d) All isolating and regulating valves, non-return valves, steam/air traps, relief/safety valves (wherever applicable), strainers, pressure reducing orifices etc. complete with the counter flanges and matching connecting pieces as required within the entire low pressure piping system.

e) Anchors, hangers and supports, etc. as required. Any platform necessary for maintenance and operation of valve and equipment located 1.5 m above any permanent floor or platform including access ladders, supporting structures etc.

f) All secondary structural steel members required for pipe supports from building steel structures and from embedded steel wherever provided including pipe supports in trenches. However, trench piping should be avoided to the extent possible.

g) Funnels, tundishes for drips and drains including all miscellaneous drain piping and drain piping from tundish outlet up to drain points. All drain and vent lines shall be conveniently terminated to floor drain points/permanent drain trenches.

h) Flanges, counter flanges, blank flanges, bolts, nuts, washers, temporary and permanent gaskets, fasteners caps etc. as required for interconnecting piping, valves & fittings.

i) Cleaning and Painting of all piping, valves & specialties at manufacturer's shop.

3.02.00 Following general requirements shall however be provided

a) Instrument Connections including instruments, root valves, sensing lines etc.

b) Pipe stubs and blanking plates etc. required for chemical cleaning and hydro testing.

For conducting acceptance test, the required pressure, temperature, flow measurement points shall be provided.

3.03.00 All miscellaneous instruments

4.00.00 GENERAL DESIGN AND CONSTRUCTION

4.01.00 General Considerations

4.01.01 The piping systems included in this section shall be designed to operate continuously without replacement during the plant service life of 30 years.

4.01.02 The piping system shall be complete in every detail and in accordance with the highest standard of workmanship.

4.01.03 All design and fabrication shall be in accordance with codes/standards specified.

4.01.04 No pipe work shall be run in trenches carrying electrical cables.

4.01.05 Pipe size above 50 NB shall be shop fabricated and of size 50 NB and below shall be field run.

4.01.06 All piping shall be identified by means of colour strips and by adequate lettering, conveniently spaced and located. Identification colours and lettering shall be as approved.

4.01.07 Air release and drain branches shall be provided wherever necessary depending upon the layout and arrangement so that the drains and air release valves are located for easy operation.

4.01.08 Unless otherwise specified, all pipe work shall be suitable for a minimum pressure of 10.0 kg/sq. cm(g) at 80 deg. C or as required by the design of the different piping system, if higher.

4.01.09 **Drain Pipe Work**

a) Low pressure drains shall have an isolating valve at the point of take-off from the pipe or vessel to be drained, or as near as possible for conventional operation.

b) Unless otherwise stated, all drain piping shall be of 25 mm NB minimum and all vent pipings shall be of 15 mm NB size minimum. For pipes up to 50mm NB, pipe wall thickness shall be as per schedule 80 of ANSI B36.10.

c) Unless otherwise stated, wherever a main or branch of any pipeline is terminated with a valve, such terminal valve shall be provided with a blank flange/blanking cap at the free end.

4.01.10 Specification of pipes used in different services included in the L.P piping section has been detailed in Annexure-I.

4.02.00 **Material Specification**

4.02.01 Materials for pipes and fittings shall be as stipulated in Annexure-I. In case bidder wants to offer alternative piping material, same may be accepted by the Purchaser depending on the merits of alternative material.

4.02.02 Pipe attachments for supports, anchors and restraints, which are coming in direct contact with pipes, shall have similar materials as the piping concerned. All other materials of supports, anchors and restraints shall be of tested quality and as per manufacturer's standards.

4.03.00 **Fabrication**

Except where otherwise specified all piping shall have butt-welded connections with a minimum of flanged joints necessary for maintenance. Where flanges are adjacent to welded fittings, weld neck flanges shall be used.

Branches shall, in general, be formed by welding. Standard fittings may be used in positions and for sizes where approval has been given in detail drawings. Pipe bends and tees shall be truly cylindrical and of uniform section. all welded branches shall be reinforced where needed as per the applicable codes/regulations.

4.03.01 Piping shall be fabricated in the shop in the largest transportable sections to minimize the number of field weld joints. The choice of field weld joints locations shall be based on the traverse of the pipe through walls, floors, sleeves or other restrictive areas. Support attachments for major piping shall be done at shop.

4.03.02 All pipes bends shall be made true to angle with no negative tolerance and shall have a smooth surface free of flat spots, crease and corrugations. A cross section through any bent portion of the pipe shall be true in diameter, within plus or minus 3% of the pipe diameter. Pipe bends shall be made from straight pipe pieces of sufficiently higher thickness so that after thinning, the minimum thickness of bends shall not be less than the minimum thickness required for the straight pipe. Thinning allowance shall be considered as per the relevant code.

4.03.03 For bends in pipes straight piece of pipes shall be bent by the contractor to required bend radius. However, forged bends (Bend radius = 1.5 x pipe diameter) wherever required shall be provided.

4.03.04 The ends of Pipe and welded fittings shall be bevelled according to details shown in the relevant piping code. All welding shall be made in such a manner that complete fusion and penetration are obtained without an excessive amount of filler metal beyond root area. The reinforcement shall be applied in such a manner that it shall have a smooth contour merging gradually with the surface of adjacent pipe and welded fittings. Backing rings shall not be used on any pipe welds, unless otherwise approved by the Engineer.

4.03.05 Cutting and Bevelling

a) Carbon steel piping - End preparation for butt welding shall be done by machining/flame cutting.

b) Socket welding - Socket weld and preparation shall be done by saw or machine cutting.

4.04.00 **Hangers, Supports, Anchors**

Normally pipe supports and anchors shall be selected at those points in the buildings where provision has been made for the loads imposed. The cutting of floor/roof beams or the reinforcement in slabs will not be permitted. Piping attached to a plant item shall be supported in such a way that the weight of the piping is not taken by the plant item.

4.04.01 Support spacing shall be as per good engineering practice. However in no case it shall be less than support spacing stipulated in ANSI B31.1.

4.04.02 Accurate weight balance calculations shall be made to determine the required supporting force at each hanger location and the pipe weight load at each equipment connection.

4.04.03 All large pipes and all long pipes shall have at least two supports each arranged so that any length of pipe or valve may be removed without any additional supports being required.

4.04.04 Support steel shall be of structural quality. Perforated strap, wire or chain shall not be used. Support components shall be connected to support steel by welding, by bolting or by beam clamps. Bolt holes shall be drilled not burned. Support components may be bolted to concrete using approved concrete anchors.

4.05.00 **Valves and Accessories**

4.05.01 General Requirements

a) All valves shall be of approved make and type and shall have cast/forged bodies with covers and glands of approved construction and materials as specified in Annexure-II & III. ~~In general all pumps (other than sump pumps), discharge valves shall be motor operated only. Tank inlet valves shall be motor operated only.~~

b) Valves and specialties to be supplied under this specification will be used for various air and water services and will be located indoor/outdoor and on horizontal/vertical runs of the pipelines. However, mounting of valves in vertical pipe runs should be avoided as far as possible.

c) All valves shall, unless otherwise stated, have the internal diameter same/as the internal diameter of the pipes to be joined.

d) All valves shall receive tests at manufacturer's or contractor's works in accordance with the specific requirements of the approved Codes of Practice. Valves shall be rising stem or otherwise as approved by the Purchaser.

e) Gate valve and Ball valve have been specified with the intention of achieving isolation and tight shut-off. In full open condition, these valves should offer minimum of resistance to fluid flow.

f) Globe valves have been specified with the intention of achieving good control of fluid passing. The plug and seat will have therefore suitable profiles for obtaining such controlling action.

g) Check valves have been specified in order to prevent reverse flow through them.

h) All valves shall function smoothly without sticking, rubbing or vibration on opening or closing and shall be suitable for most stringent service conditions i.e. flow, temperature and pressure under which they may be required to operate.

i) Material, design, manufacture, testing etc. for all valves and specialties along with the accessories shall conform to the latest editions of codes.

j) By pass valves shall be provided for larger size valves as per standards followed and as felt necessary for smooth and easy operation, even though not specifically mentioned in the specification.

k) All flanged valves and specialties to be supplied under this section shall be provided with two (2) counter flanges, bolts, nuts, washers, gaskets etc.

l) All valves shall be of approved design and manufacture. Where valves are of similar size and type they shall be interchangeable with one another. Valves shall have welded or flanged connections subject to the Purchaser's approval.

m) All valves shall have outside screwed spindles and screwed thread of spindle shall not pass through or into the stuffing box. Where valves are exposed to the weather, protective covers shall be provided for the spindles, which shall be subject to approval.

n) Gate, Globe and Ball valves shall be provided with the following accessories in addition to other standard items:

i) Hand wheel with embossed open and shut directions.
ii) Local position indicator.
iii) Motorised operation as specified by Engineer.

o) Gate valves, in addition shall be provided with following extra features

i) Bypass valve for larger valves

ii) Draining arrangement

iii) Enclosed Gear operators for valves 300 mm size and above for ease in operation.

iv) Motorised operation as specified by Engineer.

p) All gate and globe valves shall be rising stem type.

q) All valves shall be provided with hand-wheels, chain, operator, extended spindle and floor stand wherever required so that they can be operated manually by a single operator from the nearest operating floor either at a lower or higher elevation as the case may be. If such a valve is provided with integral bypass then similar arrangement shall be done for the bypass valve also.

r) All valves and specialties shall be provided with brass Tag Discs indicating Tag numbers and nomenclature of the valve including duty or service intended and the function of the valves specialties.

s) Stems shall preferably be arranged vertically with gland at the top, however, in no circumstances must the stem be inclined downward from horizontal or gland be at the bottom. Globe valves shall be installed with the pressure under the disc. Valves shall not be fitted in inverted position.

t) Where necessary, for accessibility, grease nipples shall be fitted at the end of extension piping and where possible these shall be grouped together and mounted on a common panel situated at a convenient position. A separate nipple shall be provided to lubricate each point. The Bidder shall supply the first fill of oil or grease for these parts. The Bidder shall supply a suitable manually operated grease gun for the standard type of nipple provided.

u) The spindles for all valves for use outside the building shall have weatherproof protection covers of approved construction.

v) All valves shall be fitted with indicators so that it may be readily seen whether the valves are open or shut. In the case of those valves fitted with extended spindles, indicators shall be fitted both to the extended spindles and to the valve spindles.

w) Plastic or bakelite valve hand wheels will not be accepted.

x) All valves shall be closed by rotating the hand wheel in a clockwise direction when looking at the faces of the hand wheel. The face of each hand wheel shall be clearly marked with the words 'Open' and 'Shut' with arrows adjacent to indicate the direction of rotation to which each refers.

y) Wherever practicable heavy valves of total weight including actuator, drive motor, integral by-pass etc., equal to or greater than 500 kg. shall be provided with suitable lugs to permit direct suspension by hanger rod or direct resting on bottom support, as applicable.

z) Special attention shall be given to the operating mechanism for large size valves in order that quick and easy operation is obtained and maintenance is kept to a minimum.

aa) Eyebolts shall be provided where necessary to facilitate handling heavy valves or parts of valves.

bb) The Bidder shall supply with his bid and in addition during the course of the Contract, comprehensive drawings showing the design of valves, test pressure and working pressure/temperatures. They should include a parts list referring to the various materials used in the valve construction.

cc) All sampling and root valves shall be of integral body bonnet type.

4.05.02 For Design Requirements for different valves refer Annexure-II & III.

4.06.00 **Safety/Relief Valves**

Safety/Relief valves shall be of direct spring loaded type and shall have a tight, positive and precision closing.

All safety valves shall be provided with manual lifting lever.

Valves used for air and any other compressive fluid shall be of pop type.

Safety/Relief valves shall be constructed and adjusted to permit the fluid to escape without increasing the pressure beyond 10% above the set blow off pressure. Valve shall reset at a pressure not less than 2.5% and more than 5% of the set pressure.

Releasing capacity of the safety/relief valves shall be as per the applicable codes and standards and shall be subject to the approval of the Engineer.

The seat and disk of safety valves shall be of suitable material to resist erosion. The seat of valve shall be fastened to the body of the valve in such a way that there is no possibility of the seat lifting.

4.07.00 **Hosepipe and Accessories**

4.07.01 Hose valves for service water system shall be Gate valves and service air system shall be Globe valves.

4.07.02 Hose pipes with fittings for Service Water System:

a) The water hose shall be as per IS-444 (Type-3).

b) Length of each hose shall be 15 metres.

c) For each hose, one end shall be fitted with M.S. female coupling with swiveling nuts and soft seating ring suitable for connection to male end of hose valve and other end shall be made threaded for joining with the swiveling nut of a second hose whereby two hose lengths may be joined.

4.07.03 Hose pipes with fittings for Compressed air System

a) The compressed air hose shall be as per IS-911 (Type 2).

b) The length and type of each end shall be similar to as specified in above clause no. (4.07.02) above.

5.00.00 **DRAWINGS, DATA, INFORMATION & MANUALS**

5.01.00 Drawings, data, Information to be furnished by the Bidder besides those already mentioned in volume : IIA with the offer.

5.01.01 A complete list of all piping and fittings of various sizes with their quantities and details e.g. nominal size, O.D., I.D. (as applicable) thickness, design pressure, design temperature, material of construction/code/standards etc.

5.01.02 A complete list of all valves with their type, quantities & ratings.

5.01.03 Manufacturer's catalogue indicating complete range of available size and rating of pipes & fittings.

5.01.04 Descriptive literature on the manufacturing process and quality control procedures highlighting the manufacturing, fabricating and testing facilities available in the shop.

5.02.00 **After Award of Contract**

Detail drawings including fabrication drawings of all shop fabricated piping system indicating design parameters and complete bill of material (Relevant Standards and grades to be indicated) and information/data pertaining to the hydrostatic and non-destructive test requirements to be submitted progressively.

5.02.01 Detail dimensioned drawing of each valve, specialties, indicating tag no., pressure rating, manufacturing standard, the bill of materials and hydrostatic test pressures. The drawing shall include the end preparation details and shall indicate the position of the hand wheel/operator. Technical particulars of motor operators wherever applicable shall also be indicated.

5.02.02 General arrangement drawing for each hanger/support/anchor etc. indicating identification number, auxiliary supporting structural details, other details & information as required in the specification.

5.02.03 Wiring diagram for all limit switches of motor operated valves.

5.02.04 The loading data required for design of structures shall be furnished well in advance to suit Purchaser's time schedule.

6.00.00 **BROAD GUIDELINES FOR ERECTION AND INSTALLATION OF LP PIPING**

6.01.00 All fittings like "T" pieces, flanges, reducers etc. shall be suitably matched with pipes for welding. The valves will have to be checked, cleaned or overhauled in full or in part before erection, after chemical cleaning and during commissioning.

6.02.00 Adjustments like removal of oval ties in pipes and opening or closing the fabricated bends of high pressure piping to suit the layout shall be considered

part of work and is required to carry out such work as per instruction of Owner, which shall include specified heat-treatment procedures, etc. also wherever required.

6.03.00 Certain adjustments in length may be necessary while erecting high pressure pipelines and the contractor should remove the extra lengths to suit the final layout after preparing edges afresh and adopting specified heat treatment procedures.

6.04.00 Suspension for piping, pressure parts, etc., will be supplied in running lengths, which shall be cut to suitable sizes and adjusted as required.

6.05.00 All the valves, lifting equipments, actuators, power cylinders, etc., shall be serviced and lubricated to the satisfaction of Engineer before erecting the same and also during pre-commissioning. Even after commissioning, the equipments, if there are problems in the operation, they have to be attended to by the Bidder during the tenure of the contract. Welding or jointing of extension spindle for valves to suit the site conditions and operational facility shall be part of erection work.

6.06.00 All tubes and pipes shall be cleaned and blown with compressed air and shown to the engineer before lifting. Bigger size pipes should be cleaned with flexible wire brush, wherever necessary. After cleaning is over the end caps shall be put back in tube openings till such time they are welded to other tubes.

6.07.00 Fine fittings, drain piping, oil systems & other small bore piping have to be routed according to site conditions and hence shall be done only in position. As such, layout of small-bore piping shall be done as per site requirement. There is a possibility of slight change in routing the above pipelines even after completion of erection, which shall be carried out by the Bidder without any extra cost to the Purchaser. Work shall also include fabrication of small bends at site from straight lengths to suit the site conditions.

6.08.00 No temporary supports shall be welded on the pressure parts. Welding of temporary supports, cleats, etc., on the building columns shall also be avoided. In case of absolute necessity, Contractor shall take prior approval from Engineer. Further, any cutting or alteration of member of the structure or platform or other equipments shall not be done without specific prior approval of Engineer.

6.9.00

a) All piping shall be grouped wherever practicable and shall be routed to present a neat appearance.

b) The piping shall be arranged to provide clearance for the removal of equipment for maintenance and for easy access to valves, instruments and other piping accessories required for operational maintenance.

c) Piping shall be routed above ground unless otherwise specifically indicated/ approved by the Engineer. In such special case, the piping may be arranged in trenches, or buried and properly protected as per AWWA Standards.

d) Overhead piping shall have a minimum overhead clearance of 4 meters above walkways and working areas and 7 meters above roadways unless otherwise approved by the Engineer.

e) Drains shall be provided at all low points and vents at high points as per actual layout regardless of whether some have been shown in respective drawings or not. The pipelines shall be sloped towards the drain points.

6.10.00 All drips and drains for piping and equipment whether shown in the drawings or not shall terminate on the ground floor up to station drain unless otherwise specified. Leading such drains up to station drainage is also the responsibility of the Contractor.

ANNEXURE-I
SPECIFICATION OF PIPES FOR DIFFERENT SERVICES

	A		B		C	D
Services	1. Clarified Water piping 2. DMCW piping		1. Drinking/ Potable Water Supply, piping (Clarified water, chlorinated)		1. Demineralised Water, Service and Instrument Air Piping less than and equal to 50 mm NB	1. Demineralised Water, Service and Instrument air piping for sizes equal to greater than 65 mm NB
1.00.00 Material of Pipe	Carbon Steel IS-1239 Heavy Grade upto 150 mm NB and IS-3589 for sizes above 150 mm with minimum pipe thickness of 6 mm.		Carbon Steel as per IS-1239 Heavy Grade for sizes upto 150 mm NB and IS-3589 for sizes above 150 mm NB with minimum pipe thickness of 6 mm. The pipes shall be galvanized as per IS-4736		Stainless Steel as per ASTM A-312 Gr. 304. Size- as per schedule 40 ANSI B36.10	Stainless steel as per ASTM A-312 Gr. 304. Size-upto 150 mm NB as per schedule 10S, ANSI B-36.10.
2.00.00 Construction	ERW / Seamless		ERW / Seamless		ERW	ERW
3.00.00 Joints	Slip-on Flange and butt weld for size 65 mm NB and above and Socket weld joint for size 50 mm NB and below.		Screwed flange for sizes 65 mm NB and above and screwed socket for size 50 mm NB and below.		Socket welded for size 50 NB and below	Slip-on flange and butt weld joint.
4.00.00 Fittings	Pipe Sizes > = 65 mm NB	Pipe Sizes < = 50 mm NB	Pipe Sizes > = 65 mm NB	Pipe Sizes < = 50 mm NB		

	A		B		C	D
Services	1. Clarified Water piping 2. DMCW piping		1. Drinking/ Potable Water Supply, piping (Clarified water, chlorinated)		1. Demineralised Water, Service and Instrument Air Piping less than and equal to 50 mm NB	1. Demineralised Water, Service and Instrument air piping for sizes equal to greater than 65 mm NB
4.01.00 Materials	ASTM-A-234 Gr. WPB	ASTM-A-105	ASTM-A-234 Gr. WPB galvanized as per IS-4736	ASTM-A-105 galvanised as per IS-4736	ASTM-A-182 F304	ASTM-A-351-CF8
4.02.00 Construction	Welded/ Seamless	Forged	Welded/ Seamless	Forged	Forged	Welded/Seamless
4.03.00 Standard	ANSI-B-16.9 for fabricated fitting AWWA-C-208	ANSI-B-16.11	ANSI-B-16.9	ANSI-B-16.11	ANSI-B-16.11	MSS-SP-43
4.04.00 End details	Pipe size >=65mm NB Butt welded as per ANSI-B-16.25	Pipe size <=50 mm NB Socket welded as per ANSI-B-16.11	Pipe size >=65 mm NB Screwed Flanged	Sizes <=50 mm Screwed socketed as per ANSI-B-16.11All fittings shall be galvanized.	Socket welded	Slip - on flanges

	A	B	C	D
Services	1. Clarified Water piping 2. DMCW piping	1. Drinking/ Potable Water Supply, piping (Clarified water, chlorinated)	1. Demineralised Water, Service and Instrument Air Piping less than and equal to 50 mm NB	1. Demineralised Water, Service and Instrument air piping for sizes equal to greater than 65 mm NB
5.00.00 Flanges	150 lb class as per ANSI-B-16.5 complete with nuts, bolts and gaskets	As per ANSI-B-16.5 pressure class 150lbs - galvanised-complete with nuts, bolts and gaskets.	As per ANSI-B-16.5 pressure class 150lb complete with nuts, bolts and gaskets. Material as per class 4.01.00.	150lb class, flat face, as per ANSI-B-16.5 complete with nuts, bolts and gaskets.
Pipes which fall under IS:1239 shall be hydrostatically tested according to the said code, for others refer Section-V, Vol.: II-A.				

ANNEXURE-II

SERVICES OF VARIOUS CATEGORIES OF VALVES

Valve Classification		Service		
A.	Cast iron body Gate/Globe/Check Valve	i) ii) iii) iv)	Service Water Clarified Water Drinking/ Potable Water Inhibited Demineralised Water	For sizes 65mm NB and above.
B.	Stainless steel body/ Gate/Globe /Check/Ball Valve	i) ii) iii)	For Demineralised water Potable/ Drinking Water Service and Instrument Air	For all sizes For sizes less than and equal to 50 mm NB For all sizes. Ball valves to be used in air line.
C.	Steel Body valves	i) ii)	Clarified Water Inhibited Demineralised Water for DMCW system	For sizes less than and equal to 50 mm NB
D.	Cast Iron body butterfly valve	i) ii) iii) iv) v)	For Demineralised Water Raw water Clarified Water Filtered Water Inhibited Demineralised Water for DMCW system	For butterfly valve specification refer Annexure II, Sec.IV of Vol. IIIE. For DM water line rubber lining/ EPDM/equivalent protection to be provided

ANNEXURE-III

SPECIFICATION OF VALVES

		A. Cast Iron Body Gate/ Globe/Check Valve	B. Stainless steel Body Gate/Globe/Check/Ball Valve	C. Steel Body Gate/ Globe/Check Valve/ Ball Valve
1.00.00	Valve Classification Code	CIGC	SSGC	STGC
2.00.00	Basic Design Code			
	a) Gate	a) i) IS 780 for 50 mm - 300 mm NB ii) IS2906 for 350 mm NB and above or as per MSS-SP-70	a, b, c) ANSI-B-16.34	i) API 600 for 50mm ii) API 602 for size
	b) Globe	b) MSS - SP - 85		b) BS-1873/ANSI-B-16.34
	c) Check	c) IS-5312/MSS - SP -71		c) BS-1868/ANSI B16.34
	d) Ball		d) BS-5351	
3.00.00	Pressure Class	To be suitably chosen considering the pressure requirement. Refer Clause No. 4.01.08 in this regard.		
4.00.00	Construction	Cast body and bonnet / cover	Forged body up to 50mm NB and Cast body above that	Same as Group-B
5.00.00	Material			
5.01.00	Body & Bonnet/ cover	IS 210 Gr. FG 260	ASTM-A-182 F304 for Ball Valves: A351 CF8M for cast body, A 182 F304 for forged body.	ASTM-A-216 Gr. WCB for cast body & ASTM-A-105 for forged body

		A. Cast Iron Body Gate/ Globe/Check Valve	B. Stainless steel Body Gate/Globe/Check/Ball Valve	C. Steel Body Gate/ Globe/Check Valve/ Ball Valve
5.02.00	Trim / Disc.	IS-210 Gr. FG 260	ASTM-A-182 F304 for Gate, Globe, Check valves and 351CF 8M for Ball valves. For DKW system : ASTM-A-182 F6A (min. 250 HB)	13% Cr Steel as per ASTM-A-182 Gr. F6 heat treated and hardened(min 250 NB) for cast body and ASTM-A-105 Hard faced with Stellite (min 350 HB) for forged body
5.03.00	Seating surface	13% Cr steel as per IS 1570	For Ball valves PTFE seats and seals.	13% Cr. Steel as per ASTM-A-182 Gr. F6
6.00.00	End Preparation	Socket welded for size equal to and below 50mm NB and flanged with counter flanges for 65mm NB and above.		
7.00.00	Testing			
	a) Gate	i) As per IS - 780 for 50 mm - 300 mm NB		API-598
		ii) IS-2906 for sizes equal to and above 350 mm NB	As per ANSI B-16.34	
	b) Globe	Hydrostatic Test as per MSS-SP-85		BS-1873
	c) Check	IS-5312/MSS-SP-71		BS--1868

TECHNICAL SPECIFICATION FOR PIPING, VALVES & FITTINGS (CONT.)

1.00.00 CODE & STANDARDS

1.01.00 The Design, manufacture, shop testing, erection, testing and commissioning of piping and valves shall conform to the latest revisions of the following codes and Indian Standards, in addition to other standards mentioned elsewhere in the tender documents subject to any modification and requirement as specified hereinafter.

IS : 778 - Gunmetal gate, globe and check valves for general purpose.

IS : 1239 - Mild steel tubes and fittings - Part I & II.

IS : 1536 - Centrifugally cast (spun) iron pipes for water, gas and sewage.

IS : 1537 - Vertically cast iron pressure pipe for water, gas and sewage.

IS : 1538 - Cast iron fittings for pressure pipes for water, gas and sewage.

IS : 1703 - Ball valves (horizontal) plunger type including floats for water supply purposes.

IS : 2379 - Colour for the identification of pipe line.

IS : 2685 - Code of practice for erection, installation, and maintenance of sluice valves.

IS : 14846 - Sluice valve for water works purposes (150 to 1200 mm).

IS : 3042 - Single faced sluice gates (200 to 1200 mm).

IS : 3589 - Electrically welded steel pipes for Water gas & sewage (200 to 2000 mm).

IS : 4038 - Foot valve for water works purposes.

IS : 4984 - High Density polyethylene pipes.

IS : 4985 - Unplasticised PVC Pipes.

IS : 5312 - Swing check type reflux (non-return) valve Part-I.

IS : 458 - Concrete pipes (with and without reinforcement).

IS : 3952 - Cast Iron butterfly valves for general purposes.

ASTM-A 106 - Gr.C Seamless carbon steel pipe.

ASTM - 53 - Seamless carbon steel.

AWWA-C-504 - Standard for butterfly valve.

BS : 5156 - Standard for Diaphragm valve.

IS : 554 - Pipe thread for pressure tight joints.

IS : 1363 - Black hexagon bolts, nuts and lock nuts.

IS : 1364 - Precision and semi-precision hexagon bolts, screws, nuts and lock nuts.

IS : 2062 - Structural steel fusion welding quality.

IS : 4736 - Hot dip zinc coating on steel tubes.

IS : 2825 - Code of unfired pressure vessels.

IS : 2712 - Gaskets.

IS : 4192 - Part-I Rubber lining.

IS : 3006 - Acid resistant SWG Pipe.

IS : 783 - Code of practice for laying RCC pipes.

IS : 3114 - Code of practice for CI Pipes.

BS : 5142 - Cl globe valve.

ANSI:B 16.5 - Steel pipe flanges and flanged fittings.

ANSI:B 31.1 - Power Piping code.

2.00.00 DESIGN, CONSTRUCTION AND ERECTION

2.01.00 **Piping and Fittings (General)**

2.01.01 **Design**

All piping systems shall be capable of withstanding the maximum pressure in the corresponding lines at the relevant temperatures. The minimum thickness for pipes and fittings shall be adhered to. Higher thickness in equivalent material is acceptable. However, no credit will be given for higher thickness.

2.01.02 All the piping systems, fittings and accessories supplied under this package shall be designed to operate without replacement and with normal maintenance for a plant service life of 25 years, and shall withstand the operating parameter fluctuations and cycling which can be normally expected during this period.

2.01.03 All piping systems shall be properly designed to take care of hydraulic shocks and pressure surges which may arise in the system during operation. Bidder should provide necessary protective arrangement like anchor blocks/anchor bolts, etc. for the safeguard of the piping systems under above mentioned conditions. External and internal attachments to piping shall be designed so as not to cause flattening of pipes, excessive localised bending stresses or harmful thermal gradients in pipe walls.

2.01.04 Piping and fittings shall be manufactured by an approved firm of repute. They should be truly cylindrical of clear internal diameter specified, of uniform thickness, smooth and strong, free from dents, cracks and holes and other defects. They shall allow ready cutting, chipping or drilling, welding etc.

2.01.05 All rubber lined pipes shall be seamless or bead removed ERW pipes.

2.01.06 Inspection holes shall be provided at suitable locations for pipes 800 mm NB and above as required for periodic observations and inspection purposes.

2.01.07 Material of construction for pipes carrying various fluids shall be as below: -

S.No.	Service	Material
1.	Raw water	Carbon Steel
2.	Clarified water/Filtered Water	Carbon steel
3.	Acidic Water	Rubber lined Steel
4.	Demineralised Water	Stainless Steel - 304
5.	Acid (hydrochloric)	Rubber lined Steel
6.	Alkali (Sodium Hydroxide)	
	a) Strong (5% and above)	Stainless Steel - 304
	b) Dilute (below 5%)	Stainless Steel - 304
7.	Lime Solution/Suspensions	Galvanized Steel
8.	Air	Galvanized Steel to IS 1239
9	Waste effluent from N Pit	HDPE
10.	Resin water slurry	Stainless steel Type-304

2.01.08 The portion downstream of the isolation valves of pipe lines conveying flushing water shall be of the material &

type as that of the chemical pipelines which is being flushed.

2.01.09 Pipelines carrying water, chemicals, air etc. shall be sized generally on the following velocities. However wherever minimum pipe sizes are defined in the tender drawing /data sheets the selected size shall not be less than the specified size. The velocity in the resin transfer line is specified elsewhere in the specification.

	Pipe Size	**Velocity in m/sec.**		
		Below 50 mm above	**50-150 mm**	**200 mm &**
a)	Pump suction	-	1.2 - 1.5	1.2 - 1.8
b)	Pump discharge	1.2 - 1.8	1.8 - 2.4	2.1 - 2.5
c)	Header	-	1.5 - 2.4	2.1 - 2.4
d)	Compressed air below 2 Kg/cm^2(g)	15 - 20	20 - 30	25 - 35
e)	Compressed air 2 Kg/cm^2 & above	20 - 30	25 - 40	35 - 45
f)	Suction to compressor/ Blowers	-	7 - 8	-

2.01.10 Pipeline under gravity flow shall be restricted to a flow velocity of 1 m/sec generally. Channels under gravity flow shall be sized for a maximum flow velocity of 0.6 m/sec.

2.01.11 The following " C" Value shall be used in WILLIAM & HAZEN formula for calculating the friction loss in piping systems.

I)	Carbon Steel pipe	-	100
ii)	C.I Pipe / Ductile Iron	-	100
iii)	Rubber lined steel pipe	-	120
iv)	PVC / HDPE pipes	-	140
v)	Resin Transfer Pipe	-	100

For calculating the pump head, at least 10% margin shall be taken over the pipe friction losses.

2.02.00 **Material & Dimensional Standards for Piping**

2.02.01 All piping system shall be capable of withstanding the maximum pressure and temperature in the corresponding line.

2.02.02 The Steel pipes (Welded type) for the services of raw water/clarified water/Filtered water shall conform to the following standard or codes.

i) Pipes up to 150 NB

a)	IS:1239 Part-I		(Heavy grade-Black)
b)	ASTM-A-53 Grade B Type-E	(Welded), nominal size.	Sch 80 up to 2 inch nominal size. Sch 40 above 2 inch

ii) Pipes 200 NB and above

a) IS:3589 - Grade 410

b) ASTM - A53, Type-E Grade B (Welded) - Sch. 40

iii) Pipe 500 NB and above-In this case pipes shall be rolled and butt welded. These pipes may be

fabricated by the bidder at site. The plates conforming to IS:2062 (Tested quality) or SA-285 Gr.C. or equivalent.

However, condenser polisher pipelines shall be of seamless carbon steel ASTM A 106 Gr.B all welded construction with minimum 300 lb flange connection.

2.02.03 Pipes for the Air Service shall conform to the above clause 2.02.02 and shall be galvanized to IS:4736.

2.02.04 Pipes to be used for the rubber-lined construction shall conform the above clause 2.02.02 and inside surface shall be completely de-beaded and made suitable for lining.

2.02.05 Other piping materials shall conform to the following standards.

i) IS:4984 - Class-5-High density polyethylene pipes.

ii) IS:4985 - Class-4 - PVC Pipes.

iii) ASTM A-106, Gr. C, Schedule 80 - Seamless carbon steel pipe.

iv) ASTM A-312 Grade TP-316 Schedule 40s - Stainless Steel pipes.

v) ASTM A-312 - Grade TP-316 Schedule 40 - Stainless Steel pipes (ERW OR Seamless)

2.02.06 Fittings

(a) Fittings to be used with carbon steel pipes shall conform to IS:1239 Part-II (Heavy grade) for sizes up to 150 NB.

(b) For sizes 200 NB & above steel fittings shall conform to ASTM A 234 Gr. WPB. However for sizes above 350 NB fabricated fittings (meter bends etc) may be used. Forged elbows of long radius shall be used.

(c) However inside surface of all the fittings used for the rubber lined application shall be de-beaded and made suitable for rubber lining.

(d) For Galvanized pipe application all the fittings shall be galvanized as per IS:4736.

(e) Fittings to be used in other type of piping shall conform to relevant IS/BS ANSI Standards and in conformity with the parent pipe standard.

(f) Unless otherwise shown eccentric reducers shall be installed with straight side at the top of piping connection.

2.03.00 **Design of Piping Systems**

2.03.01 For water, air and other services where steel pipes are used, joints of this size range shall be screwed/flanged type.

2.03.02 All unlined steel pipes 65 NB and above (other than Cl pipes and air service pipes) shall be joint by butt-welding.

2.03.03 All rubber lined pipes shall have flanged joints.

2.03.04 Steel pipe flanges shall be generally slip on flat face type. Weld neck flanges shall be used when flange follows immediately after a butt-welding or where it is required with respect to service conditions. When weld neck or socket weld flanges are used, their bore must be made the same as that of the pipe being welded to. Socket welded or threaded flanges may be used, with the appropriate piping system for connection of pipe to the flanged equipment.

2.03.05 All the piping flanges and counter flanges & their drilling shall conform to ANSI B 16.5 of relevant pressure & temperature class. However wherever the interferences is involved with the Owner's pipe, the flange/interconnection details shall be designed to match the piping and the details of which will be intimated later. Flanges shall conform to ANSI B.16.5 class 150 (min.) for service other than condensate polisher pipelines.

2.03.06 For easy handling & removal of equipments, valves etc. and for maintenance purpose, break up flanges for 65 NB and above sizes and suitable type of compression flexible coupling for flanged joints of 50 NB and below

size shall be provided. The over ground piping wherever routed inside building, shall have a clear head room of minimum 2.1 meter from operating floor.

2.03.07 Pipes shall generally be routed above ground but where specifically indicated/specified the pipe may be laid in trenches or buried. Buried piping shall be generally installed so that the top of pipe is 1.0 metre below the ground level unless otherwise specifically mentioned. Full length of buried piping shall be provided with 100 mm thick sand bed.

2.03.08 Butt-welding edge preparation shall be done as per ANSI B 16.25.

2.03.09 Meter bends will not be accepted for steel pipes of 350 NB and below. For sizes above 350, the meter bends shall conform to BS:534. The bend radius shall be used for all pipes 1.5 times the nominal pipe diameter.

2.03.10 Hangers and supports shall be capable of carrying the sum of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipeline movements as necessary. All guides, anchors, braces, dampener, expansion joint and structural steel to be attached to the building/structure, trenches etc. shall be provided. Type of hangers and components for all piping shall be selected and approval obtained from the ENGINEER.

2.03.11 For rubber lined pipe, lining should be applied in two (2) layers, giving a total thickness not less than 3 mm. Surface hardness of rubber lining shall be 65 ± 5^{o} Shore A

2.03.12 Pipe coming under purview of IBR should meet its requirements and getting the IBR approval shall be under Vendors scope.

3.00.00 VALVES & GATES

3.01.00 Valves will be used to start/stop or control flow. Gates will be primarily used for isolation of flow in open channels although these should be capable of throttling the flow too. Sample valves will be used in sample collection lines.

3.02.00 (a) All valves, shall be suitable for service conditions i.e. flow, temperature and pressure under which they are required. All the valves shall be of standard pressure rating of the relevant design standard.

(b) All the actuators of the valves shall be designed to handle the maximum expected pressure differential across the valves and to overcome friction forces and unbalance forces due to the flow through valve.

3.03.00 **Valves in Raw water, Clarified & Filtered water application**

3.03.01 Either Butterfly type or sluice/gate valves shall be used for isolation purposes.

3.03.02 Sluice/gate valve shall conform to IS 14846 of rating PN 1.6 (min.). Stem, seat ring and wedge facing ring shall be of stainless steel construction. Other parts shall be as per IS:780. Flanges shall be designed as per ANSI B 16.5 Cl. 300 (min.) to meet with the piping flanges. Valves shall be of outside screw and rising stem type.

Sluice valves for sizes below 50 NB and below shall conforms to IS:778 Class-2/ANSI B16.34 straight, rising stem; without side screw.

3.03.03 Sluice valves shall be provided with the following accessories in addition to the standard items.

a) Hand wheel

b) Manual Gear reduction unit operator for valves 250 NB and above.

c) Bypass valve for valve of sizes 350 NB and above.

d) Draining arrangement wherever required.

e) Arrow indicating flow direction.

f) Position indicator.

3.03.04 Sluice Valves shall be provided with back seating bush to facilitate gland renewal during full open condition.

3.03.05 Butterfly valves shall be of double flanged or lugged wafer type of low leakage rate confirming to AWWA-C-504 class 300 (min.) or BS:5155 PN 10 (min.)

3.03.06 The various components of butterfly valves shall be of the following

i)	Body	:	Cast Iron - ASTM A 48 Cl.40; BS:1452 Gr.220 SG Iron - BS:2789. Cast Iron IS:210 Gr.FG260 Cast Steel - ASTM. A 216 GR. WCB; BS:1504 Eq.Gr. Fabricated Steel as per ASTM A515 Gr.60/80 IS:2062, Gr.B/IS:2002.
ii)	Disc.	:	Cast Iron IS:210, Gr.260; Cast Iron - ASTM A 48 Cl.40; BS:1452, Gr.220, SG Iron - BS:2789. Cast Steel - ASTM A 216 Gr. WCB; BS:1504 Eq.Gr. Fabricated Steel as per ASTM A515 Gr.60/80 IS:2062, Gr.B/IS:2002.
iii)	Shaft	:	ASTM. A 296 Gr. CF8M/AISI 316: AISI 420; BS 970 Gr.316; BS:970 Gr.420 S45.
iv)	Seat rings	:	Nitrile rubber, EPDM (Ethylene propylene rubber)

3.03.07 Butterfly valves shall be fitted with sleeve type bearing such as PTFE. Valves of size 350 NB and above shall be provided with one or two thrust bearings to hold the disc securely in the centre of valve seat without hydraulic or external axial shaft loads. Sleeve and other bearings fitted into the valves body shall be of self lubricated materials that do not have any effect on the fluid handled and other components of the valves.

3.03.08 All the butterfly valves shall be provided with Hand wheel or lever as per the requirements.

For larger sizes i.e. 150 NB and above hand wheel shall be provided. For lever/wrench operated valves, means shall be provided for positively holding the disc in not less than three intermediate positions.

Manually operated valves shall be provided with reduction gear unit for valves of size 250 NB and above. Valve provided with motorized or pneumatic actuator shall be provided with a hand wheel for manual operation.

All the valves shall be equipped with adjustable mechanical stop-limiting devices to prevent over travel of the valve disc in the open and closed positions. The valve operators (Hand wheel or Gear reduction unit or Motor actuator etc.) shall be designed as per relevant International Standard.

3.03.09 All the butterfly valves shall be provided with an indicator to show the position of the disc. Flanges shall conform to ANSI B 16.5 Cl.300 (min.)

3.03.10 Ball valves or Globe Valves may also be provided for the application of Raw/ Clarified / Filtered water services for sizes 40 NB and below conforming to the following specifications.

a) **Ball Valves**

i)	Design Standard	:	BS:5351 Class 300 (min.)
ii)	Type	:	Welded/Flanged ends; Full bore: Split Body & Seat supported construction.
iii)	**Material of Construction**		
	Body	:	Carbon Steel/Cast Iron
	Ball	:	Stainless steel ANSI 420
	Seat ring	:	PTFE

	Stem	:	Stainless steel AISI 420
	Seats	:	Nitrile rubber; PTFE.

iv) Valves shall be designed to be directly operatable by a wrench / Hand lever.

v) Suitable stops shall be provided for both the fully open & close condition.

vi) All the valves shall be provided with an indicator for showing the position of the ball port.

b) **Globe Valves 50 NB and Below**

i)	Design Standard	:	IS:778 Class-2
ii)	Type	:	Straight, rising stem, with outside screw.

iii) **Material of Construction**

i)	Body, Bonnet, stuffing Box & seat rings	:	Leaded Tin Bronze conforming IS:318 Gr.2
ii)	Stem	:	Stainless Steel, AISI-316
iii)	Disc	:	IS:318 Gr. 2/AISI-316

For sizes above 50 NB

i)	Design Standard	:	IS:780/IS:2906 rating PN 1.0 min. or Equivalent/BS 5150 PN 10. (min.)
ii)	Type	:	Double Flanged or wafer body, outside screw and rising stem type.

iii) **Material of construction**

Body	:	Cast iron : IS:210 Gr. FG 260/BS:1452 Gr.14.
Stem	:	Stainless steel AISI 410/ 13% chrome steel.
Disc	:	Cast iron IS:210 Gr.260/ BS:1452 Gr.14.
Packing	:	PTFE
Seat & seat rings	:	13% chromium steel
Gland & gland nut	:	AISI 420
Hand wheel	:	Cast iron or Malleable iron.

iv) Back seat shall be provided on the stem or on the disc.

v) Renewable disc assembly shall consist of disc holder, disc, disc guide, check nut and disc retaining nut with washer.

vi) Disc of globe valve may be provided with renewable rubber seating ring.

vii) Hand wheels shall be marked with the word. OPEN or SHUT with arrow to indicate direction of opening or closing.

3.03.11 However, valves in the flushing water lines shall be of type and material specified for the chemicals which is being flushed by the line.

3.04.00 **Valves for Demineralised water application**

3.04.01 Butterfly valves or Saunder's patented diaphragm valves shall be used for the services of demineralised water application for isolation purposes.

3.04.02 The diaphragm valves shall conform to the following requirements.

a) Design Standard : BS:5156 or equivalent of required rating/class. (minimum rating of valves should be PN 10).

b) Type : Flanged and lined body ends, sealed bonnet, weir pattern, tight shut off type.

c) **Material of Construction**

Body/Bonnet	:	I)	Cast Iron IS:210 Gr.FG.260 or equivalent.
		II)	Cast steel ASTM A-216 Gr. WCB.
Body lining	:		Soft Natural rubber, Ebonite polypropylene, PVDF.
Diaphragm	:		Reinforced rubber, hypalon/app. equal.
Hand wheel	:		Cast Iron
Compressor	:		Stainless Steel
Stem & Bush	:		Stainless Steel

d) Flanges shall conform to ANSI B 16.5 Cl.300 and shall be cast/integral with the body.

e) Hand wheels shall be marked with the direction of closure.

f) Valves shall be provided with a position indicator to show the open and closed condition.

g) Valves provided with pneumatic actuators shall be provided with a hand wheel for manual operation. The valves operators shall be designed as per relevant International Standard.

3.04.03 The butterfly valves shall conform to Cl.3.03.05 to Cl.3.03.09 above except to the following requirements.

a) Body shall be lined (minimum 3 mm) with natural rubber, ebonite, polypropylene or PVDF.

b) Disc shall be lined with PVDF, polypropylene, or natural rubber.

c) Seat rings shall be of Nitrile rubber or Hypalon.

3.05.00 **Valves for Acid & Alkali Services**

Valves shall be saunder's patented diaphragm type. The valves shall conform to Cl. 3.04.02 above except to the following requirements.

a) Diaphragm shall be of reinforced teflon, EPDM/Black Butile/appd. eqv. for acid services and reinforced Neoprene/Hypalon/app eqv for alkali services.

3.06.00 **Valves for Lime Slurry / Solutions**

3.06.01 Plug valves shall be used for the application of lime slurry /lime solutions.

3.06.02 The plug valves shall conform to the following requirements.

a) Design Standard : BS:5353 Class 300 or Equivalent.

b) Type : Flanged and non lubricated, regular pattern, plug valves.

c) Material of Construction

i) Body	:	Cast Iron IS:210 Gr FG 260 or Equivalent
ii) Plug	:	Stainless Steel AISI 316
iii) Body Sleeve or Seat	:	PTFE
iv) Seat	:	PTFE

v) Gland : AISI 304 / AISI 316

vi) Cover : Cast Steel ASTM A216 Gr WCB

vii) Gland Nut : AISI :304 / AISI 316

d) Valves shall be operated by permanently fitted wrench or Hand lever. Wrench shall be mounted so that they are parallel to the valve bore axis when the valve is in fully open condition.

e) All valves shall be provided with an indicator for the position of the plug part.

f) Suitable stops shall be provided for the fully open and fully closed positions of the valve.

g) Valves of size of 250 NB and above shall be provided with a suitable reduction gear unit.

3.07.00 **Resin Transfer Line**

In resin transfer line in CPU two way eccentric plug valve as manufactured by De Zurik or approved equal shall be used. Ball valve may also be used for this application. The valves shall have type 316 stainless steel body and bearings, resilient faced plug and flanged ends. For service vessel area pressure rating should be in line with system requirement. All automatic valves shall be provided with double acting pneumatic cylinder actuators controlled by solenoid valves, manual over ride feature & local position indicators.

3.08.00 Butterfly valves in the condensate polisher service vessels.

3.08.01 They shall be lugged wafer type.

3.08.02 The material of construction shall be as below:

i) Body : Cast Steel (Please refer note written below)

ii) Disc : SS-316

iii) Shaft : SS-316

iv) Seal : Teflon

v) Seat : Teflon with Titanium back-up rings

Note: - the body material shall be SS 316 for all the butterfly valves coming at the outlet of the service vessels.

3.08.03 Flanges shall correspond to ASA 300 lb class (min).

3.08.04 All automatic valves shall be provided with double acting pneumatic cylinder actuators controlled by solenoid valves, manual over ride feature & local position indicators.

3.09.00 **Valves for Air pipe line application**

3.09.01 For Air services, globe valves or Ball valves may be used for sizes 50 NB and below.

3.09.02 For sizes higher than 50 NB, either Butterfly valve or Ball valves shall be used.

3.09.03 Globe valves shall generally conform to Cl. 3.03.10 (b) above.

3.09.04 Ball valves shall conform to the requirements stipulated in Cl.4.03.10 (a) above. However, Body material shall be leaded Tin Bronze (IS:318 Gr.2) or stainless steel (AISI:304/316).

3.09.05 Butterfly valves shall conform to the Cl.3.03.05 to 3.03.09 of this section. However, the body & Disc shall be either cast iron lined with elastomer such as PVDF or PTFE or stainless steel construction (AISI 304/316).

3.10.00 **Non-return valves (Check valves)**

3.10.01 Non return valves shall be of swing check (reflux) type or dual plate type.

3.10.02 The valves shall conform to the following specifications.

i) Design Standard : IS:5312, BS:1868, BS:5153 API 594/ API 60 or Eqvt.

ii) Type : Swing check Type and Flanged ends.

iii) Material of Construction (For non corrosive application)

a)	Body & Cover Hinge Disk/Door	:	Cast iron IS:210 Gr.FG 260/or Cast Iron BS:1452 Gr.220 or Eqvt.
b)	Hinge Pin and Door/Disc Pin	:	Cast steel ASTM A 216 Gr. WCB. High tensile Brass IS:320 HT 2 or BS:2872 eqvt.
c)	Disc facing ring	:	Stainless steel
d)	Body Seat ring	:	Stainless steel
e)	Bearing bushes	:	Leaded Tin Bronze IS:318 Gr.2
f)	Bolts	:	Carbon Steel

iv) For the application of lime, corrosive water (DM water), and air, the body, cover & Disc shall be lined with natural Rubber, PTFE or Viton. The Hinge, Hinge Pin & Disc Pin shall be coated with PVDF, or suitable elastomer. The bearing bushes shall be PTFE or Eqvt. material. Bolting shall be of stainless steel. In the absence of lining/coating, the complete valve shall be of stainless steel construction (AISI 316) for the above application.

v) For acid services, the valves shall be of lined construction as specified in (iv) above, or of Hastalloy 'B' construction and Body/Disc facing ring shall be of resilient materials such as natural rubber, PTFE or Viton.

vi) For alkali services, the complete valve shall be stainless steel construction (AISI-316).

3.10.03 Flanges shall conform to ANSI B 16.5 Cl.300 to match with the piping flanges as specified elsewhere.

3.10.04 Body shall be permanently marked with an "arrow" inscription indicating the direction of motion of the fluid for all the check valves.

3.10.05 Check valves for Raw / Clarified / Filtered water may be offered in Gun metal construction & with threaded ends for sizes 50 NB and below conforming to IS:778 or Equivalent.

3.11.00 The safety valves / relief valves at the downstream of positive displacement type metering pumps shall be of the standard type manufactured by the pump manufacturer and the material of construction shall suit to the fluid handled.

3.12.00 **Gates**

3.12.01 Design standard for gates shall be IS:3042 or Eqv.

3.12.02 The gates shall be rectangular or square sluice, rising spindle type conforming to class-1 of IS:3042.

3.12.03 Material of Construction

i)	Frame and Door	:	Cast Iron IS:210 Gr. 20
ii)	Spindles, bolts & nuts	:	M.S. to IS:2062
iii)	Face & seat rings	:	Gun metal (as per IS:3042).

3.12.04 All the parts of gates shall be applied with the coats of heavy duty bitumastic paint.

3.12.05 Each of the gates shall be provided with hand wheel, and a position indicator.

3.12.06 The gates for DM plant drains shall be rubber lined to a minimum thickness of 4.5 mm.

3.13.00 **STRAINERS**

3.13.01 **Basket Strainers**

a) Basket strainers of simplex design shall have the following materials of construction for raw/clarified/filtered water application.

i) Body : Fabricated mild steel : IS:2062 (Tested quality)

ii) Strainers : Wire shall be stainless steel (AISI:316 18 BWG 30 mesh suitably reinforced. Reinforcement material shall also be of stainless steel construction.

iii) Drain Plug/Nuts : Gun metal

b) Inside and outside of basket body shall be protected with one coat of high build zinc phosphate primer and three coats of Chlorinated rubber paint to a total thickness of 200 microns.

c) Suitable Vent and drain valves shall be provided for the strainers.

d) Screen (strainer) flow area shall be at least four times pipe sectional area. Flow area in any portion of Basket strainer assembly shall not be less than the pipe cross sectional area.

e) Pressure drop in clean condition shall not be more than 1.0 MWC.

f) Basket Strainer shall be provided with lifting lugs and suitable mounting arrangement.

g) For DM water service, body shall be rubber lined to minimum 4.5 mm thickness (soft rubber of shore Hardness 65 ± 5°A).

3.13.02 **Y-Type Strainer**

a) Y-Type strainer for water application shall be constructed of following materials :

i) Body : Cast Iron IS:210 Gr. FG 260

ii) Strainers : Wires of stainless steel AISI-316, 18 BWG 30 mesh suitably reinforced. Reinforcement material shall also be of stainless steel construction.

iii) Drain Plug/Nuts : Gun metal (threaded construction)

b) Y-Type strainers shall also conform to Cl. 3.14.01 (b), (d), (e) and (f).

c) Body of the Y-type strainers of alkali, and demineralised water shall be of Cast Iron (IS:210, Gr.FG 260) and lined with soft or hard rubber to a thickness of 4.5 mm.

d) For acid services, apart from the rubber lined body material, the screen material, shall be Polypropylene or HDPE wire cloth of suitable mesh and thickness.

3.14.00 **General Requirements for Valves, Gates, Strainers**

3.14.01 All the equipments shall be of proven design for the duty conditions and the contractor or manufacturer shall have sufficient experience in using the above equipments in water treatment application in the plants supplied earlier by them.

3.14.02 In case owner desires, the experience list/feedback from the users shall be made available to owner for any or all the equipments during the detailed engineering phase.

3.14.03 Valves coming under the purview of IBR if any shall meet its requirements and the approval of the same shall be obtained by the contractor.

3.14.04 Sizes of the valves shall be same as that of the interconnected pipe sizes except for the control valves.

3.14.05 The various equipments shall be installed so that they are easily approachable for the operating and maintenance personnel. Generally Valves shall be located about 1.2 meter to 1.5 meter from the operating platform and also they shall not be located below the ground level such as beneath the trenches etc. In such cases, extended spindle shall be provided with chain operating from operating floor. Valves which are installed below the ground floor shall be provided with a floor mounted pedestal at the top of the operating floor. The

position indicator for such valves shall be also provided along with the stand.

3.14.06 However valves which are provided (in the burried pipe line) with a valves chamber shall have manual operator/Hand wheel inside the valve chamber. The valve chamber shall be provided with built in ladders/staircases and sufficient operating space within the chamber shall also be provided for easy operation of such valves.

TECHNICAL SPECIFICATION FOR HORIZONTAL CENTRIFUGAL PUMPS(CONT.)

1.00.0 SCOPE

1.01.0 This specification covers the design, material, construction features, manufacture, inspection, testing the performance at the Vendor's/Sub-Vendor's Works and delivery to site of Horizontal Centrifugal Pumps.

2.00.00 CODES AND STANDARDS

2.01.0 The design, material, construction, manufacture inspection and performance testing of Horizontal Centrifugal Pumps shall comply with all currently applicable statutes, regulations and safety codes in the locality where the Equipment will be installed. Nothing in these specifications shall be construed to relieve the Vendor of this responsibility. The Equipment supplied shall comply with the latest applicable Indian Standards listed below. Other National Standards are acceptable, if they are established to be equal or superior to the Indian Standards.

2.02.0 List of Applicable Standards.

1	IS : 1520	Horizontal Centrifugal Pumps for clear cold fresh water.
2	IS : 5120	Technical requirements of roto dynamic special purpose pumps.
3	API : 610	Centrifugal pumps for general refinery service.
4	IS : 5639	Pumps Handling Chemicals & corrosion liquids.
5	IS : 5659	Pumps for process water.
6	HIS	Hydraulic Institute Standards, USA
7	ASTM-1-165-65	Standards Methods for Liquid Penetration Inspection.

2.03.03 In case of any contradiction with aforesaid standards and the stipulations as per the technical specifications as specified hereinafter the stipulations of the technical specifications shall prevail.

3.00.00 DESIGN REQUIREMENTS

3.01.00 The Pump shall be capable of developing the required total head at rated capacity for continuous operation. Also the pumps shall be capable of being operated to give satisfactory performance at any point on the HQ characteristics curve over the operating range of 40% to 120% of the duty point. The maximum efficiency of pump shall be preferably be within +/- 10% of the rated design flow as indicated in the data sheets. The minimum efficiency of pumps shall be 40%.

3.02.00 The total head capacity curve shall be continuously rising from the operating point towards shut-off without any zone of instability and with a minimum shut-off head of 15% more than the design head.

3.03.00 Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division. The head Vs capacity and BHP Vs capacity characteristics should match to ensure even load sharing and trouble free operation throughout the range. Components of identical pumps shall be interchangeable.

3.04.00 Pumps shall run smoothly without undue noise and vibration. Peak to peak vibration limits shall be restricted to the following values during operation:

SPEED	**Antifriction Bearing**	**Sleeve Bearing**
1500 rpm and below	**75.0 micron**	**75.0 micron**

3.05.00 The noise level shall not exceed 85 dBA. Overall sound pressure level reference 0.0002 microbar (the standard pressure reference for air sound measurement) at a distance of 1 M from the equipment.

3.06.00 The pumps shall be capable of starting with discharge valve fully open and close condition. Motors shall be selected to suit to the above requirements. Continuous Motor rating (at 50 deg.C ambient) shall be atleast ten percent (10%) above the maximum load demand of the pump in the entire operating range to take care of the system frequency variation and no case less than the maximum power requirement at any condition of the entire characteristic curve of the pump.

3.07.00 The kW rating of the drive unit shall be based on continuously driving the connected equipment for the conditions specified. However, in cases where parallel operation of the pumps are specified, the actual motor rating is to be selected by the Bidder considering overloading of the pumps in the event of tripping of operating pump(s).

3.08.00 Pumps shall be so designed that pump impellers and other accessories of the pumps are not damaged due to flow reversal.

3.09.00 The Contractor under this specification shall assume full responsibility in the operation of pump and motor as a unit.

4.00.0 DESIGN CONSTRUCTION

4.01.00 DESIGN AND CONSTRUCTION OF VARIOUS COMPONENTS OF THE PUMPS SHALL CONFORM TO THE FOLLOWING GENERAL SPECIFICATIONS. FOR MATERIAL OF CONSTRUCTION OF THE COMPONENTS, DATA SHEETS SHALL BE REFERRED TO.

4.02.0 Pump Casing

4.02.01 Pump casing shall have axially or radially split type construction. The casing shall be designed to withstand the maximum shut-off pressure developed by the pump at the pumping temperature.

4.02.02 Pump casing shall be provided with a vent connection and piping with fittings & valves. Casing drain as required shall be provided complete with drain valves, piping and plugs. It shall be provided with a connection for suction and discharge pressure gauge as standard feature. It shall be structurally sound to provide housing for the pump assembly and shall be designed hydraulically to minimum radial load at part load operation.

4.03.00 Impeller

4.03.01 Impeller shall be closed, semi-closed or open type, and it shall be designed in conformance with the detailed analysis of the liquid being handled.

4.03.01 The impeller shall be secured to the shaft, and shall be retained against circumferential movement by keying, pinning or lock rings. On pumps with overhung shaft, impellers shall be secured to the shaft by a lockout or cap screw which tightness in the direction of normal rotation.

4.04.00 Impeller/Casing Wearing Rings

4.04.01 Replaceable type wearing rings shall be provided at suitable locations of pumps. Suitable method of locking the wearing ring shall be used. Wearing rings shall be provided in pump casing and/or impeller as per manufacturer's standard practice.

4.05.00 Shaft

4.05.01 The critical speed shall be well away from the operating speed and in no case less than 130% of the rated speed.

4.05.02 The shaft shall be ground and polished to final dimensions and shall be adequately sized to withstand all stresses from rotor weight, hydraulic loads, vibration and torques coming in during operation.

4.06.00 Shaft Sleeves

4.06.01 Renewable type fine finished shaft sleeves shall be provided at the stuffing boxes/mechanical seals. Length of the shaft sleeves must extend beyond the outer faces of gland packing of seal end plates so as to distinguish between the leakage between shaft and shaft sleeve and that past the seals/gland.

4.06.02 Shaft sleeve shall be fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation.

4.07.00 Bearings

4.07.01 Heavy duty bearings, adequately designed for the type of service specified in the enclosed pump data sheet and for long, trouble free operation shall be furnished

4.07.02 The bearings offered shall be capable of taking both the radial and axial thrust coming into play during operation. In case, sleeve bearings are offered additional thrust bearings shall be provided. Antifriction bearings of standard type, if provided, shall be selected for a minimum life 16,000 hrs. of continuous operation at maximum axial and radial loads and rated speed.

4.07.03 Proper lubricating arrangement for the bearings shall be provided. The design shall be such that the bearing lubricating element does not contaminate the liquid pumped. Where there is a possibility of liquid entering the bearings suitable arrangement in the form of deflectors or any other suitable arrangement must be provided ahead of bearings assembly.

4.07.04 Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearings housing.

4.08.00 Stuffing Boxes

4.08.01 Stuffing box design should permit replacement of packing without removing any part other than the gland.

4.08.02 Stuffing boxes of packed ring construction type shall be provided wherever specified. Packed ring stuffing boxes shall be properly lubricated and sealed as per service requirements and manufacturer's standards. If external gland sealing is required, it shall be done from the pump discharge. The Bidder shall provide the necessary piping valves, fittings etc. for the gland sealing connection.

4.09.00 Mechanical Seals

4.09.01 Wherever specified in pump data sheet, mechanical seals shall be provided. Unless otherwise recommended by the tenderer, mechanical seals shall be of single type with either sliding gasket or bellows between the axially moving face and shaft sleeves or any other suitable type. The sealing faces should be highly lapped surfaces of materials known for their low frictional coefficient and resistance to corrosion against the liquid being pumped.

4.09.02 The pump supplier shall coordinate with the seal maker in establishing the seal chamber of circulation rate for maintaining a stable film at the seal face. The seal piping system shall form an integral part of the pump assembly. For the seals under vacuum service, the seal design must ensure sealing against atmospheric pressure even when the pumps are not operating. Necessary provision for seal water supply along with complete piping fittings and valves as required shall form integral part of pump supply.

4.10.00 Pump Shaft Motor Shaft Coupling

4.10.01 The pump and motor shafts shall be connected with an adequately sized flexible coupling of proven design with a spacer to facilitate dismantling of the pump without disturbing the motor. Necessary coupling guards shall also be provided.

4.11.00 Base Plate

4.11.01 A common base plate mounting both for the pump and motor shall be provided. The base plate shall be fabricated steel and of rigid construction, suitably ribbed and reinforced. Base plate and pump supports shall be so constructed and the piping unit so mounted as to minimize misalignment caused by mechanical forces such as normal piping strain, internal differential thermal expansion and hydraulic piping thrust. Suitable drain troughs and drip lip shall be provided.

4.12.00 Assembly and Dismantling

4.12.01 Assembly and dismantling of each pump with drive motor shall be possible without disturbing the grouting base plate or alignment.

4.13.00 Drive Motor (Prime Mover)

4.13.01 The kW rating of the drive shall be based on continuously driving the connected equipment for the conditions specified. In case, where parallel operation of the pumps are specified, the actual motor rating is to be selected by the tenderer considering overloading of the pumps in the event of tripping of operating pumps.

5.00.00 TESTING FOR HORIZONTAL CENTRIFUGAL PUMPS

The manufacturer shall conduct all tests required to ensure that the equipment furnished shall conform to the requirements of this specification and in compliance with the requirement of applicable Codes and Standards. The particulars of the proposed tests shall be submitted to the Owner for approval before conducting the tests.

5.01.00 Hydrostatic Tests

All pressure parts shall be hydraulically tested at 200% of pump rated head or at 150% shut off head whichever is higher. The test pressure shall be maintained for 1/2 hr. and no leakage shall be permitted. While arriving at the above pressure, the maximum suction head specified in Data Sheet shall be taken into account.

5.02.00 Performance Tests

5.02.01 All the pumps shall be tested in the Manufacture's Works at rated speed for capacity, efficiency and brake horse power. Pumps shall be given running test over the entire operating range covering from the shut off head to the maximum flow. The duration of test shall be minimum one (1) hour. A minimum of seven readings approximately equidistant shall be taken for plotting the curves with one point at design flow. Testing of pumps shall be in accordance with stipulations of Hydraulic Institute Standards or as applicable equivalent

5.02.02 The test shall be preferably conducted with the actual motor being furnished.

5.02.03 Only those pumps shall be subjected to strip down examination visually to check for mechanical damages after testing at shop in case abnormal noise level and excessive vibration is observed during the performance test. Otherwise strip down examination is limited to bearing inspection only.

5.02.04 The pump accessories e.g. the thrust bearing, couplings etc. shall be subjected to tests as per manufacturer's standards.

5.03.00 Mechanical Balancing

All rotating components of the pumps shall be statically balanced. In addition to static balancing, rotating components of the pumps shall be balanced dynamically at or near the operating speed. Tenderer shall furnish acceptance norm for this test.

5.04.00 Visual Inspection

Pumps shall be offered for visual inspection by the bidder before shipment. The components of the pumps shall not be painted before inspection.

5.05.00 NPSH Test

NPSH test shall be conducted with water as medium if required. NPSH shall not be mandatory in case type test certificates are furnished for the similar rating of pumps.

5.06.00 Noise and Vibration Measurement

Noise and vibration shall be measured during the performance testing at shop as well as during the site test.

5.06.01 The noise level shall not exceed 85 dBA. Noise level measurement will be made as per applicable internationally acceptable standard. The measurement shall be carried out with calibrated integrating sound level meter meeting the requirement of IEC:651 or BS:5969 or IS:9779. Sound pressure level will be measured all round the pump and motor set at a distance of one meter from the nearest surface of the machine and at a height of 1.5 m from the floor level. A minimum of six (6) points should be covered for measurement. The measurement shall be done with a slow response on the A-weighted scale. The average of the A-Weighted sound pressure measurements expressed in decibels to a reference 0.0002 microbars shall not exceed the specified value.

The tests shall be carried out on the machine operating at rated speed and as near as possible to the rated power. Corrections for background noise and correction on account of test environment will be considered in line with applicable standard. For this purpose all the additional data required should necessarily be collected during the test.

5.06.2 Vibration check will also be done as per HIS. Vibration would be checked at thrust bearing locations on horizontal, radial and vertical direction. The acceptance limits would be as per HIS. The instrument used would be IRD 308 or equivalent with velocity pick-up. Vibration limits to be specified as per the speed of the pump.

5.07.00 Material Test Certificate

5.07.01 Material of the various pump components shall be tested in accordance with the relevant standards. Test certificates for these shall be furnished for the Owner's approval.

5.07.02 Where stage inspection is desired by BHEL/customer all material test certificates shall be correlated and verified with the actual material used for construction before starting fabrication by BHEL/customer's inspector who will stamp the material. In case mill test certificate for the material are not available, the supplier shall carry out physical and chemical tests at his own cost from a testing agency, approved by BHEL/Customer, as per the requirement of specified material standard. The sample for physical and chemical testing shall be drawn up in presence of BHEL/Customer's inspector who shall also witness the testing.

5.08.00 Non Destructive Testing

(a) UT shall be carried out on shafts of diameter more than 50 mm.

(b) DP tests shall be carried out on shaft and impeller.

(c) No weld repair shall be allowed on cast iron.

5.09.00 Field Testing

5.09.01 After installation, the pumps offered shall be operated to prove satisfactory performance as individual equipment as well as a system run. If the performance at site is found not to the requirements then the equipment shall be rectified or replaced by the Vendor, at no extra cost to the Owner. The procedure of the above testing will be mutually agreed between the Owner and the contractor. Noice and vibration tests shall also be repeated at site.

5.09.02 Based on observation of the trial operation, if modifications and repairs are necessary, the same shall be carried out by the contractor to the full satisfaction of the engineer and then the performance and guarantee tests to be repeated at site as per relevant clauses of the specification.

TECHNICAL SPECIFICATION FOR METERING PUMPS (CONT.)

1.00.0 GENERAL

1.01.01 Specification cover the design, material, construction features, manufacture, inspection, testing the performance at the vendor's/sub-vendor's works, delivery to site, erection, commissioning and testing of metering pumps.

2.00.0 GENERAL DESIGN FEATURES

2.00.01 Pumps shall be simplex positive displacement hydraulically operated diaphragm design, driven by squirrel cage induction motor through suitable speed reduction unit. Maximum pump stroke speed shall not exceed 100 per minute.

2.00.02 The stroke shall be continuously adjustable to give a capacity variation 0-100% range while the pump is running or stopped. Adjustment of capacity shall be done by manual control facility (micrometric adjusting type) to be provided locally for each of the pump.

2.00.03 The stroke shall be continuously adjustable to give a capacity variation 0-100% range while the pump is running or stopped. Adjustment of capacity shall be done by manual control facility (micrometric adjusting type) to be provided locally for each of the pump.

2.00.04 Capacity variation may be effected by changing eccentricity of the driving crank or by suitable hydraulic circuit. Pump accuracy shall be industry standard ± 1% of capacity setting.

2.00.05 Pumps shall be provided with an integral relief valve, spring operated to release pressure when delivery line blockage occurs.

2.00.06 Crankcase shall be constructed of high quality cast iron, which will also house the gearbox and guides of cross head.

2.00.07 Guided, controlled travel, double-ball check valves or equivalent, shall be provided both on the suction and discharge side.

2.00.08 Material of construction of the various parts shall be as per the details furnished elsewhere in the specification. However all parts coming in contact with acid shall be of Haste alloy 'B' and for alkali it should be of SS-316 only.

2.00.09 Suitable gland seal shall be provided to prevent leakage.

2.00.10 Electric drive motor particulars should follow enclosed electrical chapters.

3.00.00 TESTING

3.01.00 Testing and Inspection at Manufacturer's Works

3.01.01 The manufacturer shall conduct all tests required to ensure that the equipment furnished conforms to the requirements of this Specification and is in compliance with requirements of the applicable codes. The particulars of the proposed tests and the procedures for the tests shall be submitted to Owner for approval before conducting the tests.

3.01.02 The Owner's representatives shall be given full access to all tests for which the Manufacturer shall inform the Owner allowing adequate time so that if the Owner so desires, his representatives can witness the test.

3.01.03 All materials and castings used for the equipment shall be of tested quality. The test certificates shall be made available to Owner.

3.01.04 The pump casing shall be hydraulically tested at 200% pump operating pressure or 150% of design pressure whichever is higher. The test pressure shall be maintained at least for ½ an hour.

3.01.05 The rotating parts of pump drive shall be subjected to static balancing.

3.01.06 All pumps shall be tested at the shop for capacity, volumetric accuracy, repetitive accuracy, power and volumetric efficiency. The tests are to be done according to the requirements of the "Hydraulic Institute" of U.S.A. and Indian Standards as applicable.

3.01.07 The pump accessories e.g. gear box, speed reduction unit etc. will be subjected to tests as per manufacturer's standards. The test results shall be furnished to the Owner.

3.01.08 The combined variation of the pump and motor should be restricted within limits specified by Hydraulic Institute Standard, USA when the pump operated singly or in parallel.

3.01.09 All pumps shall be subject to strip down examination visually to check for mechanical damages after performance testing at shop.

3.01.10 Diaphragm of the metering pump shall be type tested as per applicable code/standard.

3.01.11 Performance test shall be carried out for the setting of pressure relief valve.

3.01.12 Test reports and certificates of all the above-mentioned tests to ensure satisfactory operation of the system shall be submitted to the Owner for approval before dispatch.

3.02.00 Test at Site

After erection at site pumps as detailed under different groups shall be operated to prove satisfactory performance as individual equipment as well as a system. If the performance at site is found to be not to the requirements, then the equipment shall be rectified or replaced by the Vendor at no extra cost to the Owner.

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