be provided for fittings and specials which are not manufactured with pushfit 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 neccessary 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. (For all vertical drainage pipes)

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 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.

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

C. HDPE Pipe Installation (Fusion)

a. Use fusion equipment specially designed for heat fusion of HDPE. The equipment utilized shall be regulated for the different melt strength materials. Compatibility fusion techniques shall be used when polyethylene of different melt indexes are fused together.

b. Use the following procedure to butt fused HDPE pipe. If a procedure noted below contradicts manufacturer's recommendations, follow the manufacturer's recommendation.

c. Maintain the proper temperature of the heater plate as recommended by the pipe manufacturer. Check it with a tempilstik or pyrometer for correct surface temperature.

d. Clean pipe ends inside and outside with a clean cotton cloth to remove dirt, water, grease, and other foreign materials.

e. Square (face) the pipe ends using the facing tools on the fusion machine. Remove all burrs, chips, and fillings before joining pipe or fittings.

f. Check the line-up of pipe ends in the fusion machine to see that pipe ends meet squarely and completely over the entire surface to be fused. The clamps shall be tight so that the pipe does not slip during the fusion process.

g. Insert the clean heater plate between the aligned ends and bring the ends firmly in contact with the plate but do not apply pressure while achieving the melt pattern. Allow the pipe ends to heat and soften. Softening depths shall be per the manufacturer's recommendation.

h. Carefully move the pipe ends away from the heater plate and remove the plate (if the softened material sticks to the heater plate, discontinue the joint, clean heater plate, square pipe ends, and start over).

i. The melted ends shall be connected rapidly but not slammed together. Apply enough pressure to form a double rollback bead to the body of the pipe around the entire circumference of the pipe about 1/8-inch (3.175-mm) to 3/16-inch (4.763-mm) wide. Pressure is necessary to cause the heated material to flow together.

j. Allow the joint to cool and solidify properly. Remove the pipe from the clamps and inspect the joint appearance.

k. Plan joint completion to accommodate temporary test bulkheads for hydrostatic testing on the day of installation.

l. Assembling joints

m. Flanged Joints

i. Flange adapters shall be pressure rated the same as the pipe. Flange adapters shall be heat fused to the pipe as outlined in the heat fusion section.
ii. Gaskets shall be used between the polyethylene flange adapters when recommended by the HDPE pipe manufacturer. Sufficient torque shall be applied evenly to the bolts to prevent leaks. After initial installation and tightening of flanged connections, allow the connections to set for a few hours then conduct a final tightening of the bolts.
iii. Lubricate nuts and bolts with oil or graphite prior to installation.
iv. Check operation of valves connected to molded stub end flange adapters. Insert polyethylene spacer if recommended by pipe manufacturer for clearance.

n. Mechanical Joints

i. Wipe the socket and the plain end clean. Lubrication and additional cleaning should be provided by brushing both the gasket and plain end with an approved pipe lubricant just prior to slipping the gasket onto the plain end for joint assembly. Place the gland on the plain end with the lip extension toward the plain end, followed by the gasket with the narrow edge of the gasket toward the plain end.
ii. Insert the pipe into the socket and press the gasket firmly and evenly into the gasket recess. Keep the joint straight during assembly.
iii. Push the gland toward the socket and center it around the pipe with the gland lip against the gasket. Insert bolts and hand tighten nuts. Make deflection after assembly but before tightening bolts.

iv. Tighten the bolts to the normal range of bolt torque as indicated in AWWA C-600 while maintaining approximately the same distance between the gland and the face of the flange at all points around the socket.

o. Ductile iron to HDPE connections

Flanged connections between ductile iron pipe or fittings and HDPE pipe or fittings shall be provided.

Mechanical joint connections between ductile iron pipe or fittings and HDPE pipe or fittings shall use ductile iron mechanical joint. Mechanical joints shall be fully thrust restrained. Gaskets, bolts, and hexagonal nuts shall be standard rubber gaskets. Follower gland shall match class 350 compact fittings.

HDPE pipe stiffeners shall be constructed of stainless steel and shall be flanged on one end to prevent over-insertion into the receiving pipe.

p. Qualification of the operators

Each operator performing fusion joining shall be qualified in the use of the manufacturer's recommended fusion procedure(s) by the following:

v. Appropriate training or experience in the use of the fusion procedure.
vi. Making a sample joint according to the procedure that passes the following inspections and tests:
vii. The joint shall be visually examined during and after joining and found to have the same appearance as a photograph or sample of an acceptable joint that was joined in accordance with the procedure; and
viii. The joint shall be tested or examined by 1 of the following methods:
ix. Pressure and tensile test as described in 49 CFR 192.283
x. Ultrasonic inspection and found to be free of flaws that would cause failure
xi. Cut into at least 3 longitudinal straps, each of which is:
xii. Visually examined and found to be free of voids or un bonded areas on the cut surface of the joint, and
xiii. Deformed bending, torque, or impact and if failure occurs, it must not initiate in the joint area.
xiv. Each operator shall be re-qualified under the procedure if during any 12-month period Operator has not made any joints under the procedure; or Operator has 3 joints or 3% of the joints made, whichever is greater, that are found unacceptable by testing according to 49 CFR 192.513.
xv. Plastic pipes Laying and Jointing

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.

D. Cast iron pipes

Laying

Fittings used for CI drainage pipe shall conform to IS:1538-1976. Wherever possible junction from branch pipes shall be made by a Y/tee. Laying of pipes shall as per the drawings.

Drip Seal Joints :

Drip seal PJS-43 (pipe joint sealant) shall be used for joining various diameters of C.I. pipes and specials. This sealant replaces the standard Drip seal caulked joints. The application is by Homogenously mixing the two pack system in cold condition.

Application Procedure:

Clean the pipe joints thoroughly to ensure it is free from any traces of oil, dirt or any other foreign body. Mix two parts of Drip Seal thoroughly with an iron flat to get a homogenous compound. * Place Spun yarn in the pipe joint as a filler and then take the required quantity of the compound and push it in the joint with a caulking tool, MS flat / damp finger uniformly all

over to obtain a smooth and uniform joint. Dip the fingers in water every often to ensure the compound does not stick to the hands of the workmen, but this will ensure perfect sealing and the smooth surface for the joint cement. (* The compound prepared from the two mixtures is to be used within 30 minutes) Precaution to be taken to wash hands thoroughly with soap before and after use. Preferably use disposable gloves for hand application.

a. Compression Gaskets

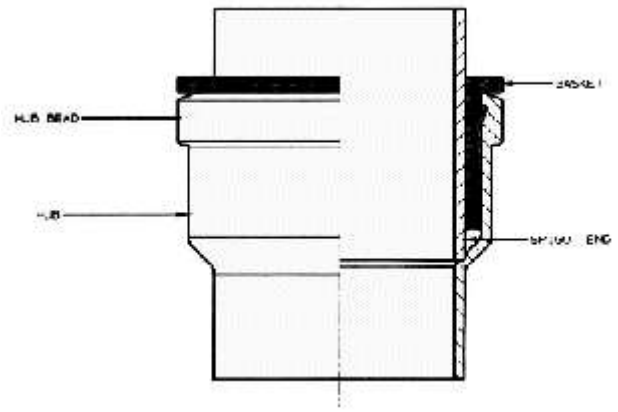
The compression gasket is a precision moulded one-piece gasket that is made of an elastomer that meets the requirements of ASTM C-564. The physical characteristics of this elastomer ensure that the gasket will not decay or deteriorate from contact with the materials flowing in the pipe or chemicals in the soil or air around the pipe. The compression joint is made as follows:

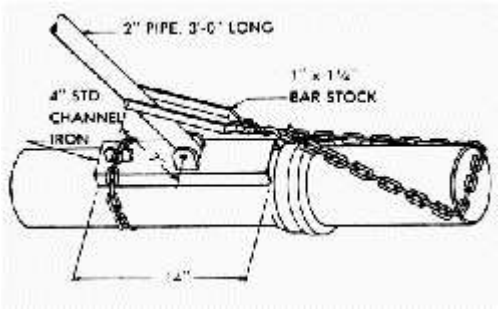
i. Clean the hub and spigot so they are reasonably free from dirt, mud, sand, gravel or other foreign materials. When installing pipe that has been cut, make sure the sharp edge is removed. The sharp edge may jam against the gasket's seals making joining very difficult. The sharp edge may be removed by filing or tapping the edge with a ball-peen hammer.

ii. Fold and insert the gasket into the hub. The gasket must be inserted into the hub completely. Only the flange which contains the identification information remains exposed on the outside of the hub.

iii. Lubricate the joint following the manufacturer's recommendations. Sizes 2" through 15" may be lubricated using a manufacturer's recommended lubricant. Some manufacturers recommend using an adhesive lubricant on large diameter pipe and fittings (5"-15"). It should be noted that use of the adhesive lubricant does not take the place of proper join restraint when required.

iv. Align the pipe so that it is straight. Using the tool of your choice, push or pull the pigot through all of the sealing rings of the gasket. You will feel the spigot end of the pipe bottom out in the hub. Fittings may be installed by using the tool of your choice or by driving the fitting home by using a lead maul. To do this, strike the fitting on the driving lug or across the full hub. Hit it as hard as necessary, the lead will deform without harming the fitting. Using the lead maul is the fastest and easiest way to install fittings on hub and spigot cast iron soil pipe. Proper safety procedures should be observed in making the joint.

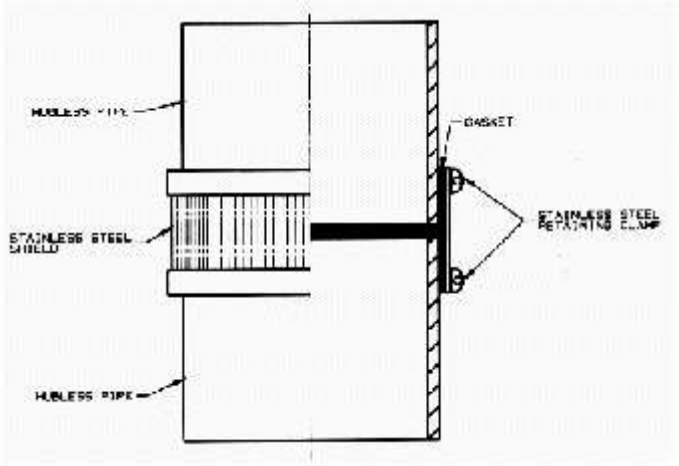




b. Hub less Joints

Hub less cast iron soil pipe is joined by using the hub less coupling. Several different types of hub less couplings are available. The following will outline the installation procedures of hub less couplings that meet the requirements of CISPI 310. It must be noted that these installation procedures are not intended to be applicable for couplings other than those manufactured in accordance with CISPI 310. These couplings are manufactured using a stainless steel shield and clamp assembly and an elastomeric sealing sleeve conforming to the requirements of ASTM C-564. The following steps should be taken to ensure a proper joint.

i. Place the gasket on the end of one pipe or fitting and the stainless steel clamp and shield assembly on the end of the other pipe or fitting.
ii. Firmly seat the pipe or fitting ends against the integrally moulded centre stop inside the elastomeric sealing sleeve.
iii. Slide the



stainless steel shield and clamp assembly into position over the gasket and tighten the bands. The bands should be tightened using a calibrated torque wrench set at 60 in./lbs. For larger diameter couplings that have four bands, the inner bands should be tightened first and then the outer bands tightened. In all cases, when tightening bands they should be tightened alternately to ensure that the coupling shield is drawn up uniformly

3.3 Drainage Accessories.

A. Traps:

a. General:
i. Traps shall be provided on all fixtures connected to the waste and sanitary system except for fixtures having integral traps.
ii. All traps shall have a seal of not less than 50mm and not more than 100mm.
iii. All traps shall have the same internal diameter as the fixtures outlets.

b. Exposed Traps:

i. Exposed traps for fixtures shall be chromium plated cast brass.

c. Cast Iron Traps

i. Traps installed in connection with C.I. pipe shall be of the same quality and grade of the pipe, the size of outlet shall correspond to the socket of the pipe receiving it.

d. Urinal Traps:

i. Urinal traps shall be of CP `P' Trap with minimum effective water bed of 75mm.
ii. Floor Trap Inlets: Bathroom Floor trap / drain wherever indicated on drawings shall be of UPVC material with inlet & outlet connections as shown in the drawings.
iii. Floor drain shall have provision for installation of chrome plated cast bronze frame grating.

e. Floor Trap / Drain

i. Traps and connections shall ensure free and silent flow of discharged water.
ii. Where specified, the Contractor shall provide a HDPE pipe inlet hopper without or with one, two or three inlet sockets to receive the waste pipe.
iii. Joint between waste and hopper shall be connected to a HDPE 'P' or `S' trap with at least 50mm seal.
iv. Floor trap inlet hoppers and the trap shall be set in cement concrete blocks.

v. 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.

vi. 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.

C.P./stainless steel grating:

- For bathrooms floor drain / Trap, grating will be supplied by client. Contractor shall allow for its installation with installed floor trap / drain as directed by Employers representative.
- 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. Roof Drains

Rain water outlets shall be **UPVC body** 100mm dia size dome, wide serrated flashing flanged, and flashing clamp device with integral gravel stop. Rain water outlets shall be selected to suit the type of roof where installed and shall be provided with a no hub outlet for mechanical jointing to rain water pipe. Rain water outlets shall be provided with perforated extension assemblies, where required to match the roof construction. Hepworth PME or equivalent approved.

C. Scupper type Rain water Drain

Scupper type Balcony /rain water outlets shall be dura coated **UPVC body** with reversible back/bottom outlet, oblique grate with combination frame and membrane flashing fixed with chrome plated cover. Hepworth PME or equivalent approved.

D. Planter Bed Drain

Flower bed drain where specified shall be heavy duty, dome type drain coated **UPVC body** with bottom outlet complete with combination membrane flashing clamp/gravel guard, low silhouette dome and UPVC mesh screen over dome, no floor trap is required.

E. Relief Vents:

a. Drainage systems are likely to develop extremely high and objectionable pneumatic effects in several specific portions of such piping.

b. Special air pressure relief vents shall be provided to control, within tolerable limits.

c. Air pressure relief vent, at least one-half the diameter of the building drain, shall be provided at the top of vertical offset so as to supply such additional air to the drain as may be required by the sudden increase in liquid velocity in the vertical offset Where a building trap or other sharp change in flow direction is provided in the building drain downstream from the vertical offset ,an air pressure relief vent shall be provided at the base of and within 3 ft (0.900m) of the vertical offset. Lower relief vent shall be branch –connected to the upper relief vent at a sufficient height.

d. Soil and waste stacks shall be provided with a yoke relief vent at each tenth story of the drainage stack, counting downward from the top storey.

e. Lower end of the yoke relief vent shall connect to the drainage stack by means of a Y located below the horizontal branch drain serving fixtures in that story, and the upper end

shall connect to the vent stack by means of a T or inverted Y located at least 3 ft (900mm) above the floor level as shown in the drawing.

F. Gully Traps / Area Drains for car park areas

a. Gully Traps / Area drains shall be used for Tower footprint.

b. Area Drains shall be 150x150 mm in size as shown in drawings for (tower footprint) to B4 level of heavy duty UPVC construction, sealed with extension piece, Ductile iron heavy duty non rocking type cover for each trap, secured with threaded gunmetal bolts and gaskets as shown on drawings.

c. Fixing pvc 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 C.I. cover with frame of 300mm x 225mm internal size. The weight of cover to be not less than 5 kg & frame not be less than 3.5kg as per standard design. 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.

G. Cleanout Plugs:

a. Pipe cleanouts shall be of the same size as the pipe except that cleanout plug larger than 100 mm dia. shall not be used.

b. Cleanout installed shall consist of a long sweep 1/4 bend extended to the location shown.

c. A heavy cast brass or cast iron ferrule with countersunk cast brass head screw plug shall be caulked into the hub of the fitting and shall be flush with the floor.

d. Cleanout shall be of same material as that of the pipe.

e. Cleanout plugs shall be provided with keyholes for openings as directed by the Employers representative/ Consultant.

f. Cleanouts in connection with other piping shall be T Pattern, 90 branch drainage fitting with o cast brass screw plug of the same size as the pipe.

g. Cleanouts installed in finished floors shall be provided with chrome plated cast brass, nickel brass or nickel bronze cover secured to the plug or cover frame and set flush with the finished floor. Heads of fastening screws shall not project above the cover surface.

H. Ductile Iron Grating:

a. Ductile iron grating shall be of heavy quality flat with perfect edge and of a quality procurable of the specified width, thickness and lengths.

b. Ductile iron gratings shown on driveways should have necessary strength to withstand the load.

I. FRP Grating:

a. FRP grating shall be of heavy quality flat with perfect edge and of a quality procurable of the specified width, thickness and lengths.

b. FRP gratings shown on driveways should have necessary strength to withstand the load.

J. Waste Pipe from Appliances:

a. All pipes shall be fixed in gradient towards the outfall of drains as per drawings/ as directed by the Employers representative.

b. Pipes inside a toilet room shall be in chase unless otherwise shown on drawings. Where required, pipes may run at ceiling level in suitable gradient and supported on structural hangers/ clamps.

K. Grease Trap

1. 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.

2. Masonry Grease Interceptor

a. Size of Grease Trap
   i. The size given in Bill of Quantities and drawings shall be internal size of chamber. The work shall be done strictly as per standard drawing and following specifications.

b. Bed Concrete
   i. Shall be in 1:4:8 cement concrete 150 mm thick.

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

d. Plaster

   i. 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.

e. Chamber Covers
   i. Covers shall be of size and duty as mentioned in Bill of Quantities. Covers shall be of cast iron as per the details given in the drawing and shall be fixed on frame embedded in concrete.
   ii. I steps shall be provided at two corners of the chamber.
   iii. All Cast Iron and MS items shall be painted with two coats of bitumastic paint.

f. Cast iron Manhole cover and Frame
   i. The Cast Iron Manhole Cover and Frame shall conform to IS:1726 and the grade and types have been specified in the Bill of Quantities. The cover and frames shall be cleanly cast and they shall be free from air and sand holes and from cold shuts. They shall be neatly dressed and carefully trimmed. All castings shall be free from voids whether due to shrinkage, gas inclusion or other causes. Covers shall have a raised checkered design on the top surface to provide an adequate non-slip grip.
   ii. The sizes of covers specified shall be taken as the clear internal dimensions of the frame.
   iii. 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.

L. Excavation for soil pipes.

No extra payment shall be admissible with respect to excavation refilling and disposal of surplus earth for cast iron and caste pipes.

M. Inspection Chamber

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. The cover shall be LD-2.5 / MD-10 / HD-20 as per placing of the chamber.

N. Catch Basin

Designing & Construction of Road Catch Basin Chamber of the following sizes in brick work 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. Cost shall be inclusive of providing, PCC/SFRC heavy duty grating with frame.

O. Sanitary fixtures and fittings (Installation Only)

a. Scope:

Work under this section shall consist of providing labor for necessary to install, test and commission of all sanitary fixtures.

b. General Requirements

i. All fixtures and accessories shall be fixed to meet the Architectural/ Interior designer's requirements. Wherever necessary the fittings shall be centered to dimensions and pattern desired.

ii. All fittings and fixtures shall be fixed in a neat workman like manner true to level, plumb, square and secure with substantial hangers and supports, at height with clearance as shown on drawings and in accordance with the manufacturer's recommendations. Cutting of tiles where necessary shall be true to geometric sizes as required.

iii. Upon completion of the work, all labels, stickers, plasters, etc. shall be removed from the fixtures and all fixtures shall be cleaned with soap and water so as to present a neat and clean toilet.

iv. Unless otherwise specified, all C.P. accessories shall be fixed with C.P. brass half round head screws and cup washers using rawl plugs or teak wood as directed. The rate shall include cutting and making good as directed by the Employers representative.

v. Porcelain accessories shall be fixed in walls and set in cement mortar 1:2 and fixed in relation to the tiling work as directed. The rate shall include cutting and making good the same.

3.4 TESTING AND COMMISSIONING OF DRAINAGE SYSTEM

A. Carry out all tests and inspections to prove that the installation meets the requirements of the Building Regulations and BS EN 12056-2.

B. Carry out all tests required by the building control officer giving adequate notice. Should the installation fail to hold against any test, identify the location of the failure or leak, rectify and re-test at no additional cost to this contract.

C. Tests shall include all new pipe work and fittings from the point of connection to the underground drainage, to the point of connection and termination at roof level as a vent pipe.

D. The installation shall be tested section by section as the work proceeds and subsequently on completion, to ensure that the installation is free from superfluous matter and obstruction and

that all work which is to be concealed, is free from defects before it is finally enclosed. Systems shall be submitted to two separate tests, air test and hydraulic performance test in accordance with BS EN 12056-2.

E. The waste and sanitary drainage pipework systems shall be air tested at a pressure equal to 38mm water gauge which shall remain constant for a period of 3 minutes. Pipes shall be tested in the presence of the supervising officer and all pipework shall be visible at the time of the test. All test bungs are to be removed in the presence of the owner's representative.
F. Before testing, all waste and sanitary drainage pipes shall be cleaned and prepared thoroughly as follows:
G. Traps for all appliances and floor gullies shall be plugged and flushed thoroughly with clean water
H. Main stacks and branches shall have duct covers and ceiling tiles removed where necessary
I. Access covers, cleaning and rodding eyes shall be removed and the stacks rodded by means of drain rods or similar flexible springs and plungers, of a suitable diameter
J. Obstructions in pipes shall be removed using suitable cleaning tools
K. Care should be taken when carrying out the above operations to ensure deposits and other extraneous matter are not flushed into the drainage system
L. In order to be assured of the cleanliness of the system, these cleaning operations shall be carried in the presence of the owner's representative.
M. A water test may be called for, but this shall only apply to the horizontal sections of plumbing and drainage and the section of pipework below the lowest sanitary appliance. This shall be carried out by inserting a plug in the lowest end of the pipe where it enters the inspection chambers and filling the system up to a head of 15m or the flood level of the lowest connected appliance, whichever is the lower.
N. Before commencing air tests all water seals of all sanitary appliances and floor gullies etc. must be fully charged with water and all open ends of pipework i.e. vents and/or outfalls, must be plugged off.
O. All traps must retain not less than 25mm of seal when subjected to the appropriate discharge tests. The number of appliances to be tested shall be as detailed in BS EN 12056-2 Table NG.1.
P. Upon completion of satisfactory testing to all stack pipes, branch pipes and appliances, all duct covers should be re-fixed and ceiling tiles replaced where necessary.
Q. Allow for intermediate testing where work is to be concealed by other services. Should final tests reveal defects on concealed pipework, rectify the defects at no additional cost.
R. All tests shall be carried out in the presence of the owner's representative, providing any aid or facilities required. Smoke tests shall not be carried out on plastics pipes.
S. Keep a record of all tests carried out, including the following:

- Date of test
- Location and Identification of the pipeline
- Drawing reference
- Method of test
- Result of test
- Signature of operative undertaking test
- Signature of supervising officer
- Marked up schematic

4. TANK FITMENTS

Scope of work under this section comprises the supply, erection, testing and commissioning of all tank fitments, as specified in the Bill of Quantities. Tank Fitments shall be suitable for the purpose they are intended.

A. The contractor shall provide all inlets, outlets, washouts, vents, ball cocks, overflows control valves and all such other piping connections including level indicators (internal & external) with necessary controls to water storage tanks.
B. All pipes crossing through RCC work shall have puddle flanges fabricated from MS/GI pipes of required size and length and welded to 6/8 mm thick MS plate and to be hot dip galvanised after fabrication.
C. All puddle flanges must be fixed in true alignment and level to ensure further connection in proper order.
D. Full way gate valves of approved make shall be provided as near the tank as practicable on every outlet pipe from the storage tank except the overflow pipe.
E. Overflow and vent pipes shall terminate with mosquito proof grating.
F. The overflow pipe shall be so placed to allow the discharge of water being readily seen.
G. The overflow pipe shall be of size as indicated on the drawings.
H. A stop valve shall also be provided in the inlet water connection to the tank.
I. The outlet pipes shall be fixed approximately 75mm above the bottom of the tank towards which the floor of the tank is sloping to enable the tank to be emptied for cleaning.

4.1 Puddle Flanges for Reservoir (Inserts)

A. Inlets, outlets, inter connection sleeves and drain outlets for the reservoir shall be made through GI puddle flanges obtained from reputed manufacturers and shall be inserted at suitable levels as indicated on the drawings.

B. Puddle flanges end connections (Threaded / Flanged) shall be as per the pipe diameter. i.e- Threaded Up to 40mm dia & Flanged for 50mm & above. Puddle flanges for Pump suction & water inlet connection shall be both side flanged type.

C. Contractor shall be responsible for placing the inserts at required level well in advance and before making the final shuttering layout for casting the walls.

D. Puddle flange shall be of GI hot dipped galvanized for functional applications and shall be MS with red oxide and enamel painted for Non functional sleeves (Please refer the drawings for details)
E. G.I./MS puddle flanges fabricated 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. (The entire fitting shall be hot dipped galvanized (Flanges shall confirm to BS-10 Table-E) sizes and details as indicated in drawing.

4.2 FRP Manhole cover and Frame

F. Covers and frames shall conform to BS EN 124:1994 and shall be of the following grades & types:
G. Heavy duty type with double seal, Water proof, locking arrangement. Shape of the cover to be circular with 600 mm dia or 1000mm x750mm as shown on drawings. These FRP covers should have minimum load bearing capacity of 500Kg.
H. Covers and frames shall be neatly moulded and shall be free from air (blow) holes. Covers shall be neatly dressed and carefully trimmed
I. Covers shall have a raised chequered design on the top surface to provide an adequate non-slip grip.
J. Covers and frames shall be corrosion resistance and shall not have any impact / lose its properties when exposed to chemical / sewage / rain water / moister conditions.
K. Covers and frames shall be UV protected and shall not have peeling / fading of the colors due to sunlight
L. Covers and frames shall withstand to extreme temperature (+100°C to - 80°C).
M. Covers and frames shall be thoroughly tested as per BS EN 124 1994 & AASHTO M306 or equivalent standards for drainage and utility services.

N. Covers shall be capable of easy opening and closing and shall be fitted in the frame in workmanship like manner. The cover shall be gas tight and water tight.
O. Size of covers specified shall be taken as the clear internal dimensions of the frame.
P. Frame of manhole cover shall be firmly embedded to correct alignment and level in RCC slab or plain concrete, as the case may be on the top of the masonry.
Q. After completion of the work, manhole covers shall be sealed by means of thick Grease or cement mortar.

4.3 FRP Step Ladder

A. For effective maintenance of the tanks, portable FRP step ladder to suit the depth of the tank shall be provided with necessary hooks inside the tank.
B. Portable for inside access to be supplied by contractor.
C. FRP step ladder shall be minimum 600 mm wide or as specified in drawings & height shall be as per the tank height.

4.4 Link Seals

A. Link seal shall be used in tanks and in places where positive hydrostatic sealing is mandatory.
B. Link seals shall be suitable to withstand a pressure of 20 psig - It shall be capable of withstanding temperatures from as low as –60F to as high as 400F.
C. It shall provide minimum three hours of protection against flames, smoke, gases and water even when exposed to temperatures up to 1900F.
D. Seal shall be of HDPE thermoplastic / heavy wall welded or seamless pipe to withstand angular and off centre pipe misalignment and has to seal effectively.

SL NO	MODELS	TYPE	SEAL ELEMENT	PRESSURE PLATE	BOLTS & NUTS	TEMPERATURE RANGE (F)
1	C	Standard	EPDM Black	Composite	Steel zinc dichromate	-40 to +250
2	S	Steel	EPDM Black	Composite	316 Stainless steel	-40 to +250
3	O	Oil resistant	Nitrile Green	Composite	Steel zinc dichromate	-40 to +250
4	OS	Oil resistant	Nitrile Green	Composite	316 Stainless steel	-40 to +250
5	T	High / low Temperature	Silicone Grey	Steel zinc dichromate	Steel zinc dichromate	-67 to +400
6	FD/FS	Fire Seals	Silicon Grey	Steel zinc dichromate	Steel zinc dichromate	-67 to +400
7	M	non Insulating	EPDM Black	Steel	Steel zinc dichromate	-40 to +250

5. PUMPS

5.1 General criteria for all types of pumps

A. Scope of work under this section comprises the supply, erection, testing and commissioning pumps of the duty, type and capacities specified in the Equipment Schedule and schedule of quantities. Pumps shall be suitable for the purpose they are intended.

B. Design verification of pumps w.r.t Schematic shall be Contractor scope of works. Contractor to obtain approval from Client / Engineer before ordering the pumps.
C. Piping, valves, strainers and fittings shall be as specified in the relevant sections of these specifications. Flexible connections shall be provided at the suction and discharge pipe connections of the pumps as indicated on the drawings.
D. The Pump shall have minimum efficiency of 80% and shut off head shall be 1.2 times of duty head.
E. Single stage pumps shall have the impeller sized to maximum of 80% of the largest size available in the pump series and type, for the selected duty.
F. The pump casing shall withstand 1.5 times the no-delivery pressure or 2 times of the duty pressure whichever is higher.
G. Driver motor shall be rated at least 20% in excess (1.2 times) of maximum BKW of the pump plus transmission losses.
H. Motor selected shall be non –overloading type for the entire range of the pump curve.
I. All the motors shall be suitable for 415V, 50Hz, ±10% for 3phase application and 230V, 50Hz, ±10% for 1phase application
J. Control panel shall be dust and damp proof steel cabinet supplied by the pump manufacturer and shall include a built-in-anti-condensation heater.
K. Power factor of motor shall not be less than 0.85 lagging under any conditions of load and capacitors of suitable size to raise the inherent power factor to this figure shall be included.
L. Sound pressure Level shall not exceed 83dBA @ 1.5 m from source.
M. Material of construction for different classes of construction of centrifugal pumps shall be generally as follows:

CLASSES	ALL CAST IRON	ALL BRONZE	BRONZE FITTED	STD FITTED
Casing	Cast iron gr.20	Bronze	Cast iron	**Cast iron**
Impellers	Cast iron gr.20	Bronze	Bronze	**Bronze**
Wearing rings & bush	Cast iron gr.20	Bronze	Bronze	**Bronze**
Shaft	Stainless Steel	Stainless Steel	Stainless Steel	**Stainless Steel**
Shaft sleeve	Mild steel	Bronze	Bronze	**Bronze**
Sleeve nuts	Mild steel	Bronze	Bronze	**Bronze**
Gland	Cast iron / GM	CI / GM	CI / GM	**CI / GM**

Note: - "Standard fitted" class of Construction shall be used unless otherwise specified.

a. Essential Design Features
Pumps shall have suitable features properly designed to ensure satisfactory performance, such as the following:

b. For Water Pump Sets
i. In case of more than one duty point, the performance range shall be indicated and the prime mover shall be of sufficient power to take the entire load in this range. Head (restrictions) shall be indicated in the nameplates to avoid overloading of the prime mover.
ii. For working in parallel, pumps shall be with stable head and capacity characteristics.
iii. Arrangement for cooling of bearings where required.
iv. Balancing water leakage connection shall be provided in case of multistage pumps with balancing discs.
v. Thrust bearing of adequate size.
vi. Pump head in Equipment schedule and BOQ need s to be verified by contractor based on final shop drawings and final head to be submitted for approval prior to procurement and supply

c. For Sewage Pump Sets
i. The size of solids which can be handled shall be at least 8mm – 12mm by the outlet width of the impeller.

ii. Casing and impeller shall be so designed to allow free passage of the specified max size of solid.
iii. Hand holes shall be provided in the casing one to allow early access to the impeller eye, and one close as possible to the casing throat.
iv. On account of the abrasive nature of sewage, provision shall be made on stuffing boxes to ensure clear water supply or grease lubrication to the glands shall be provided from external source according to the directions of the manufacturer.

d. Test at Works

Pump shall be tested at the factory to determine the following
i. The discharge against the specified head when running at the rated speed under specified suction lift or head.
ii. The power absorbed by the pump at the pump shaft (BP) under the above specified conditions and
iii. Efficiency of the pump under the above specified conditions.
iv. Pumps shall be tested at manufacturers works and a test certificate furnished before supply and tested at site after installation as per procedure as per clause 13 of 5120 – 1968.

e. Pump Operation
i. Pumps shall be primed before it delivers any fluid. During starting vent cock in the casing shall be open slightly to remove any dissolved air in the water.
ii. Discharge valve shall be set so that the least load is thrown on the driver when the pump is started.
iii. Valves shall be opened gradually to avoid throwing a large sudden load on the driver and to prevent sudden surge in the discharge line.
iv. Discharge valve shall be fully open when starting mixed flow or propeller pumps because the brake horse power will then be a minimum.

f. Running

i. Journal and thrust bearings shall be cool and have sufficient supply of oil.
ii. Packing shall be adjusted to permit a slight leakage to cool and lubricate it.
iii. Water shall be flowing to the water seal of the suction gland to prevent air from leaking in.

g. Shutting Down

When shutting down, the discharge valve shall be in the same position as when starting by closing the discharge valve gradually so that less power is dropped from the line and any sudden pressure surges in the pipe system are avoided.

5.2 Multi-Pump Hydro-pneumatic Variable speed booster Systems for Domestic (cold and hot) and Grey water application.

The packaged water booster pump system shall be a standard product of a single pump manufacturer. Non-standard or “one of a kind” packaged (assembled) pump systems shall not be considered.

The packaged water booster pump system shall use 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.

For additional details / specification refer point ‘General criteria for all types of pumps’

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.

Pump head in Equipment schedule and BOQ need s to be verified by contractor based on final shop drawings and final head to be submitted for approval prior to procurement and supply.

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. Calculation shall be submitted for approval.

C. 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 (optional on the suction side for suction lift applications).

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

D. MOTOR

The motors shall comply with relevant national/international standards for the construction, safety & performance. The motors shall be as follows:

1. Shall be robust in construction, self starting induction motor
2. shall be TEFC type,

3. Shall have class F insulation,
4. Shall have efficiency class IE- 2 as per IEC60034-30,
5. Drive-end motor bearings shall be designed to absorb thrust and shall be adequately sized to ensure long motor life.
6. Motor shall be compatible with VFD.

E. CONTROL CABINET

1. Starter type :- Refer equipment schedule
2. Specification :- Refer electrical specification
   a. **SECTION-2.9 MOTOR STARTER**
   b. **SECTION-2.12 EARTHING**
   c. **SECTION-2.6 LV CABLE**

F. ELECTRONIC CONTROLLER AND PROGRAMMABLE FUNCTIONS

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.

Electronic controller should perform 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.

PROGRAMMABLE FUNCTIONS

System functions shall be programmable through the keypad. These programmable functions and information shall include, but not be limited to:

a. Closed loop control.
b. Automatic pump alternations
c. Automatic cascade control of pumps
d. Set point adjustment and control
e. Clock Program
f. Flow estimation function
g. Programmable pump testing
h. Programming of No of starts/stops per hour

i. Remote controlling of the entire Hydro Pneumatic System through Ethernet. (User has to provide Static IP address to HPS system which can be accessed by BMS computer for remote control)

j. Standby pump designation

k. Friction Loss Compensation (set point)

l. Pump status – RUN,TRIP,STOP

m. Elapsed running hours for each pump (Automatic Pump change over based on run hours)

n. System pressure set point

o. Actual system pressure

p. Pump speed (percentage)

q. Fault memory up to recent 24 faults with time stamping

r. To display calculated system flow

s. Pressure transducer design settings

t. Redundant primary sensor for pressure monitoring

u. High and low discharge pressure shut-down limit

v. Analog input for remote set-point control

w. Digital input for remote stop/start

5.3 Multi-Pump Constant flow Systems for Transfer Pumps for Domestic and Grey water applications

The packaged water transfer pump system shall be a standard product of a single pump manufacturer. The manufacturer of the packaged pump system shall also be the manufacturer of the pumps. Non-standard, “one of a kind” packaged (assembled) pump systems shall not be considered equal.

The packaged water pump system shall use dedicated electronic pump controller to maintain a constant desirable water flow and head as indicated in schematics, drawings and schedules.

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.

For additional details / specification refer point ‘General criteria for all types of pumps’

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.

Pump head in Equipment schedule and BOQ need s to be verified by contractor based on final shop drawings and final head to be submitted for approval prior to procurement and supply.

B. 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 (optional on the suction side for suction lift applications).

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

C. 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.

D. MOTOR

The motors shall comply with relevant national/international standards for the construction, safety & performance. The motors shall be as follows:

1. Shall be robust in construction, self starting induction motor
2. shall be TEFC type,
3. Shall have class F insulation,
4. Shall have efficiency class IE- 2 as per IEC60034-30,
5. Drive-end motor bearings shall be designed to absorb thrust and shall be adequately sized to ensure long motor life.
6. Motor shall be compatible with VFD.

E. CONTROL CABINET

a. Starter type :- Refer equipment schedule

b. Specification :- Refer electrical specification

i. **SECTION-2.9 MOTOR STARTER**

ii. **SECTION-2.12 EARTHING**

iii. **SECTION-2.6 LV CABLE**

F. ELECTRONIC CONTROLLER AND PROGRAMMABLE FUNCTIONS

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.

Automatic Level Control System

a. Water pumps shall behave accordingly:
   i. High level alarm (over-flow)- Turn off pump
   ii. Low level alarm- turn on pump
   iii. Earthing probe.
   iv. Alarm for no flow condition
   v. All status to be sent to the IBMS
   vi. Low water
   vii. Power on
   viii. Pump on
   ix. Pump Stop
   x. Pump Trip
   xi. Off / Auto / Duty pump selector

Pumps shall changeover automatically to maintain the system flow and head depending on demand, time, and fault.

If the system includes a 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.

Programmable Functions

System functions shall be programmable through the keypad. These programmable functions and information shall include, but not be limited to:

a. Closed loop control.

b. Automatic pump alternations

c. Automatic cascade control of pumps

d. Set point adjustment and control

e. Clock Program

f. Flow estimation function

g. Programmable pump testing

h. Programming of No of starts/stops per hour

i. Remote controlling of the entire Hydro Pneumatic System through Ethernet. (User has to provide Static IP address to HPS system which can be accessed by BMS computer for remote control)

j. Standby pump designation

k. Friction Loss Compensation (set point)

l. Pump status

m. Elapsed running hours for each pump

n. System pressure set point

o. Actual system pressure

p. Pump speed (percentage)

q. Fault memory up to recent 24 faults with time stamping

r. To display calculated system flow

s. Pressure transducer design settings

t. Redundant primary sensor for pressure monitoring

u. High and low discharge pressure shut-down limit

v. Analog input for remote set-point control

w. Digital input for remote stop/start

5.4 Submersible Sump Pump

A. PUMP

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. Pumps for drainage shall be single stage, single entry.

Pump shall be C.I. casing and C.I. 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. The MOC of the sump shall be in accordance to schedule of quantity. Stuffing box shall be provided with mechanical seals.

Each pump shall be provided with a suitably rated induction motor suitable for 415 volts, 3 phase, 50 Hz A.C. power supply. Each pump shall be provided with in built liquid level controller for operating the pump between predetermined levels.

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 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 upto motor and controller/probes etc. (Including earthing). Level control shall be such that one pump starts on required level, 2nd pump cuts in at high level and alarms is given at extra high level. All level controllers shall be provided with remote level indication and alarms.

Submersible sump pumps shall be duplex arranged suitable for pumping storm and sanitary waste. Each pump shall have a capacity, as specified in the Pump Schedule.

For additional details / specification refer point no. 5.1, 'General criteria for all types of pumps'

Pump shall have cast-iron shell, cast iron recessed vortex impeller or cast iron 2 vane non-clog impeller. Impellers shall have pump out vanes or back shroud to prevent stringy materials from binding blades or wrapping around shaft. Shaft shall be 316 stainless steel. Provide factorysealed grease lubricated ball bearings and silicone or tungsten carbide mechanical shaft seals. Motor shall be hermetically sealed, oil filled, with ball bearings, and designed for continuous and intermittent operation.

G. Pump and motor shall be suitable for 60 °C liquids pumped continuously.

H. Pump shall be factory tested prior to shipment.
I. Provide a hot dipped galvanised corrosion resistant chain for lifting out each pump out of the sump. Attach chain to pump and to side of sump or cover at a suitable location.
J. All electrical panels shall be lockable.

B. For Sewage Pump Sets

a. The size of solids which can be handled shall be at least 8mm – 12mm by the outlet width of the impeller.
b. Casing and impeller shall be so designed to allow free passage of the specified max size of solid.
c. Hand holes shall be provided in the casing one to allow early access to the impeller eye, and one close as possible to the casing throat.
d. On account of the abrasive nature of sewage, provision shall be made on stuffing boxes to ensure clear water supply or grease lubrication to the glands shall be provided from externalsource according to the directions of the manufacturer.

C. Motor Design

The pump motor shall be a squirrel cage induction, housed in air filled water-tight enclosure. Oil filled motors are not acceptable. The stator windings shall be Class "F" insulation (155 degree C or 311 degree F) for general usage and class `H' insulation (180 degree C or 317-8 grade 2) for submersible type. 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. The motors shall be designed for continuous running duty type at 415 volts, 3 phase, 50 Hz power supply 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.

K. CONTROL CABINET

c. Starter type :- Refer equipment schedule
d. Specification :- Refer electrical specification

iv. **SECTION-2.9 MOTOR STARTER**
v. **SECTION-2.12 EARTHING**
vi. **SECTION-2.6 LV CABLE**

L. ELECTRONIC CONTROLLER AND PROGRAMMABLE FUNCTIONS

Electronic Controller

An electronic dedicated pump logic controller shall operate the pumps and alternating between pumps to maintain relatively equal pump operating hours.

Contractor shall provide **4 mercury float type level switches with water proof cable for duplex units for following control logic and as per drawings and equipment schedule,**

Control Action	**Type of Signal**
Pump 1 & 2 ON	**High Level**
Pump 1 on	**Medium level**
Pump 1 & 2 OFF	**Low Level**
High Level Alarm	**Overflow**

Provide pump control panel and high level alarm panel. Panels shall have IP55 rating or equivalent. The high level alarm panel shall include an alarm horn, warning light, silencing switch and a dry contact for remote alarm annunciation.

If the system includes a 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.

Programmable Functions

System functions shall be programmable and These programmable functions and information shall include, but not be limited to:

a. Closed loop control.
b. Automatic pump changeover based on pump run hour
c. Automatic cascade control of pumps
d. Set point adjustment and control
e. Clock Program
f. Programmable pump testing
g. Programming of No of starts/stops per hour
h. Standby/Assistant pump designation
i. Pump status
j. Elapsed running hours for each pump
k. Fault memory up to recent 24 faults with time stamping
l. Analog input for remote set-point control
m. Digital input for remote stop/start

5.5 GENERAL INSTALLATION OF PUMPS

A. Both the suction and discharge lines shall be independently supported so as no strains will be thrown on the casing.
B. Suction line shall be as short and straight as possible. Any elbow shall have large radii. For pumps operation with suction lifts no valves other than a foot –valve shall be placed in it. Generally, the diameter is made one or two sizes larger than the pump flange size. When an oversize line is used, reducer shall be placed between it and the pump flange size.
C. Suction line shall be airtight to avoid high spots at which dissolved gases or air might separate out and destroy the vacuum. After piping is installed and when the pump is running, all joints shall be inspected with a flame, as air leakage will draw the flame to the opening. Same method shall be used to determine leakage through the packing box. Inlet end of the suction line shall be 1 to 2 m below the minimum water level of the pump (not less than 1 m) to prevent air from being drawn into the pipe with the water.
D. Long straight piping shall be provided between the elbow and suction flange to even out the flow of the water as it enters the pump. Pump should be placed to secure the greatest possible suction head and yet to be available for inspection and repair work.

E. Check valve and gate valve shall be placed in the discharge line.
F. Foundation shall be heavy to reduce vibrations and shall be rigid to avoid any twisting or misalignment. A space of 20 to 40 mm shall be allowed between the base plate and
G. top of the foundation which shall be filled with grouting to secure a uniform load distribution. Vibration isolators shall be proposed / installed below the base of pumps to eliminate the vibration transfer to the structure.
H. When the grouting is dried, the base plate shall be drawn down evenly to avoid springing it. After this has been done, the shaft shall be aligned both radially and axially with the driver by means of shims or wedges so that it turns freely.

6. FIRESTOPPING AND SMOKE SEALS

Refer Annexure -1 for technical details.

7. SUPPORTS AND HANGERS

Contractor shall allow for design , fabrication, installation and coordination with other trades for hangers, supporting system and expansion joints(for expansion joints refer section B.3) for the installed system

Section Includes:

A. Pipe hangers, Floor & wall supports, Vertical piping supports
B. Distribution piping in shaft and chases
C. Pipe anchors
D. Hanger rods and accessories
E. Building attachments and support insulators
F. Trapeze pipe hangers.
G. Metal framing systems.
H. Thermal-hanger shield inserts.
I. Fastener systems.
J. Pipe stands.
K. Pipeline Anchors & Guides.
L. Equipment supports.
M. Steel ropes & wires

7.1 PERFORMANCE REQUIREMENTS

A. Design: Design hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
B. Structural Performance: Hangers and supports for piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7 or BS EN 13480.
C. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
D. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
E. The hangers and supporting system for the building shall be take care of the following effects

a. Seismic Movements(Earthquake case)
b. Effect of Wind - Building swing (Wind case)
c. Building settlement
d. Expansion and contraction
e. Column shortening for any given floor(including effects of creep and shrinkage)

Important Note:

1. **The contractor shall collect the building sway/lateral movement data in wind case and earth quake case from structural engineer before proceeding for the designing / selection of hangers and supporting system.**
2. **Contractor shall also obtain seismic requirement for the project from Lodha / Architect and provide certification and mitigate for their system related to Rising Mains.**
3. **Column shortening for any given floor (including effects of creep and shrinkage) shall be as per structural consultant recommendation for the respective project.**

7.2 SUBMITTALS

A. Contractor shall submit following calculations for hangers and supporting system for Consultant's review, Calculations shall be prepared and sealed by a qualified Structural Engineer and shall show compliance with the loading requirements. Furnish engineering calculations including, but not limited to, the following items.

   a. Hanger design criteria
   b. Point loadings.
   c. Wall and column attachments.
   d. Embedment's for supporting for all horizontal and vertical piping.
   e. Stresses and forces on mountings and hangers from expansion and contraction of piping.
   f. Engineering calculations to demonstrate compliance with requirements as specified in clause 1.2-E and 1.2-F above.

B. Product Data: For each type of product indicated.

C. Shop Drawings: Show fabrication and installation details and for the following; include Product Data for components:

   a. Trapeze pipe hangers.
   b. Metal framing systems.
   c. Pipe stands.
   d. Equipment supports.
   e. Detail fabrication and assembly of trapeze hangers.
   f. Design Calculations.

D. Welding certificates.

   Welding test certificates shall be submitted for the client representative approval.

7.3 Products

A. PIPE HANGERS

   a. Plastic piping up to DN 150 (6 inch): Split ring type EPDM lined steel pipe clamp with welded suspension nut.

   b. Plastic piping over DN 150 (6 inch): Adjustable galvanised steel clevis (Acoustical isolation shall be used at supports for drainage piping). Proprietary products supplied by piping system manufacturer shall be acceptable, where available.

   c. Multiple Hangers for Combination of services: Hot dip galvanised steel, continuous channels cast-in in concrete or suspended from ceiling. Pipe hanger / supports shall be as specified before (make appropriate selection). For piping placed above the cross member, use of U-bolts (B Line B 510 Series) shall be permitted.
   B-Line B 22-I-12 series or SH type channels with B 219 Series or approved equal

B. FLOOR SUPPORTS

   a. Ferrous piping up to DN 150 (6 inch): Adjustable pipe stanchion saddle support complete with U-bolt, stand pipe with adjuster and floor flange, use galvanised steel pipe covering shield for insulated piping.(alternatively rubber support inserts shall be installed at support points to prevent crushing of insulation).
   b. Ferrous piping over DN 150 (6 inch): Steel pipe roll with steel base and stand. RCC / structural steel pedestals shall be provided, as appropriate, to locate the base. Rubber support inserts shall be installed at support points to prevent crushing of insulation. Galvanised steel insulation protection shield shall be used outside rubber support inserts on roller based supports.

   c. Plastic piping Same as that of ferrous piping.

C. WALL SUPPORTS

a. Multiple hangers for plumbing pipes up to DN 75 (2 inch): Electro galvanized U-strap pipe clamps with elastomer lining placed on painted / galvanized steel channel attached to wall.

D. VERTICAL PIPING SUPPORTS

a. Ferrous piping up to DN 150 (6 inch): Galvanised steel riser clamps and / or offset pipe clamp. Rubber support inserts shall be used at the supports for insulated piping.

b. Ferrous piping over DN 150 (6 inch): Designed and fabricated at site with the following components:

i. Gusset plates with integral bearing plates (minimum thickness equal to that of the pipe) welded to pipe.
ii. Cross channels resting on permanent construction (floor slab / block work); offset to accommodate piping insulation and attached to each other by steel flats welded at both ends
iii. `Z' cleats welded on the cross channels at the ends of the bearing plates to restrict movement.
iv. Heavy duty vibration isolation pads (50 durometer) placed under bearing plates for vibration / thermal isolation
v. Vapour barrier sealed around the gusset plate with mastic sealant

c. Plastic non-insulated piping up to DN 75: U-bolts with rubber sleeve / or U-strap clamps with rubber lining attached to hot dip galvanized channel sections anchored to wall.

d. Plastic piping over DN 75 (3 inch) - Non-insulated: Galvanised steel offset riser clamp with EPDM lining; resting on steel sections Ref. : B-Line B 3148 and B 3195 or approved equal

e. Plastic piping over DN 75 (3 inch) - Insulated: Galvanised steel offset riser clamps over rubber support inserts installed at support points to prevent crushing of insulation.

f. Plastic piping: Zinc coated clip with internally threaded neck, sleeve, back nut, coach (wood) screw and plastic wall insert Ref. : B-Line B 3373 and / or B 3148 or approved equal

E. PIPE ANCHORS

a. Shall be provided in suitable locations to control the direction and effects of movement of the pipe work systems and to resist stresses and loading on pipework due to forces acting on the pipe work system. Use materials similar or compatible with the pipework systems. Comply with the requirements of BS EN 13480-3.
b. Ensure structure is suitable for the transmitted stress.
c. Provide guides in accordance with the expansion joint manufacturer’s requirements. Ensure that movement of pipework is directed from anchor points towards loops and bellows and ensure thrust is along the line of the pipework. Provide a friction reducing material between adjacent metal surfaces subject to movement.
d. The anchor and guide components shall be of suitable size and design to withstand and transfer the pipeline thrust. They shall be constructed to the general requirements of BS 13480.
e. The anchor loads, anchor and guide locations, method of fixing to the structure and design details shall be submitted and reviewed prior to commencement of the works.
f. Where bellows are used the manufacturer’s recommendations shall be submitted for review and strictly adhered to.
g. Thrust blocks and suitable anchors shall be provided where pipework internal pressures are not contained by the jointing system.

h. Install guides on each side of axial expansion joints. The first primary guide shall be located within a distance of 4 pipe diameters or 300mm, whichever is the less. The second primary guide shall be located within a distance of 14 pipe diameters from the first guide. Where axial expansion joints are positioned next to an anchor the maximum distance shall be 4 pipe diameters or 300mm, whichever is the less
i. Ferrous piping (Horizontal, non-insulated): Galvanised steel anchor chair and U-bolt attached to structural steel framework.
j. Ferrous piping (Horizontal, insulated): Gusset plates (minimum thickness equal to that of the pipe) welded to pipe and bolted to structural steel frame. Vapour barrier shall be sealed around the gusset plate with mastic sealant.
k. Ferrous piping (Vertical, non-insulated): Steel U-Bolt fixed to steel channel. The bolt shall be back welded to the pipe after installation.
l. Ferrous piping (Vertical, insulated): Same as the support of vertical insulated ferrous piping over DN 150 (6 inch); excluding the vibration isolation pad. The bearing plate shall be welded or bolted down to the cross channel.
m. Plastic piping (Horizontal): Galvanised steel anchor chair and U- bolt attached to structural steel framework.
n. Plastic piping (Vertical): Steel U-Bolt fixed to steel channel.
o. Anchor / Thrust block
   i. Contractor shall provide suitably designed anchor blocks in cement concrete/steel support to cater to the excess thrust due to water hammer and high pressure
   ii. Thrust blocks shall be provided at all bends, tees and such other location as determined by the Employer representative.
   iii. Exact location, design, size and mix of the concrete blocks/steel support shall be as shown on the drawings or as directed by the Employer representative prior to execution of work.
   iv. Contractor to submit detailed calculation & drawings for the Anchor & Thrust block for Engineer's approval.

F. Hanger rods and Accessories

a. Galvanised steel hanger rods: Galvanised mild steel rods with continuous male thread.

b. Turnbuckles: Galvanised, malleable iron castings with female threaded ends, matching with the threaded hanger rods, shall be provided where required. Back nuts shall be provided on both sides of the turnbuckle after adjustment.

c. Ball hangers: Manufacturers proprietary products shall be provided for allowing angular movement of the hanger rod, where required.

d. Threaded rod couplers: Galvanised steel unit machined from bar stock for joining two lengths of threaded hanger rods. Back nuts shall be provided on both sides of the coupler.

G. Building Attachements

a. Concrete inserts: Malleable iron or galvanised steel concrete inserts complete with adjustable insert nut, suitable for hanger rods of size 22 mm (7/8 inch) diameter and under. Galvanised steel continuous concrete insert shall be provided at the Contractor's option.
b. Self -drilling type concrete inserts: Galvanised steel self drilling expansion type concrete inserts for hanger rods up to 12 mm (½ inch) dia., shall be provided at the Contractor's option.

c. Support rails (cast-in type): Electro-galvanised steel sections with anchor lugs and filler strip complete with hammer head nut or extension pieces. Ref. : B-Line B 22 - I - 12 or approved equal

d. Support rails (surface mounted type): Electro-galvanized steel sections complete with hammerhead nut or extension pieces. The rail shall be single or double as appropriate. Ref : B-Line SH series or approved equal

e. Inserts and Expansion bolts:

i. Furnish and set inserts in concrete forms.
ii. Concrete inserts shall be as follows: Black malleable iron universal type for threaded connections with lateral adjustment for pipe sizes up to 200mm.
iii. For pipes 200 mm and over or equivalent group of pipes on trapeze, use two or more inserts to prevent exceeding maximum loading.
iv. As an alternative to the above mentioned inserts the Contractor may use expansion bolts. If the Contractor uses expansion bolts, the maximum spacing between supports may need to be reduced so as not to exceed the maximum loading and the expansion bolt locations shall be determined in coordination with the structural elements.

7.4 SUPPORT INSULATORS.

The Contractor shall provide moulded hard rubber insulators at all supports of insulated pipe work to transmit pipe load to hangers (or supports) without crushing the insulation. The rubber density shall not be less than 1100 kg/m3 and operating temperature range shall be -20 deg C to 110 deg C. The thickness of insulators shall be same as the insulation, and vapor barrier (where specified) shall be continuous across the outside of the insulators.

7.5 TRAPEZE PIPE HANGERS

Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel, G.I hanger rods, nuts, saddles, and U-bolts(Rubber lined). Alternatively comply with BS EN 13480-3 section 13

7.6 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
b. Please refer to manufacturers list attached with tender documents.
c. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
d. Standard: MFMA-4.
e. Channels: Continuous slotted steel channel with inturned lips.
f. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
g. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel
h. Metallic Coating: Electroplated zinc or Hot-dipped galvanized
i. Paint Coating: Epoxy or Polyester.
j. Plastic Coating: Polyurethane, Epoxy or Polyester

7.7 FASTENER SYSTEMS

A. Verify suitability of fasteners in this article for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) thick.
B. Supports shall be solidly fixed to the structure using proprietary manufactured drill and plug fixing devices with removable bolt or screw. Wooden plugs, loose fill or masonry nails will not be allowed. Gun fixings will only be allowed when specifically approved.
C. At each support fixing a steel channel or angle iron section shall be secured to the structure from which pipe work supports and brackets and equipment supports shall be attached.

D. Holes in steelwork supports and brackets shall be formed by correctly drilling, using the recommended tolerances for that which is to be inserted. Flame gun / welding torch holes burned out will not be allowed.
E. Where individual pipes up to 50mm diameter are supported on timber or lightweight walls, ceilings or partitions, brackets shall be of the screw fixing type and primary channel or angle iron brackets shall not be used. On solid / heavy walls over 100mm thickness, individual pipe work may be supported by the use of built-in, long shank holder bats or pipe brackets.
F. Supports from the building structural steelwork shall be made using proprietary manufactured steel clamps or girder lugs. Direct drilling of the structural steelwork will not be allowed.
G. Where high level pipe work and equipment cannot be supported from the structure, a primary Galvanized steelwork supporting frame shall be provided, fixed to the floor and of suitable design to spread the load evenly, from which all pipe work and equipment shall be supported.
H. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
I. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
J. Use largest size of bolt, screw to suit diameter of hole in equipment to be fixed. Ensure that fixings are tested for tensile loading to BS 5080, this particularly applies to expanding anchors.
K. Plastic plugs of suitable size and length shall be used. Use screws to BS 1210. For fixing to concrete, brickwork or block work use sheradized steel wood screws but in damp or exposed situations use greased brass screws.
L. Obtain approval if shot fired fixings are proposed.

7.8 Pipe Stands

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
C. Low-Type, Single-Pipe Stand: One-piece GI base unit with plastic roller, for roof installation without membrane penetration.
D. High-Type, Single-Pipe Stand:

a. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
b. Base: G.I
c. Vertical Members: Two or more G.I continuous-thread rods.
d. Horizontal Member: G.I rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand:

e. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
f. Bases: One or more; plastic.
g. Vertical Members: Two or more protective-coated-steel channels.
h. Horizontal Member: Protective-coated-steel channel.

F. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
G. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

7.9 Equipment Support

Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes. Corrosion Protection Paint.

7.10 Installation of hangers and supports.

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.

Clamps shall be of approved design and fabricated from MS flats (which shall be galvanized after fabrication) of thickness to be minimum 3mm to 5mm and sizes to be as per drawings. Clamps shall be fixed in accordance to manufacturer's details/shop drawings to be submitted by the contractors.

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.

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

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.

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 ant vibration hangers/supports.

A. Pipe work support systems shall be supported from the building structure, generally conforming with the following and where specified elsewhere:

- BS EN 13480-3 Metallic Industrial Piping. Design and Calculation
- MSS SP 58, Pipes, hangers and supports- Materials Design and Manufacturer
- MSS SP 69, Pipes, hangers and supports- Selection and Application

- Manufacturer's recommendations in respect of plastic pipe.
- EJMA Standards for expansion joints
- Uniform Mechanical Code
- Seismic Restraint Manual for Mechanical Systems.

B. Pipe work supports are to be arranged so that minimum stress is imposed upon the pipelines. Additional supports are required on either side of equipment such as valves, strainers, sudden changes in direction and the like on pipe work. It is important to ensure that all materials used for pipe work supports are compatible with the pipeline materials.

C. The details shown elsewhere indicate brackets, and support details which may be acceptable subject to the application but the final working details, drawings or sketches shall be submitted for Review.

D. Rigid coupling may be used with IPS steel piping systems, which meet the support and hanging requirements of ASME B31.1 and ASME B31.9. An adequate number of grooved flexible couplings shall also be used to compensate for thermal expansion/contraction of the pipe and column shortening due to creepage & shrinkage.

E. INSERTS

a. Inserts shall be provided to relevant Sections for placement in concrete formwork for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
b. Hooked rod shall be provided in concrete for inserts carrying pipe over DN 150 (6 inch).
c. Where concrete slabs form finished ceiling, inserts shall be installed flush with the slab soffit.
d. Where inserts are omitted due to error, the slab shall be drilled through from below and through bolt with square steel plate and nut above shall be provided, recessed into and grouted flush with slab. Method statement for the same shall be submitted for approval.
e. Type and quality of expansion type anchors, where used, shall be selected to suit the concrete into which it is to be installed.
f. Hanger or support assembly shall be capable of taking up the filled weight of piping for half spans on either side plus 100 kg, with minimum overall factor of safety of two.
g. Hangers shall be installed with minimum 12 mm (½ inch) space between finished covering and adjacent work.
h. Hanger shall be placed within 300 mm (12 inch) of each horizontal elbow.
i. Hangers shall have a minimum vertical adjustment of 38 mm (1½ inch).
j. Multiple or trapeze hangers shall be provided where several pipes can be installed in parallel and at same elevation.
k. Riser piping shall be supported independently of connected horizontal piping.
l. Piping shall be supported on both sides (at the system side only on connections to equipment) of flexible connections.
m. No support, hanger or anchor shall be attached to the building structural elements wherein their installation, weight or expansion stress will result in damage to the structure.
n. One coat of zinc rich primer shall be applied, after scraping and brushing the area clean, to the weld and surrounding areas, where pipe support members are welded to building structural framing.
o. Piping buried in raft slabs or trenches shall be supported as detailed on the Contract drawings. The support shall be capable of holding the pipe in position against buoyant forces exerted during pouring of concrete.
p. Pipe work supports are to be arranged so that no undue stress is imposed upon the pipes.
q. The installer will be responsible for marking out the exact positions where pipe brackets are to be built in and for checking the accuracy, levels and alignment of supports after building in by others.
r. All vertical pipes shall be fixed by galvanized clamps and galvanized angle brackets truly vertical.

s. 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.
t. Horizontal pipes running along ceiling shall be fixed on galvanized adjustable type clamps of special design as directed and as required.
u. Horizontal pipes shall be laid to uniform slope and the clamps adjusted to the proper levels so that the pipes fully reset on them.
v. 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.
w. All pipes clamps, supports and hangers shall be galvanized. Factory made prefabricated clamps shall be preferred.
x. Contractor may fabricate the clamps of special nature (at the discretion of the clients representative) and galvanize them after fabrication but before installation. All nuts, bolts, washers and other fasteners shall be factory galvanized.
y. Frames shall be of approved design and fabricated from MS flats (which shall be galvanized after fabrication) of thickness and sizes as per contractor's approved shop drawings.
z. Clamps shall be fixed in accordance to manufacturer's details/shop drawings to be submitted by the contractors.
aa. 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.
bb. 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 and shall be ready made item from a reputed supplier.
cc. Galvanized slotted angle/channel of approved sizes supports on walls shall be provided wherever shown on approved shop drawings.
dd. 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.
ee. All G.I Brackets should be painted with anti rust coat prior being embedded in concrete at the time of civil work itself G.I Brackets as shown in approved shop drawings.
ff. Pipe work supports shall not exceed the maximum intervals as per manufacturer's recommendation. However the sagging of the installation will not be accepted. All pipe work support installation should be straight. Zig zag installation will not be accepted.
gg. Additional supports shall be provided for equipment such as valves, strainers and ancillaries so that minimum stress is imposed on the pipework and the weight is not taken by the pipework. The support arrangement shall allow safe operation and removal of the component.
hh. All brackets and supports shall allow free movement of the pipes due to expansion and contraction with special regard to prevention of damage to any thermal insulation and vapour barrier. Fixed supports and roller/guide flexible support at appropriate locations to be provided to accommodate pipe movement due to thermal expansion/contraction and column shortening at every floor due to creep age , shrinkage and lateral displacement (wind and earth quake case and building settlement).
ii. Where multiple pipe runs of differing bores are supported from a common point, use support spacing of pipe requiring the closest spacing with adequate provision for the unequal movement due to expansion and contraction. Supports shall also be provided at bends where there is a run of pipework 1 meter or more both sides of the bend.
jj. Cantilever type supports from walls will not be allowed except for single pipes of diameters up to 50 mm.
kk. Obtain approval for all fixings to structural concrete or structural steelwork and loads imposed on the structure. Shot fired fixings shall not be used or any reinforcement drilled through.
ll. Static point loadings transferred to the structure which cannot be accommodated by the structural fixings shall be spread over a larger area by means of additional brackets and/or additional load spreading primary steelwork.
mm. For vertical support spacing check total self-weight and pressure loading against manufacturer's recommendations when using mechanical joints or end load capable

flexible couplings. Ensure adequate support when using non-end load capable flexible couplings.

nn. Direct clipping of the pipes, conduits or cables to the wall or the ceiling or any other structural members shall not be allowed.

oo. In case the supports are to be taken from the block work than the contractor shall clearly identify the locations for the solid block or lintels.

pp. In case of dry wall partions only conduits and small pipes (50mm plastic pipes) can be supported from the drywall partion frame (any extra support location shall be clearly defined) . in case of a heavy material purpose built steel frame shall be provided by the MEP trade contractor.

qq. The area which is crowded for the services installation; MEP contractor shall coordinate among themselves and design the support according to loads which will supported from the same supports.

rr. MEP Contractor is not allowed to cut any support of the drywall partition frame. This shall be coordinated on site with dry wall partition vendors before the start of the work.

ss. All the Suspended equipment and system components support shall be based on the dynamic loading of the equipment and supporting shall be designed accordingly.

8. NOISE, VIBRATION AND SEISMIC CONTROL

A. This section relates to the prevention of unwanted vibration transmission from mechanical and electrical items of equipment to sensitive areas inside and outside the building.
B. Fabricate, assemble, deliver to site and install vibration control measures to meet the performance standards specified.
C. All intermediate mechanical plant room shall have necessary vibration isolation in supporting system as well as in installation.
D. In seismic control areas provide anti vibration mountings suitable for the zonal classification of the area as indicated in Section A 1.7
E. Note the requirement to reselect vibration control equipment to suit the final actual operating weights and speed of operation of plant.
F. The Contractor shall refer and comply with all the applicable requirements indicated in acoustic consultant's reports/ recommendations if any.
G. The Contractor shall be responsible for ensuring that the acoustic performance of the equipments meets the design criterion described in the relevant sections of the project specification at the date of equipment procurement.
H. The Contractor shall furnish the complete acoustic report of the equipment prior to start of the procurement procedure.
I. Provide flexible connections to all Pumps.

8.1 SUBMITTALS

A. Provide a fully documented set of the calculations upon which the vibration equipment has been selected.
B. Contractor shall submit the typical details of equipments with the vibration isolations details as per acoustic consultant's requirement.

8.2 VIBRATION CONTROL

A. Vibration Isolators - General

a. Supply and install vibration isolators as indicated in the BOQ and also wherever necessary to limit vibration transmission into the building structure, supporting structure Pipe work & Pumps etc.
b. Ensure that any vibration transmitted from the mechanical and electrical services installations into the building structure does not exceed the 83dba at 1.5m distance.
c. Ensure that the maximum vibration amplitudes specified in BS 6472-1 guidelines are not exceeded.
d. Select vibration isolators so that they are suitable for the loading, operating and environmental conditions which will prevail. Pay special attention to vibration isolators exposed to atmospheric or adverse interior conditions and apply appropriate finishes to prevent corrosion.
e. The static deflection of vibration isolators shall be selected to give the necessary degree of isolation efficiency under the lowest normal operating speed of the isolated plant. Selection shall allow for asymmetric load distribution such that the minimum static deflection is achieved on all vibration isolators under normal operating conditions.
f. All machines and bases shall be carefully levelled. Replace any vibration isolators which are "bottomed out" or where the springs have deformed from a cylindrical shape at no extra cost to the contract.
g. All vibration isolators shall be colour coded or otherwise clearly marked to indicate rated load and deflection capacity to facilitate identification during installation.
h. All external connections to vibration isolated plant shall be made using flexible connections. Particular care shall be taken to ensure that the connection of pipes, ducts, shafts, electrical conduit etc., to vibration isolated plant neither short circuits the plant vibration isolation, nor impedes the free movement of the vibration isolated plant.
i. The vibration isolation system shall be selected to support the operating weight of the plant and equipment to be isolated only. All associated pipework, valves, filters, ductwork etc., and their contents shall be supported independently so as not to impose additional

forces on the isolator system. All flexible connections shall be selected and arranged to accommodate this requirement.

j. All plant, pipe work and ductwork shall be resiliently isolated from any part of the building structure as specified, or as otherwise required, to achieve the specified noise and vibration criteria. Particular attention shall be paid to areas where low noise levels are specified. The mounting of any item of plant, pipe work (bigger than 50mm plastic pipes) or ductwork from lightweight (stud) partitions is not permitted.

k. Select spring mounts with an overload capacity of 50% and with an outside diameter of at least 75% of the operating height. Mark mounts permanently with load capacity.

l. Anti-vibration isolator should be submitted to Engineer's approval.

8.3 Vibration Isolation Plant and Equipment

A. Unless otherwise stated, plant and equipment isolators shall be provided as indicated on the following schedules. For specification of isolator types refer to the following clauses. Isolators must be selected for the operating weight of equipment and shall be positioned for equal deflection.

B. Un housed Spring Mounts (Type S)

Provide where indicated on the vibration isolation schedule un housed spring mounts. The mountings shall comprise of free standing, un housed, laterally stable steel spring with a top and bottom load plate and levelling bolt.

C. Vertically Restrained Spring Mounts (Type L)

Provide where indicated on the vibration isolation schedule vertically restrained spring mounts. The mountings shall comprise high strength; low stress helical steel and springs capped with steel pressure plate on neoprene base pad. Supply base plate pre-frilled for bolting down and painted for protection. Supply unit complete with lockable leveling device to limit the vertical movement.

D. Pre-Compressed Moulded Glass Fibre Mounts (Type F)

Provide where indicated on the vibration isolation schedule pre-compressed moulded glass fiber mounts. The mountings shall be composed of inert inorganic material covered with an elastomeric coating to increase damping and protect the glass fibers. The isolation pad shall be bonded to a steel load transfer washer and formed steel bolt down bracket and shall include a steel bolt with a neoprene grommet.

E. Spring Compression Hangers (Type H)

Provide where indicated on the vibration isolation schedule spring hanger mountings. In addition spring hangers shall be used to support all pipework and ductwork connected to rotating and reciprocating machinery within plant room areas or within 15 m of the plant which ever is the lesser.

When used for supporting pipe work and ductwork the springs shall have a minimum deflection of 25mm unless otherwise stated.

The hangers shall comprise of a steel spring or glass fibre pad or a combination of both retained in a welded steel bracket. The steel spring shall be free standing, unhoused and laterally stable having horizontal spring stiffness equal to or greater than 1.3 times the vertical stiffness. The hanger bracket shall be designed to carry five times overload without failure and shall allow up to 15mm dia rod misalignment without metal to metal contact.

F. Kinetic Neoprene Mounts (Type N)

Provide where indicated on the vibration isolation schedule Kinetic neoprene isolators. The moulded neoprene isolators shall be complete with a cast in tapped steel load plate to permit bolting to supported equipment and a cast in steel anchor base plate pre-drilled for holding down bolts. The neoprene shall be oil and corrosion resistant.

G. Inertia Bases (Type S-I) Provide where indicated on the vibration isolation schedule inertia bases manufactured from welded steel channels designed to receive concrete poured into the steel frame. The steel frame shall incorporate pre-located equipment anchor bolts and free-standing laterally stable spring mounts generally as described under type S mounts.

H. Inertia Bases (Type L-I)

Provide where indicated on the vibration isolation schedule inertia bases generally as type S-I except that the springs shall be type L vertically restrained.

I. Inertia Bases (Type F-I)

Provide where indicated on the vibration isolation schedule inertia bases generally to type S-I except that the isolators shall be moulded glass fiber isolators as described under type F mounts. For all inertia base, calculation shall be submitted for approval.

J. Steel Base Frames (Type S-B)

Provide where indicated on the vibration isolation schedule steel frame bases manufactured from structural steel members incorporating isolator mounting brackets and supported by free standing spring isolators as described under type S mounts.

K. Steel Base Frames (Type L-B)

Provide where indicated on the vibration isolation schedule steel beam bases manufactured from structural steel members incorporating isolator mounting brackets and supported by vertically restrained spring isolators as described under type L mounts.

8.4 Flexible connections – General

A. Flexible connections shall be fitted to all Pump Suction and Discharge connections, centrifugal reciprocating or vibrating equipment where it is marked on the drawing, and where anti-vibration mounts, inertia bases are fitted.

B. Flexible Connections must have been tested for Noise and Vibration reduction capabilities, with due Certification being submitted to the Engineer for approval prior to the order being placed.

C. Flexible Connections are to be fitted as close to the source of vibration as practicable. The pipe at the other end of the Flexible Connection is to be a fixed point. This is necessary to reduce the noise, vibration and resonances from the distribution pipework to the building fabric, and prevent any stresses in the pipework from being transmitted upon the pump or vibrating equipment. To ensure correct alignment, a spool piece is to be employed during installation.

D. Rubber Flexible Connections shall be single convolution of hand laid multi ply reinforced EPDM rubber with wire reinforced cuffs. Flanges shall be removable and suitably profiled to control the convolution shape; plate flanges must not be used.

E. To avoid over tightening and damaging the sealing face of the rubber bellows the flanges shall be designed to make metal to metal contact with its mating flange when fully tightened.

F. Threaded and adjustable tie bars with rubber top hat washers shall be used where the working pressure exceeds 1.5 bar g. When untied Flexibles are used, the manufacturer's recommendations for anchors and guides shall be followed to prevent forces being exerted on to the pump casing and AV mounts.

G. All flexible connections shall be compliant with the PED (Pressure Equipment Directive) and be stamped with the CE mark.

8.5 Rubber type flexible connectors high tensile synthetic fibre reinforced type for temperatures up to 70°c

A. For working temperatures up to 70°C the bellows carcass shall be reinforced using high tensile synthetic fiber.

8.6 Flexible connectors for use with equipment on spring type supports

A. For installations where the pump and/or pipe work is on spring type supports, the flexible shall be as indicated above(rubber of stainless steel), but shall be a lateral type unit with a double membrane to give greater flexibility for this type of installation.

8.7 Vibration Isolation Schedule

Equipment type	Equipment location									
	Basement		Ground or up to 6m floor span		9m floor span		12m floor span		15m floor span	
	Isolator type	Static deflection (mm)	Isolator type	Static deflection (mm)	Isolator type	Static deflection (mm)	Isolator type	Static deflection (mm)	Isolator type	Static deflection (mm)
Close coupled up to 7.5 kW	N *	9	N	9	S-B	25	S-B	25	S-B	25
Close coupled over 7.5 kW	S-I *	19	S-I	25	S-I	38	S-I	62	S-I	62
Base mounted and belt driven up to 7.5 kW	F-I *	9	F-I	9	S-I	38	S-I	44	S-I	62
Base mounted and belt driven over 7.5 kW	S-I *	25	S-I	25	S-I	44	S-I	62	S-I	88

8.8 Installation and Testing

A. Carry out commissioning tests in accordance with this specification.
B. Demonstrate at commissioning stage, to the satisfaction of the Clients representative, that all specified vibration levels have been achieved.
C. When installing anti-vibration mountings comply with manufacturer's instructions.
D. Level equipment to ensure loads are evenly distributed.
E. Protect all equipment from damage by ingress of water or dirt.

9. EXPANSION FITTING.

Section Includes:

A. Expansion Loops.
B. Mechanical Expansion Joints
C. Unrestrained Expansion Joints.
D. Restrained Expansion Joints.
E. Alignment guides and anchors.
F. Flexible Connections

9.1 Performance requirements

Responsibility of Contractor:

A. Determine required system expansion, compensation, and location of all guides anchors and expansion devices using finalized contractor's installation drawings.
B. Design and provide expansion compensation devices, equipment and anchors.
C. Provide calculations by a licensed professional engineer substantiating that expansion compensation is designed to meet all system expansion requirements and safely accept generated forces without failure.
D. Coordinate expansion requirements with the work of other trades.
E. Provide structural engineer with required loads and forces required to support and restrain piping. Approval of these loads is required prior to pipe work installation commencing.
F. Provide sufficient supports, fixing and pipework components in such a manner that expansion and contraction of the pipework is fully accommodated.
G. Generally movement shall be accommodated at all changes in direction and/or at terminations of pipework.
H. Branch connections or pipe junctions to main pipework shall be made with 2 Nr 90° changes in direction to form an offset of suitable length to facilitate the expansion/contraction and prevent excess strains on the pipework joints at the junctions.
I. Where expansion or contraction of pipework cannot be accommodated as described above expansion loops or mechanical expansion joints shall be provided.
J. The application, location and type of joints shall be in accordance with BS 6129-1.
K. Where expansion devices are installed the correct amount of "cold draw" must be applied and adequate provision shall be made for temporary clamps or spacer pieces during the testing operations defined elsewhere.
L. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures. Mechanical expansion devices and flexible connections used on water services piping shall be WRAS approved, or similarly approved for potable water systems by the local municipality.
M. Capability: Products to absorb 200 percent of maximum axial movement between anchors.
N. Provide & Comply to lateral displacement (wind case & earthquake case) building settlement and column shortening (due to creepage and shrinkage) requirements specified as mentioned earlier.

9.2 Submittals

A. Product Data: For each type of product indicated.
B. Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

   a. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
   b. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
   c. Alignment Guide Details: Detail field assembly and attachment to building structure.
   d. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

C. Welding certificates.
D. Product Certificates: For each type of expansion joint, from manufacturer.
E. Maintenance Data: For expansion joints to include in maintenance manuals.
F. Expansion joints calculation for vertical risers: Furnish movement calculation based on the following criteria:

a. Minimum creepage and shrinkage factor of 3mm per floor.
b. Thermal expansion and contraction
c. Lateral displacement(wind & earthquake case) & building settlement as specified in section B.1-clasue E & F

9.3 Products

A. Expansion systems

a. Where possible provision for movement due to thermal expansion and contraction shall be made by natural changes in the direction of pipe work. Provide expansion loops or mechanical joints if necessary.
b. Anchors and guides shall be positioned to contain all movement and resist the maximum loads imposed.
c. Anchors and guides are to be located at points which prevent excess stresses on pipe work, joints and equipment connections.
d. Similar provisions shall be made for building movement or building settlement.

B. Expansion loops general

a. Where possible provision for movement due to thermal expansion and contraction shall be made by natural changes in the direction of pipe work. Provide expansion loops or mechanical joints if necessary.
b. Anchors and guides shall be positioned to contain all movement and resist the maximum loads imposed.
c. Anchors and guides are to be located at points which prevent excess stresses on pipe work, joints and equipment connections.
d. Similar provisions shall be made for building movement or building settlement.

C. Expansion Loops - Steel

a. Provide expansion loop in the material and finish of the associated pipeline. The loop shall be sized to limit the total stress set up in the material of the pipe wall to less than 69 MPa. The Contractor shall supply calculations for approval by the engineer.
b. Bends shall be from a single length of pipe or by welding fittings if expansion loops are too large to manufacturer in the piece.
c. Drawings indicating the method of anchoring and guides shall be supplied to the engineer for approval.
d. The spacing of the supports shall not exceed the centres given in the pipework section. Where there are two or more pipes the spacings shall be based in the centres required by the smallest bore pipework.
e. Vertical rising pipework shall be supported at the base or, as required to withstand the total weight of the riser and thrust.

D. Mechanical expansion Joints

a. Where natural flexing of the pipework is not practical thermal expansion and building movement shall be accommodated by the use of expansion joints.
b. Expansion joints may be of the restrained or unrestrained type and shall be provided with welded, screwed or flanged ends as appropriate.
c. Expansion joint convolutions shall be of a thick wall spirally wound, multi-ply construction with a corrosion resistant inner ply in AISI 316L stainless steel. Units should be fitted with stainless steel inner sleeves, in compliance with EMJA.
d. Expansion joints shall be capable of not less than 5000 complete reversals of movement at the given working conditions and the manufacturer shall be able to produce calculations to that effect, in full compliance with EJMA (Expansion Joint Manufacturers Association).

e. Expansion joints shall be capable of withstanding a test pressure 1.5 times the design working pressure without deformation. .
f. Expansion joints and their corresponding anchors and guides shall be indicated on the shop drawings and shall be installed strictly in accordance with the manufacturer's instructions and guidelines.
g. All mechanical expansion joints shall be in accordance with BS 6129-1 or EJMA Standards by the expansion joints. They shall be provided with flanged or screwed ends to BS EN 1092-1 and BS EN 10226-1 or ANSI B16.3 and ANSI B16.1, respectively, as appropriate. They shall be manufactured from stainless steel appropriate to the working pressures of the various systems. They shall be supplied with external protective sleeves.
h. Grooved flexible couplings shall also be used to compensate for thermal expansion/contraction of the pipe and column shortening due to creepage & shrinkage.
i. The manufacturer's requirements shall be complied with and anchor loads shall be calculated and their proposed locations approved prior to commencement of the works. Where axial bellows are installed the manufacturer shall visit the site and inspect the final installation prior to cold pressure testing.
j. Lateral expansion joints are sometimes also called articulated or fully articulated. Angular expansion joints are sometimes referred to as hinged. For larger lateral movements in two planes two gimbal expansion joints may be used instead of the lateral unit. Restrained expansion joints are not designed to support associated pipework.

E. Unstrained expansion joints

a. Axial expansion joints shall only be used in positions where pressure thrust can be contained by adequate anchor points contained by the building fabric. Recommended guide spacing and tolerances as described in Engineering Appliances "Guide to the use of Expansion joints" are critical and must be strictly adhered to.
b. Axial expansion joints shall be as manufactured by Engineering Appliances Limited their type EA01, EA02EA04, EA06, EA07, EA08, EA15 and EA16 or equivalent approved.
c. Axial expansion joints are not restrained and will exert a pressure thrust. This load can be very high and needs to be contained by suitable anchors. Comply with BS 13480.

F. Restrained Expansion joints

a. Restrained expansion joints shall be used as an offset type either by using lateral or angular expansion joints to compensate for thermal expansion or building movement. The expansion joint restraints shall be designed to absorb the full pressure thrust of the expansion joint convolutions.
b. Lateral expansion joints shall be of the thick wall spirally wound multi-ply construction and fitted with threaded tie bars and low friction self-lubricating hemispherical nuts, allowing movement in two planes. Lateral expansion joints shall be as manufactured by Engineering Appliances Limited their type EA20, EA23 and EA24 or Equivalent approved.
c. Angular expansion joints shall be of the thick wall spirally wound multi-ply construction and be used in pairs or threes. All hinge pins shall be PTFE coated to reduce friction and prevent corrosion. Angular expansion joints shall be as manufactured by Engineering Appliances Limited their type EA31 and EA32 or Equivalent approved.
d. For movement in two planes Gimbal Expansion joints shall be used in pairs or in combination with one Angular Expansion joint. All hinge pins shall be PTFE coated to reduce friction and prevent corrosion. Gimbal expansion joints shall be as manufactured by Engineering Appliances Limited their type EA38 or Equivalent approved.

G. Service crossing building expansion joints

a. At points where services cross the building expansion joints flexible connections, compensators, or expansion joints shall be provided to accommodate the building movement within the services installation.
b. Brackets and supports each side of the flexible joint shall be so arranged that services crossing the building expansion joint remain symmetrical and correctly aligned.

9.4 Installation

A. Install pipe work so that stress is kept below the maximum permissible design stress as given in the appropriate pipe work standard.
B. Prior to installation, submit to the consultant for approval the exact locations and working drawing details including magnitude and direction of thrusts of all expansion joints, guides, anchors and other associated equipment.
C. Connect to items of plant and equipment in such a way that no stress is placed on the equipment or its connections.
D. Do not use branch connections as anchor points.
E. Wherever possible, cater for expansion and contraction by the inherent natural flexibility of the service pipework. Where the use of inherent natural flexibility is not practicable, supply, install and connect expansion joints into the pipework installation.
F. Install expansion joints in full accordance with the manufacturer's recommendations and instructions.
G. Prior to commencement of the installation, the contractor must agree with the expansion joint manufacturer to visit site to ensure his guidelines for selection and installation are adhered to. And that the anchors and guides are correctly positioned to ensure that the expansion joints function as intended. During system installation and just prior to application of heat onto the systems, the expansion joint manufacturer is to visit site to check that the installation is installed as designed and a Certificate of Compliance issued.
H. Install expansion joints with a cold pull (cold draw) equal to 50% of total expansion, except where expansion joints are supplied with cold pull already applied. Apply cold pull (cold draw) by means of flanges secured to the ends of pipe to be pulled together with long high tensile steel bolts and nuts. A check with the design figure for correct gap plus allowance for gasket thickness shall be made before final pull is made. A change to standard bolting shall be made when the gap is closed. Do not apply cold pull (cold draw) until the anchor installations have been completed and approved by the Consultant / PM.
I. Install guides on each side of axial expansion joints. The first primary guide shall be located within a distance of 4 pipe diameters or 300mm, whichever is the less. The second primary guide shall be located within a distance of 14 pipe diameters from the first guide.

J. Where axial expansion joints are positioned next to an anchor the maximum distance shall be 4 pipe diameters or 300mm, whichever is the less.
K. Provide intermediate guides for the remainder of the pipework at appropriate intervals.
L. Ensure that guides are capable of withstanding a lateral force of at least 15% of the anchor force.
M. Ensure that the lateral movement of the pipeline permitted by the guide is no more than 2mm (±1mm) for pipes up to 100mm nominal size and 4mm (±2mm) for larger pipes, for the two primary guides next to the expansion joint. For intermediate guides the movement should be no more than 4mm (±2mm) and 8mm (±4mm) respectively.
N. Where pipework up to 50mm size is fixed to solid walls, brackets may be of either the screw fixing type or long shank built-in type. For fixing to woodwork and lightweight partitions or walls, brackets shall be screw-on pattern and may be adjustable two-piece type.
O. Brackets for mild steel pipework shall be mild steel or malleable iron. Brackets for copper pipework shall be brass or gunmetal.
P. Obtain approval from the Consultant/Project Manager for any fixings to structural concrete or structural steel work.
Q. Fixings to the building structural element shall generally be by "Redheads", rawlbolts clamps adaptors or similar approved heavy fixings and white metal crawl plugs or approved plastic type plugs for light loads. Drilling of structural steelwork shall not be used for pipe supports. Supports with backplate in floor screed shall not be used.
R. Pipework shall be securely supported, singly or in groups, graded to levels required for venting and draining and having regard to the requirements for differential expansion, anchors and guides and thermal insulation sizing.
S. Pipework exposed to view shall have approved brackets or clips of neat appearance, screw fixed to the wall at intervals to give uniform spacings and neat appearance.
T. Non-ferrous clips and rollers shall be used on copper pipes or if steel clips are used lead packing sleeves shall be fitted between pipe and clip.
U. Mains in ducts shall be supported on rollers and chairs using fabricated mild steel brackets (painted) or galvanized channel sections with allowance for building-in or bolting-on to the surface of the duct wall.

V. Pipes at ceiling level or in roof spaces shall be suspended from rods or straps using adjustable mild steel hangers with swinging joints or purpose-made angle iron cradles or other steel sections. Clips shall be used on cold pipes with rollers and chairs on hot pipes and where expansion cannot be readily taken upon hanging brackets.

W. Exposed external steel brackets shall be fabricated then hot dipped galvanized before erection, unless otherwise specified.

X. Allowance for the fitting of pipe covering protection saddles specified shall be made at the support positions on mains that require continuous unbroken weatherproof or vapor proof seal finish, as in the case cold water pipes. Where required, fit load-bearing insulation at supports at the time of erecting this pipework.

Y. Pipework of 65mm size and larger subjected to expansion and contraction and hung from supports shall be suspended on swivel hangers unless otherwise agreed with the client.

Z. Hangers for horizontal pipework at high level shall be supported from mild steel angle or channel sections or approved proprietary devices, suitable for building-in or otherwise securing to the structure. Adjustable mild steel hangers shall be used. Drop rods shall not be less than 13mm diameter. Pipe rings shall be of malleable cast iron or fabricated steel, made in halves and secured by bolts or screws. Alternatively, malleable iron hinged pipe rings may be used, but calliper hooks will not be permitted.

AA. Pipework supports shall be arranged so that minimum stress is imposed upon the pipelines. Provide additional supports on either side of pipework ancillaries and equipment such as valves, strainers, and heating coils and other pipeline mounted equipment. It is important to ensure that all materials used for pipework supports are compatible with the pipeline materials

BB. Installation of Flexible Grooved end expansion joints

a. Install in accordance with OEM Manufacturers instruction manual.
b. OEM Factory trained field representative shall provide on- site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review to ensure contractor is following best recommended practices in grooved product installation. (A distributor's representative is not considered qualified to conduct the training or jobsite visit(s).
c. All mild steel supports and channels shall be replaced with GI or mild steel with Zinc coating
d. Install expansion joints of sizes matching sizes of piping in which they are installed.
e. Install packed-type expansion joints with packing suitable for fluid service.
f. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
g. Install rubber packless expansion joints according to FSA-NMEJ-702 "Rubber Flanged Non-Metallic Expansion Joint. Installation, Maintenance and Storage"
h. Install grooved-joint expansion joints to grooved-end steel piping.

10. QUALITY ASSURANCE, TESTING AND COMMISSIONING.

10.1 Quality Assurance

A. **Hangers and Supports**

a. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel." Alternatively comply with BS 2971.
b. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code. Alternatively comply with HVCA code of practice TR/5, skilled craftsmen up to class 2 standard are required.
c. Clevis or Band Hangers used for sprinkler system piping shall be UL listed and labeled.

d. Unless otherwise stated, all steel components shall be galvanized post manufacture, according to ASTM B633 SC3.
e. Test certificate for heat aging at 1200C, as per ASTM D2240, shall be furnished for EPDM gasketting used as separation between pipe and hangers.
f. Each hanger and support shall have the manufacturer's name and part number stamped on it.

g. All hangers and supports shall be manufactured at an ISO 9001 certified facility. Manufacturer's ISO certificate, clearly stating Pipe Supports within the scope of registration, shall be furnished.

B. **Noise and Vibration**

a. Ensure that the design, construction, materials and finishes of all equipment are suitable for the location, climatic and operating conditions to which the installation will be exposed.
b. Ensure that the whole installation complies with the relevant standards, including the following:

i. BS 4800 - Schedule of paint colours for building purposes
ii. BS 6472-1 - Guide to evaluation of human exposure to vibration in buildings. Vibration sources other than blasting
iii. BS EN ISO 9001- Quality management system requirements.
iv. IS 1893 -Criteria for Earthquake resistant design of structures.
v. ISO-7235- Guide to evaluation of human exposure to vibration in buildings, vibration sources other than blasting
vi. NEBB- National Environmental Balancing bureau.

C. **Expansion Fitting**

Comply with the following:
a. BS 13480-3 - Metallic industrial piping. Design and calculation
b. BS 6129-1 - Code of practice for the selection and application of bellows expansion joints for use in pressure systems. Metallic bellows expansion joint
c. EJMA "Standards of the Expansion Joint Manufacturers Association"

D. **Testing and commissioning**

d. The work content and contract programme shall be based on the recommended procedures set out in the following documents (hereafter called the "commissioning documents"):

CIBSE Commissioning Codes:
CIBSE Code W: Water Distribution Systems
e. CIBSE Technical Memoranda:
TM17: Building Services Maintenance Management

f. BSRIA Documents:
BG1/2007: Operating and Maintenance Manuals for Building Services
BG2/2010: The Commissioning of Water Systems
AG1/2001.1: Pre-Commissioning Cleaning of Water Systems
BG11/2010: Commissioning Job Book
g. Undertake commissioning in accordance with all manufacturer's literature relating to the plant and equipment installed as part of the engineering services installations.

10.2 TESTING AND COMMISSIONING.

A. **Summary**

a. Employ the services of an independent specialist commissioning subcontractor to programme, commission and collate test results.
b. The Contractor shall provide skilled technicians/engineer to commission the plant and associated controls to the satisfaction of the Owners representative.
c. Provide all necessary attendance to operate and maintain the plant and equipment during the commissioning period as required to suit the needs of the specialist commissioning contractor.
d. The technicians/ engineers will be required to demonstrate the correct procedures in starting and stopping the plant, running the various items of equipment under automatic and manual control and the correct maintenance of the plant.
e. This section provides a framework for the testing, regulation and commissioning procedures to be employed.
f. The scope of the works in this section may be divided into three stages:
i. Pre-installation stage
ii. Installation stage
iii. Commissioning stage
g. Final approval of commissioning of the System / equipment is subjected to clearance of local municipal corporation, CFO & commissioning consultant.
h. The repetition of any test or commissioning shall be done if warranted by the Statutory Authority.

B. **SCOPE OF WORKS.**

a. Pre-Installation Stage

i. Ensure that sufficient valves, test points, dampers etc. are incorporated and correctly located to allow satisfactory testing, regulating and commissioning.
ii. Ensure that all provisions for commissioning are included in the working drawings prior to being sent to the Owners representative.
iii. Produce an agreed programme and method statements for the commissioning works for approval by the Owners representative.

b. Installation Stage
i. Undertake all tests and collate and witness all tests.
ii. Ensure that all water systems have been properly cleaned, flushed, filled and vented.
iii. Prepare method statements for the commissioning of each system.
iv. Attend the manufacturer's / supplier's works for performance tests on all major items of plant and equipment including, but not limited to, the following:
- MCCs
- Domestic & Grey water Pumps
- Drainage pumps
- Solar water heating system
- Fire proofing/Stopping

v. Collate all satisfactory test certificates for inclusion in the O&M manuals. Any plant or equipment that fails to meet the specified duty shall require to be replaced unless given authorization to do otherwise by the Owners representative.

c. Commissioning Stage

i. Commission the works in accordance with the commissioning programme.
ii. Independently retest 10% of the electrical tests on all power circuits. Should the tests indicate an unacceptable level of error the whole system shall be re-tested.
iii. Witness and accept the commissioning of all specialist systems by the manufacturers / suppliers including, but not limited to the following:
- Solar water heating system
- LV Panels
- Fire proofing.
iv. Collate all testing and commissioning records for inclusion in the O&M manuals.
v. Demonstrate, to the satisfaction of the Owners representative, that the systems are properly regulated and set to work.
vi. Ensure that all detectors, etc. are properly adjusted and calibrated and that all controls conditions are achieved. Ensure that all systems operate to their design intent including all safety, alarm and control scenarios.

C. Submittals

d. Submit the following at the appropriate time for comment and review:

i. Commissioning programme
ii. Commissioning method statements
iii. Testing and commissioning record sheets

e. Commissioning Programme

i. Within 2 weeks of appointment, provide a commissioning programme indicating the various activities and associated time periods required for the commissioning of the services. Agree this programme with the Owners representative and other relevant parties for incorporation into the main contract programme.
ii. Take into account the contract programme and identify the following periods:
- Pre-commissioning of water systems & related electrical systems.
- Power on date
- Dynamic commissioning
- Performance demonstrations and witnessing
- Operation and maintenance manual
- Handover and employer's training

iii. The following for each system:
- Earliest and latest start date
- Finish date
- Duration to complete task (in days)

iv. The following milestones:
- Completion of static tests (pipework and electrical tests)
- Period required for dynamic testing (balancing and integrated tests)
- Power on to the MCCs
- Cooling on to the building

v. Demonstration to the Owners representative.
- Submittals required to show building regulation compliance
- Employers training
- Practical completion

vi. Ensure that all systems are shown separately and not grouped together, e.g. "MCC's" is not acceptable but "MCC1", "MCC2", etc. would be acceptable.
vii. Each system shall be separately identified and all interdependencies shall be shown.

viii. Indicate the period required for the fully integrated testing of the systems to demonstrate that all systems interact with each other in the correct manner. This is particularly relevant to fire alarm, BMS and any life safety items with hard-wired interlocks.

ix. Carry out a major review and update of the commissioning network at monthly intervals thereafter, and if necessary revise and amend his programme to suit the progress of the works. Copies of the programme and network analysis together with any revisions shall be issued to the Owners representative for comment.

x. C. Commissioning Method Statements

- Within 30 days of appointment, provide method statements for each system and sub-system for the whole works listing all the activities in complete detail for comment and approval by the Owners representative.

xi. Identify the following:

- Specific details of the task
- Responsibilities of each party
- Any pre-requisites or milestones
- Interfaces with other systems
- Documentation proposed
- Health and safety considerations
- Demonstration procedures

xii. No commissioning shall take place without an approved method statement being in place.

xiii. Testing and Commissioning Record Sheets

- Submit testing and commissioning record sheets to the Owners representative for comment. Agree information and sheets to be used with the Owners representative Record information on agreed documentation and submit to the Owners representative for comment and review.

xiv. Co-Ordination

- Co-ordinate the commissioning works with the works of others and assist as necessary.
- Indicate on the drawings where access is required into ceiling voids and partitions and ensure that these points are available at the start of the commissioning works and are not closed up until the commissioning works are complete.

D. Factory Tests

a. Valves, Cocks and Fittings

- Type-Test' and approval certificate for pressure test and compliance with the regulations laid down by the local Authority / Standards / Project Manager.

b. All major equipment’s should be factory tested and contractor shall allow for factory visit for witnessing of client & consultant.

- Pumps for Plumbing system.
- Solar water heating system.

E. On site testing and commissioning

a. The contractor shall allow sufficient time prior to completion of contract work, the Contractor shall liaise and submit for the client's approval a detailed programme for conducting on-site acceptance tests and commissioning.

b. The Contractor shall start up, operate, test and adjust the systems in accordance with the agreed programme. The setting shall be supervised by the manufacturer's representative, who shall remain on site until the equipment is operating satisfactorily and accepted by the Client. The Contractor shall advice and co-ordinate with the manufacturer's representatives so that all testing is carried out according to the agreed programme.

c. The whole installation shall be given the following tests to bring the systems into running order. The Client shall be given reasonable notice together with a copy of recorded test results, generally not less than seven (7) days, regarding the nature of tests, the time and

location. Acceptance tests will only be witnessed by the Client when the submitted tests results are found satisfactorily.

d. All instruments, tools, material and labour required to perform these tests shall be provided by this Contractor.
e. Before the tests are carried out, the Contractor shall remove connected equipment and components which are liable to damage under test, and shall provide and fix all the necessary gauges, blanking flanges, etc.
f. Prior to the system start-up, the follow firing inspection, tests and pre-commissioning treatment shall be carried out by the Contractor:
g. Tanks and Level Switches
   i. Check sides and edges of sectional tanks for distortion. The tanks shall be thoroughly cleaned with water and drained.
   ii. Also, the level switch shall be simulated for the various cut-in and cut-out settings.

h. Pressure Switches.
   i. The testing equipment arrangement for pressure switches and pressure gauges shall be as shown on the approved shop drawings.
   ii. The pressure gauges to be tested shall be connected as shown on the approved shop drawing in lieu of the pressure switch. The gauges to be tested shall be regarded acceptable when the pressure readings of all three gauges are the same throughout the jacking pressure range varied by applying the hand pump.
i. Hydrostatic Tests
   i. All parts of the water circuit shall be filled with water before hydrostatic pressure testing, and pump running tests for verification of pressure and flow rate, are conducted.
   ii. The hand-jacking pump shall be applied to increase the system pressure to 1.5 times the working pressure but in any case not less than 10 bar for water supply and 6 bar for drainage. The pressure shall be maintained for a period not less than 24 hours.
   iii. Where any section of pipe work or equipment is found to be unable to withstand the maximum pipe work test pressure, it shall be isolated during the pipe work test then that section of pipe work or equipment shall be made good and re-tested at the appropriate test pressure.
   iv. The working pressure for various systems shall be estimated by contractor and submit for approval to the consultant.
   v. All valves and accessories etc should be factory tested at 1.5 times of its design working pressure system

j. Drains
   i. House drains shall be hydrostatically tested to a water head of 1.2 m at the high end and not more than 2.4m at the low end and shall show no appreciable loss of water after elapse of two hours.
   ii. In every test, water used shall be left in the pipes until they are covered with earth or other trench filling material to a depth of at least 1 m over the top of pipes and until permission is given by the client/consultant for the water to be released. If after the client/consultant has approved the sewer or pipeline and has given permission for the trenches to be refilled the pipes become damaged and loses water from any cause and/or admit subsoil water, the Contractor shall uncover the pipes and make good the defect and the pipes retested as before and all at the Contractor's expense.

k. Cleaning, Flushing and Pre-Treatment
   i. 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.
   ii. All strainers shall be inspected and cleaned out or replaced.
   iii. 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 client/consultant for approval.

l. Electrical Tests

i. Electrical tests shall comply with the current edition of IEE regulations and requirements enforced by Local Authorities.
ii. Electrical insulation tests earth electrode resistance test and cost amenity test shall apply to bus bars, isolators and other equipment and wiring where applicable.
iii. A 500V DC instrument shall be used to check the insulation resistance. The reading shall not be less than 1 mega-ohm in all instances.
iv. Function simulation tests shall be performed to ensure that the systems have been installed to the control requirements as described in the Specification therein.

m. Pump Drives

i. The direct coupling of the pump drives shall be dismantled before the pump motor control panel is energized.
ii. The Contractor shall demonstrate to the client/consultant of acceptable clearances of the coupling alignment for ensuring satisfactory power transmission.
iii. The coupling shall not be re-mated again till the correct motor rotation has been demonstrated with power drawn from the energized pump motor control panel.

n. Pump Operating Test

The Contractor shall ensure to the satisfaction of the client / consultant that the installation or portion thereof which has been set to work complies with all requirements including the following:

i. That the plant and apparatus shall be of robust construction and of capacity for the duty specified.
ii. That all valves, switches, controls and the like are properly regulated and capable of proper operation and in the case of valves are capable of being shut-off.
iii. That all apparatus shall be silent.
iv. That all instruments are correctly calibrated and read accurately.
v. That all services are tested in accordance with the details of the relevant clauses of this Specification.

F. Statutory Authorities tests and Inspections

a. As and when notified in writing or instructed by the client/ consultant, the contractor shall submit shop drawing and attend all tests and inspections carried out by Local Authorities and other Statutory Authorities shall forthwith execute free of charge any rectification work ordered by the client/ consultant 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
b. Practical Completion of the Main Contract and the Contractor shall make all allowances in this respect.
c. 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.
d. 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 client/consultant 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 client/consultant may at his discretion instruct the Contractor for additional submissions to the Local Authorities whenever necessary.
e. The Contractor shall notify the client/consultant 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 client/consultant without delay.

G. Preliminary commissioning Checks

a. Ensure that all equipment & system is thoroughly cleaned, lubricated and checked for serviceability before setting to work. Particular attention is drawn to the removal of building debris from the pipe work systems.
b. Special attention is drawn to the need for thoroughly flushing out all pipe work systems to ensure that all foreign matter is removed.
c. All automatic controls and safety devices shall be inspected and checked for service ability before the working fluid or electricity is applied to the system.

H. **Commissioning**

When the various installations have been completed and the preliminary commissioning checks carried out, the Contractor shall set to work, regulate and calibrate all system in the entire installation. Special attention shall be paid to the following items:

a. That all valves, switches, controls, etc. are regulated and capable of proper operation and in the case of isolation valves that they are capable of tight shut off.
b. That all apparatus is silent in accordance with the requirements of this Specification.
c. That all instruments are correctly calibrated and read accurately.
d. That all services are tested in accordance with the details in the relevant clauses of this Specification.
e. Operate pumps, pressure reducing sets, etc. to ensure that all control systems are functioning correctly and are properly set, sequenced or interlocked.

I. **Final Acceptance tests**

a. 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 client/consultant.
b. 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.
c. 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.
d. Final approval of commissioning of the equipment is subjected to clearance of commissioning consultant and the Chief Fire officer, Mumbai.

J. **Rejection of Plant**

a. 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 client/consultant either in whole or in part as he considers necessary/appropriate. Adjustment and/or modification work as required by the client/consultant 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/client/consultant.
b. 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 Employer.

K. **Handing Over of documents**

a. All testing and commissioning shall be done by the Contractor to the entire satisfaction of the Client and all testing and commissioning documents shall be handed over to the Client.
b. 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 Client.

11. Reference.

1. National Building Code of India 2005: Part 4 and part 9
2. Mumbai Water Rules
3. ASPE American Society of Plumbing Engineers
4. Relevant BIS Codes
5. Uniform Plumbing Code of India: 2008 Edition
6. Energy Conservation Building Code 2009
7. Energy Policy Act 1992
8. Pollution Control Acts, 1998, Central Pollution Control Board
9. Manual on Water Supply and Treatment, 1999, Central Public Health and Environmental Engineering Organization (CPHEEO)
10. BMC NOC
11. API 600 / BS 5154 : Specifications for Gun Metal gate,
12. IS778/780/2906: check Valves for water supply.
13. IS-800: Specifications for Structural steel
14. IS-814: Specifications for covered electrodes for metal are welding of structural steel.
15. IS 5329 – 1983: Code of practice for sanitary pipe work above ground for buildings.
16. IS 12251 – 1987: Code of practice for drainage of building basements
17. IS 2064 – 1973: Code of practice for selection, installation and maintenance of sanitary Appliances.
18. IS 6924 – 1973: Code of practice for construction of refuse chutes in multi-storeyed buildings.
19. IS 1200 (Part 1): Method of measurement of building earthwork.
20. IS 1200 (Part 16): Method of measurement of laying of water and sewer lines including appurtenant.
21. IS 1200 (Part 19): Method of measurement of Water supply, plumbing and drains.
22. IS 13592 – 1992: Specification for unplasticized PVC pipes for soil and waste discharge system inside building including ventilation and rainwater.
23. IS 2527 – 1984: Code of practice for fixing rainwater gutters and down pipes for roof drainage.
24. IS 2685 – 1971: Code of practice for selection, installation and maintenance of sluice valves.
25. IS 6784 – 1984: Method of performance testing of water meters.
26. IS 2692 – 1989: Specification of ferrules for water services.
27. IS 771 – (Part 3to 6): Specific requirements for urinal.
28. IS 2548 (Part 1&2): Specification for plastic seats and covers for water closets.
29. IS 3004 – 1979: Specification for plug cocks for water supply purposes.
30. IS 1711 – 1984: Specification for self-closing taps for water supply.
31. IS 1703 – 1977: Specification for ball valves (Horizontal plunger type) including floats for water supply purposes.
32. IS 4038 – 1979: Specification for foot valves for water works purposes. 34. IS 1172 – 1983: Code of basic requirements for water supply, drainage & sanitation (revised).
35. IS 1726 – 1991: Code for cast iron manhole frame and cover (third revision).
36. IS 1742 – 1983: Code of practice for building drainage.(Second revision).
37. IS 2064 – 1973: Code of practice for selection, installation and maintenance of sanitary appliances.
38. IS 2065 – 1983: Code of practice for water supply to buildings.
39. IS 4111 – 1986: Code of practice for Ancillary structures in sewerage system.
40. BS 4515: Specification for unplasticized PVC pipe fittings.
41. IS 732 & IS 2274 – 1963: Indian Standard code of practice for electrical wiring & installation.
42. IS 1536 – 1976: Specification for centrifugally cast (spun) iron pressure pipes for water, gas and sewage.
43. IS 1537 – 1976: Specification for vertically cast iron pressure pipes for water, gas and sewage.
44. IS 1538 (Part-1 to 23) – 1976: Specification for cast iron fittings for pressure pipes for water, gas and sewage.
45. IS 780 – 1984: Specification for sluice valves for water works purposes.

46. Shade No.536 of IS-5 : Paint Shade for main Equipment's/accessories
47. I.E / I.E.C rules for earthling protection code.
48. BS EN 50347 General purpose three-phase induction motors having standard dimensions and outputs.
49. IEC 60072-1 Dimensions and output series for rotating electrical machines - Part 1
50. IEC 60085 Electrical insulation - Thermal evaluation and designation
51. IEC 60034 Rotating electrical machines - Part 30-1: Efficiency classes of line operated AC motors (IE code)

----------END OF SECTION----------