CLAUSE NO.	TECHNICAL REQUIREMENTS

Valves-350Nb and above shall have pressure equalizing bypass valves, wherever system parameters warrant the same.

Valves-350Nb and above shall also be provided with gear operator arrangement suitable for manual operation. Manual operation of valve shall be through worm and gear arrangement having totally enclosed gearing with hand wheel diameter and gear ratio designed to meet the required operating torque It shall be designed to hold the valve disc in intermediate position between full open and full closed position without creeping or fluttering. Adjustable stops shall be provided to prevent over travel in either direction.

Limit and torque switches (if applicable) shall be enclosed in water tight enclosures along with suitable space heaters for motor actuated valves, which may be either for On-Off operation or inching operation with position transmitter.

2.18.02 **Material of Construction (Butterfly Valves)**

Materials and other design details shall be as indicated below :

(a) **Cast Iron Butterfly Valves**

Body & Disc	ASTM A48, Gr. 40 with 2% Ni/ IS: 210. Gr. FG-260, with 2% Ni and epoxy coated
Shaft	BS 970 431 S: 291 / EN 57, or AISI-410 or AWWA-permitted shaft material equivalent to EN-57/AISI-410 or better.
Seat ring	18-8 Stainless steel
Seal	Nitrile Rubber

(b) **Stainless Steel Butterfly Valves**

Body & Disc	ASTM A 351, Gr. CF8M
Shaft	ASTM A 182, Gr. 316
Disc & Seat Rings	EPT/BUNA-N/Neoprene

(c) **Carbon steel Butterfly Valves**

Body & Disc	ASTM A 216, Gr. WCB
Shaft	ASTM A 182, Gr. 304
Disc & Seat Rings	EPT/BUNA-N/Neoprene

CLAUSE NO.	TECHNICAL REQUIREMENTS

Testing of valves shall be as per AWWA C – 504 or BS – 5155 as applicable. For fabricated body butterfly valves all the longitudinal and circumferential weld seams on valve body shall be 100% radiographed or ultrasound tested.

2.18.03 **Proof of Design Test (Type Test) for Butterfly Valves**

Proof of Design (P.O.D.) test certificates shall be furnished by the bidder for all applicable size-ranges and classes of Butterfly valves supplied by him, in the absence of which actual P.O.D. test shall be conducted by the bidder in the presence of Employer's representative.

All valves that are designed and manufactured as per AWWA-C-504 shall be governed by the relevant clauses of P.O.D test in AWWA-C-504. For Butterfly valves designed and manufactured to EN-593 or equivalent, the P.O.D. test methods and procedures shall generally follow the guidelines of AWWA-C-504 in all respect except that Body & seat hydro test and disc-strength test shall be conducted at the pressures specified in EN-593 or the applicable code. Actuators shall also meet requirements of P.O.D. test of AWWA-C-504.

2.19.00 **MATERIAL OF CONSTRUCTION (GATE/GLOBE/CHECK VALVE)**

(a) The materials shall generally comply with the following:

(1)	**Cast Steel Valves**	
	Body & bonnet	ASTM A 216 Gr. WCB/ ASTM A 105
	Disc for non-return Valves	ASTM A 216 Gr. WCB/ ASTM A 105
	Trim.	ASTM A 182 Gr. F6
(2)	**Stainless steel valves**	
	Body & Bonnet	ASTM A 351 Gr. CF 8M/ ASTM A 182 Gr. 304
	Disc	-do-
	Trim.	ASTM 182 Gr. F. 316
(3)	**Cast iron valves**	
	Body & bonnet	BS 1452 Gr.14/IS-210 Gr.FG 260
	Seating surfaces and rings	13% chromium steel
	Disc for non-return valves	BS 1452 Gr.14/IS-210 Gr FG 260
	Hinge pin for non-return Valves	AISI 316

CLAUSE NO.	TECHNICAL REQUIREMENTS

		Stem for gate globe valves	13% chromium steel
		Back seat	13 % chromium steel
	(4)	**Gun Metal valves**	
		Body and bonnet	IS 318 Gr. 2/ Equivalent Standard
		Trim.	-do-

(b) Cast iron body valves shall have stainless steel stem and seat.

(c) Material for counter flanges shall be the same as for the piping.

2.20.00 **Float operated valves**

(a) Valve shall automatically control the rate of filling and will shut off when a predetermined level is reached and close to prevent over flow on pre-set maximum water level. Valve shall also open and close in direct proportion to rise or fall of water level.

(b) DESIGN AND CONSTRUCTION FEATURES

The following design and construction feature of the valve shall be the minimum acceptable.

(c) Valves shall be right-angled or globe pattern.

(d) Valves shall be balance piston type with float ball.

(e) Leather liner shall not be provided.

(f) The body and cover material shall be cast iron conforming to ASTM-A 126 Grade 'B' or IS: 210 Grade 200 or equivalent, and Float shall be of copper with epoxy painting of two (2) coats.

(g) Valves shall be suitable for flow velocities of 2 to 2.5m/sec.

(h) The valves shall have flanged connections.

2.21.00 **PAINTING OF VALVES:**

Two (2) coats of primer followed by three (3) coats of enamel of approved color code/shade (usually same as that of connected piping) shall be applied to all exposed surfaces except stainless steel surface, Galvanized steel surface and gun metal surface at shop as required to prevent corrosion, before dispatch. The use of grease/oil other than light grade mineral oil, for corrosion protection is prohibited. The total DFT of paining shall be 150 micron (minimum). If during transport, unloading/unpacking or erection at site any part of the painted surface gets damaged, the same shall be made good by the contractor by repainting with compatible painting primer and enamel to the satisfaction of the project manager.

CLAUSE NO.	TECHNICAL REQUIREMENTS	एनटीपीसी NTPC
2.22.00	**Tanks and Accessories**	
2.22.01	The designer and manufacturer of storage tanks shall comply with and obtain approval of all currently applicable statutory regulations and safety codes in the locality where the equipment will be installed. The tanks shall conform to IS 803/IS804/IS 805/ IS 2825/ API 650/ IS 4049/ IS 4682 (part-I) and IS 4864 to 4870/ ASME B & PV code Sec.-VIII as the case may be.	
2.22.02	**DESIGN AND CONSTRUCTION**	
	(a) Design of all vertical atmospheric storage tanks containing water, acid, alkali and other chemical shall conform to IS:803 & API 650.	
	(b) Design of all horizontal atmospheric storage tanks containing water, acid, alkali and other chemicals shall generally conform to IS:2825 as regards to fabrication and general construction taking care of combined bending, shear & hoop stresses developed due to supporting arrangement.	
	(c) Design temperature of vessels shall be 10 deg.C higher than the maximum temperature that any part of the vessel is likely to attain during the course of operation.	
	(d) Tank shall be made from mild steel plates to BS 4360/IS-2062 Gr.B (or equivalent).	
	(e) The joint efficiency factors to be adopted for design calculations shall be in accordance with the specified design code.	
	(f) Tank shall be provided with suitable supporting joints. All vessels shall be provided with lifting lugs, eye bolts etc. for effective handling during erection.	
	(g) The material for flanges shall be of ASTM A 105/ IS-2062 Gr.B.	
	(h) For cylindrical tanks, the plates shall be cold rolled through plate bending machine by several number of passes to true curvature.	
	(i) Vessel seams shall be so positioned that they do not pass through vessel connections. For cylindrical vessel consisting of more than two sections longitudinal seams shall be offset.	
	(j) Tanks shall be provided with float operated level indicators/level gauges/level transmitters and level switches, as required, with complete assembly. Suitable flanged pads for level switches mounting shall also be provided. The level indicator can be top or side mounted as the case may be.	
	(k) In addition to inlet and outlet nozzles, the tanks shall be provided with vents, overflow, drain nozzles complete for various connections on tanks. Overflow lines from storage tanks is to be routed to the nearest surface drains. For tanks containing dm water, alkaline water or power cycle water the vent to atmosphere shall be through carbon-di-oxide absorber vessel suitably mounted on the tank. CO_2 absorber vessel shall be provided with the initial	

	fill of chemicals. Similarly for equipment cooling water overhead tank, the overflow & drain from tank shall be combined together and shall be led to nearest drain (at zero level) via. a seal-trough so as not to come directly in contact with atmosphere.
	(l) Tanks shall have suitable stairs/ladders on inside and outside of the tanks, manholes/inspection covers as required and also platform suitably located.
	(m) Tank supporting arrangement as approved by Employer shall be provided with all plates/angles/joints/flats and supporting attachment including lugs, saddles, legs etc.
	(n) Piercing nozzles/pipes from tank body / dish ends shall be adequately compensated as per relevant code.
	(o) Tank fabrication drg. and design calculations shall be approved by the Project Manager.
2.22.03	**Corrosion protection**
	(a) A corrosion allowance, applicable to surface in contact with corrosive media, when required, shall be taken into consideration.
	(b) Manholes shall be provided for easy access into the vessels. The size shall be minimum 500 mm and will be with cover plate, nuts bolts, etc. to ensure leak tightness at the test pressure.
	(c) Each tank shall be provided with drilled cleats welded to the tank for electrical grounding. Material of cleats shall be same as that of the shell.
	(d) Epoxy-coating shall be provided on the inside of vessel in three coats (minimum) resulting in total thickness of not less than 150 micron in which ever case required, such as equipment cooling water overhead tank, sodium hydroxide tank, condensate storage tank, condensate surge tank etc.
.2.22.04	**Cleaning & Painting**
	(a) Inside surface of all tanks shall be protected by anti-corrosive paints as required.
	(b) For tanks/vessel requiring epoxy painting, all inside surface shall be blast cleaned using non-siliceous abrasive after usual wire brushing.
	(c) Outside surfaces of all vessels shall be provided with two coats of primer with three (3) coats of epoxy resin based paint of approved color.
2.23.00	**RUBBER EXPANSION JOINTS**
2.23.01	All parts of expansion joints shall be suitably designed for all stresses that may occur during continuous operation and for any additional stresses that may occur during installation and also during transient condition.

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CLAUSE NO.	TECHNICAL REQUIREMENTS
2.23.02	The expansion joints shall be single bellow rubber expansion joints. The arches of the expansion joints shall be filled with soft rubber.
2.23.03	The tube (i.e. inner cover) and the cover (outer) shall be made of natural or synthetic rubber of adequate hardness. The shore hardness shall not be less than 60 deg. A for outer and 50 deg. A for inner cover.
2.23.04	The carcass between the tube and the cover shall be made of high quality cotton duck, preferably, square woven to provide equal strength in both directions of the weave. The fabric plies shall be impregnated with age resistant rubber or synthetic compound and laminated into a unit.
2.23.05	Reinforcement, consisting of solid metal rings embedded in carcass shall be provided.
2.23.06	Expansion joints shall be complete with stretcher bolt assembly. The expansion joints shall be suitable to absorb piping movements and accommodate mismatch between pipe lines.
2.23.07	The expansion joints shall be of heavy duty construction made of high grade abrasion-resistant natural or synthetic rubber compound. The basic fabric for the' duck' shall be either a superior quality braided cotton or synthetic fibre having maximum flexibility and non-set characteristic.
2.23.08	The expansion joints shall be adequately reinforced, with solid steel rings, to meet the service conditions under which they are to operate.
2.23.09	All expansion joints shall be provided with stainless steel retaining rings for DM water application and IS 2062 Gr B galvanized for ordinary water for use on the inner face of the rubber flanges, to prevent any possibility of damage to the rubber when the bolts are tightened. These rings shall be split and beveled type for easy installation and replacement and shall be drilled to match the drilling on the end rubber flanges and shall be in two or more pieces.
2.23.10	The expansion joints shall have integral fabric reinforced full-face rubber flanges. The bolt on one flange shall have no eccentricity in relation to the corresponding bolt hole on the flange on the other face. The end rubber flanges shall be drilled to suit the companion pipe flanges.
2.23.11	All exposed surfaces of the expansion joint shall be given a 3 mm thick coating of neoprene. This surface shall be reasonably uniform and free from any blisters, porosity and other surface defects.
2.23.12	Each control unit shall consist of two (2) numbers of triangular stretcher bolt plates, a stretcher bolt with washers, nuts, and lock nuts. Each plate shall be drilled with three holes, two for fixing the plate on to the companion steel flange and the third for fixing the stretcher bolt.
2.23.13	Each joint shall have a permanently attached brass or stainless steel metal tag indicating the tag numbers and other salient design features.

CLAUSE NO.	TECHNICAL REQUIREMENTS	एनटीपीसी NTPC
2.23.14	Bidder to note that any metallic part which comes in contact with DM /corrosive water shall be of Stainless Steel material.	
2.24.00	**STRAINERS**	
2.24.01	**Simplex type**	
	The strainers shall be basket type and of simplex construction. The strainer shall be provided with plugged drain/blow off and vent connections. The free area of the strainer element shall be at least four (4) times the internal area of the connecting pipe lines. The strainer element shall be 20 mesh. Pressure drop across the strainers in new condition shall not exceed 1.5 MCW at full flow. Wire mesh of the strainers shall be suitably reinforced, to avoid buckling under operation. Strainer shall have screwed blow off connection fitted with a removable plug. The material of construction of various parts shall be as follows:	
	(a) Body — IS: 318, Gr. 2 up to 50 mm Nb, and IS: 210 Gr. FG 260 above 50 mm Nb. (For DM water/ -Body: AISI 316 or equivalent)	
	(b) Strainer Element — Stainless steel (AISI 316)	
	(c) End connection — Screwed upto 50 mm Nb, and Flanged above 50 mm Nb	
2.24.02	**Duplex type**	
	(a) The strainers shall be basket type and of duplex construction. The strainer shall be provided with plugged drain/blow off and vent connections. The free area of the strainer element shall be at least four (4) times the internal area of the connecting pipe. The mesh of strainer element shall be commensurate with the actual service required. Pressure drop across the strainer in new condition shall not exceed 4.0 MWC at full flow.	
	(b) Wire mesh (if applicable) of the strainers shall be suitably reinforced. The material of construction of various parts shall be as follows.	
	Body — IS: 318, Gr. 2 up to 50 mm Nb, and IS:210, Gr. FG 260 or ASTM-A-515 Gr. 75/IS-2062 Gr. B and internally epoxy-painted above 50 mm NB.	
	Strainer element — Stainless steel (AISI 316)	
	End connection — Screwed up to 50mm Nb, and Flanged above 50 mm Nb. Gasket shall be of full face type	

(c) The strainer will have a permanent stainless steel tag fixed on the strainer body indicating the strainer tag number and service and other salient data.

(d) The size of the strainer and the flow direction will be indicated on the strainer body casting.

(e) Thickness of the strainer element should be designed to withstand the pressure developed within the strainer due to 100% clogged condition exerting shut-off pressure on the element.

2.24.03 Two shop coats of paint preceded by two coats of primer shall be applied to all exposed surfaces as required to prevent corrosion.. All parts shall be adequately protected for rust prevention. The use of grease or oil other than light grade mineral oils for corrosion protection is prohibited..

TECHNICAL PARTICULARS OF TANKS AND ACCESSORIES

Sl. No.	Description	Tech. Particulars
1.00	**CONDENSATE STORAGE TANKS**	
1.01	Number required	One per unit
1.02	Capacity of each tank (Effective)	800 Cu.m
1.03	Size (Dia & Height)/Plate Thickness	10.8 x 9.5 m/minimum (shell & roof) plate thickness 8mm and Base plate thickness 10mm
1.04	Type and pressure class atmospheric	Vertical, cylindrical,
1.05	Material of construction	MS- (IS-2062 Gr.B or equivalent).as per specified code, 8mm thickness (minimum)
1.06	Inside protection	Solvent free epoxy coating (minimum two coats) of total DFT 200 microns
1.07	External painting followed by 3 coats of epoxy micron	Epoxy paint (2 coats of primer paint) - minimum DFT 100
1.08	Location	Outdoor
1.09	Overflow, drain, vent and sample connection	Required

CLAUSE NO.	TECHNICAL REQUIREMENTS	
	1.10 Level Indicator	
	a) Number	One for each tank
	b) Type	Mechanical float type with dial type indicator (Guide wire, Float and Housing of Stainless steel - 316 Gr. construction)
	1.11 Manhole (minimum 500mm size)	Two (2)-one on shell and the other on roof
	1.12 Special Fittings	
	a) Hydraulic Seal of Overflow/Drain	Required
	b) Additional nozzle connection	number and size to be indicated to successful Bidder
	c) Nozzle connection for Instrument/spare	Three (3) nos. for each tank
	d) CO2 Absorber for vent (not to be kept on roof of tank, but to be kept on ground level)	Required
	e) Outside stair case (spiral)	Required
	f) Inside Ladder	Required
	g) Draw off sump	Required
	h) Root valve for level transmitter	Root valves for two (2) nos. level transmitter for each tank required
	Note: Control & Instrumentation facilities required for each of the condensate storage tanks shall also be incorporated by the bidder.	

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SUB-SECTION – A-26

PIPING VALVES AND FITTINGS

CLAUSE NO.	TECHNICAL REQUIREMENTS

PIPING VALVES AND FITTINGS

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 : 458	-	Concrete pipes (with and without reinforcement).
IS : 554	-	Pipe thread for pressure tight joints.
IS : 778	-	Gunmetal gate, globe and check valves for general purpose.
IS : 14846	-	Sluice valves for water purpose.
IS : 783	-	Code of practice for laying RCC pipes.
IS : 1239	-	Mild steel tubes and fittings - Part I & II.
IS : 1363	-	Black hexagon bolts, nuts and lock nuts.
IS : 1364	-	Precision and semi-precision hexagon bolts, screws, nuts and lock nuts.
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 : 2062	-	Structural steel fusion welding quality.
IS : 2379	-	Colour for the identification of pipe line.
IS : 2685	-	Code of practice for erection, installation, and maintenance of sluice valves.
IS : 2712	-	Gaskets.
IS : 2825	-	Code of unfired pressure vessels.

CLAUSE NO.	TECHNICAL REQUIREMENTS

	IS : 3006	-	Acid resistant SWG Pipe.
	IS : 3114	-	Code of practice for CI Pipes.
	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 : 3952	-	Cast Iron butterfly valves for general purposes.
	IS : 4038	-	Foot valve for water works purposes.
	IS : 4192	-	Part-I Rubber lining.
	IS : 4736	-	Hot dip zinc coating on steel tubes.
	IS : 4984	-	High Density polyethylene pipes.
	IS : 4985	-	Unplasticised PVC Pipes.
	IS : 5312	-	Swing check type reflux (non-return) valve Part-I.
	BS : 5156	-	Standard for Diaphragm valve.
	BS: EN 593	-	Industrisal Valves – Metallic Butterfly Valves
	BS : 5142	-	CI globe valve.
	ASTM-A 106	-	Gr.C Seamless carbon steel pipe.
	ASTM - 53	-	Seamless carbon steel.
	AWWA-C-504	-	Rubber seated butterfly valve.
	AWWA M11	-	Steel Pipe – A Guide for design and installation.
	ANSI:B - 16.5	-	Steel pipe flanges and flanged fittings.
	ANSI:B - 31.1	-	Power Piping code

2.00.00 SCOPE

The equipment & material to be supplied under this section shall include but not be limited to the following.

CLAUSE NO.	TECHNICAL REQUIREMENTS
	a) Pipes, bends, elbows, tees, branches laterals, crosses, reducing unions, couplings, cap, expansion joints, flanges, blank flanges, saddles, shoes, sampling connections etc. necessary for making a reliable piping system. b) Gaskets, ring joint, bracking rings, jointing material etc. as required. c) Instrument tapping connection, stub and thermo-wells. d) Supply and machining work of flanges, pipe spools and matching pipes to connect flow measuring orifice nozzles etc., pressure accumulators as necessary. e) Valve and gates, to start/stop and regulate flow. f) Strainers. g) Anchor block (for buried/over-ground piping), support brackets, clamps, support trestles, hangers etc. for the piping under the scope of contract. h) Bolts, nuts, fasteners as required for interconnecting piping, valves and fitting as well as for terminal points. i) Secondary steel for pipe supports and embedded steel. Also pipe supports and necessary embedment required to be embedded in concrete for under ground/above ground pipes. j) Painting anti-corrosive coatings, etc. inside and outside of pipes as necessary. k) All embedded parts required for all tanks/water retaining structures made of RCC including puddle pipes shall be supplied by the contractor.
3.00.00	**DESIGN, CONSTRUCTION AND ERECTION**
3.01.00	**Piping and Fittings (General)**
3.01.01	**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.
3.01.02	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.

3.01.03 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.

3.01.04 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.

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

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

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

S.No	Service	Recommended Material
1.	Raw water	Carbon Steel
2.	Clarified water	Carbon steel
3.	Filtered Water	a) SS-304 for the line from filtered water pumps upto DM Plant. b) GI pipe for the pipe feeding to potable water system.
4.	Sea Water	a) Stainless steel–316L or cupro-nickel alloy suitable for sea water application for sizes up to 100 NB or below. Above 100 NB: The piping systems handling sea-water shall be of carbon steel having i) coating of high build solvent free polyurethane (PU) of adequate thickness (minimum 2mm DFT) on the internal surface of the pipes as per AWWA-C-222.ii) 100% solvent free epoxy of 1500 microns ,iii)Vinyl

S.No	Service	Recommended Material
		Ester glass flake filled coating of 1000 microns. The pipes which cannot be coated internally, shall be of stainless steel construction confirming to ASTM-A-312 GR. 316 L.
5.	Acidic Water	Rubber lined Steel
6.	Decationised Water	Rubber lined Steel
7.	Demineralised Water	SS -304
8.	Acid (Conc Hydrochloric acid) (5 – 30%)	Polypropylene lined steel
9	Acid (Dilute Hydrochloric acid) (less than 5%)	Rubber lined Steel
10.	Acid (Sulfuric) a) Strong (Conc) b) Dilute (upto 10%)	 SS – 304 L Polypropylene lined steel
11.	Alkali (Sodium Hydroxide) a) Strong (5% and above) b) Dilute (below 5%)	 Stainless Steel Rubber lined Steel /Stainless steel
12.	Alum Solution	Rubber lined Steel
13.	Lime slurry/Solution/ Suspensions	Galvanised Steel
14.	Coagulant aid Solution	Rubber lined Steel
15.	Liquid and Gas Chlorine (Under Pressure)	Seamless Carbon Steel Schedule 80 (Heavy Duty)

S.No	Service	Recommended Material
16.	Chlorinated Water	*Rubber lined Steel for above ground* & HDPE pipe for below ground
17.	Wet Chlorine gas (Under Vacuum)	Polypropylene
18.	*Sludge (From Clarifier /tube settler/lamella clarifier)*	Cast Iron (Class A as per IS: 1536) / Ductile Iron
19	Air	Galvanised Steel
20	Waste effluent from DM plant vessels & chemical solution tank's etc.	Rubber lined Steel for above ground & HDPE pipe for below ground
21	Resin water slurry	Stainless steel Type-304
22	Backwash/Rinse water from discharge of Backwash pumps in DM plant	SS-316

Note: Irrespective of the recommended piping material as mentioned above, Bidder shall supply the material of pipes indicated in Scope of Works (Part-A) and in tender Drawings.

3.01.08 However the portion down stream 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.

3.01.09 **Minimum sizes for various pipelines are indicated in the tender drawings/data sheet. Bidder to provide the same as specified.** However, for pipe lines where sizes are not indicated, sizing shall be done based on the following velocities as indicated below:.

Sl.	Description	Velocity in meters/ second		
		Pipe size Below 50mm	Pipe Size 50 to 100 mm	Pipe Size 200 mm & above
a)	Pump suction	1.2 - 1.5	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	1.5 - 2.4	2.1 - 2.4

CLAUSE NO.	TECHNICAL REQUIREMENTS

		Velocity in meters/ second		
d)	Compressed air below 2 Kg/cm^2(g)	15 – 20	20 – 30	25 – 35
e)	Compressed air 2 Kg/cm^2(g) & above	20 – 30	25 – 40	35 – 45
f)	Suction to compressor/ Blowers	7 – 8	7 – 8	7 – 8

Pipe line under gravity flow shall be restricted to a flow velocity of 1 m/sec generally. Channels (Other than Cold water channel of Circulating Water System) under gravity flow shall be sized for a maximum flow velocity of 0.6 m/sec.

3.01.10 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)	Carbon Steel pipe with internal lining	- 120
iii)	C.I Pipe / Ductile Iron	- 100
iv)	Rubberlined steel pipe	- 120
iv)	PVC / HDPE / GRP pipes	- 140
v)	Stainless Steel	- 100

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

3.02.00 **Material & Dimensional Standards for Piping**

3.02.01 All piping system shall be capable of withstanding the maximum pressure and temperature in the corresponding line. The pressure rating of individual piping system component such as valves, flanges etc shall however be not less than that specified.

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

Pipes up to 150 NB: IS:1239 Part-I (Heavy grade-Black), ASTM-A-53 Grade B (Welded) -Schedule 80 up to 2 inch size and Schedule 40 above 2 inch nominal size.

CLAUSE NO.	TECHNICAL REQUIREMENTS

Pipes 200 NB and above: IS:3589 - Grade 410; ASTM - A53, Type-E Grade B (Welded) – Schedule 40.

However, condenser polisher headers for condensate polishing plant shall be of seamless carbon steel A 106 Gr.B all welded construction with 300 lb flange connection. Inlet and discharge end shall be prepared for field welding.

3.02.03 (a) The thickness of the pipes shall be selected based on the design pressure of the system (maximum test pressure or maximum surge pressure due to transients). Corrosion allowance of 2mm shall be included for unlined/ un-coated pipes and 1 mm for lined/coated pipes and negative tolerance specified by the Standard/Code shall be added to arrive at the final thickness. Thickness selected shall also meet the requirements of AWWA – M11 (for deflection & buckling criteria considering water filled for compacted soil) in case of buried pipes. However the final thickness shall not be less than that specified as per IS: 3589 as indicated below.

Sl	Nominal Pipe Size (mm)	Outside Diameter (mm)	Wall thickness (mm)
	200 NB	219.1	4.5
	250 NB	273	5
	300 NB	323.9	5.6
	350 NB	355.6	5.6
	400 NB	406.4	6.3
	450 NB	457	6.3
	500 NB	508	6.3
	600 NB	610	6.3
	700 NB	711	7.1
	800 NB	813	8.0
	900 NB	914	8.8
	1000 NB	1016	8.8
	1200 NB	1219	10
	1400 NB	1422	12.5

CLAUSE NO.	TECHNICAL REQUIREMENTS

Sl	Nominal Pipe Size (mm)	Outside Diameter (mm)	Wall thickness (mm)
	1600 NB	1626	14.2
	1800 NB	1829	14.2
	2000 NB	2032	16
	2200 NB	2235	17.5
	2500 NB	2540	20

(b) Spirally welded pipes as per API – 5 LS or IS:3589 are also acceptable for pipe of size 400 NB and above

(c) Preferably all steel pipes shall be supplied from the approved manufactures from their works. However, for Pipe Sizes 600NB and above, Bidder may fabricate pipes at site. Pipes to be fabricated by the bidder shall be rolled and butt welded from plates/coil conforming to ASTM A – 53 type E Gr. B / IS 2062 Grade 410 WC or Equivalent, of required thickness (as defined above) at site. Bidder shall clearly bring out their proposal regarding this aspect in their bid. The site-fabricated pipe (finished product) shall meet the required quality specified in the design Standard (IS:3589) with regard to Mechanical, Chemical Properties, Tolerances etc. However, for such site fabricated pipes, the Hydrostatic Test Pressure shall be 1.5 times the design pressure or 2 times the working pressure as the case may be. Other Testing requirements for such site-fabricated pipes shall be as per relevant Table in Sub-section-III E of Part-B of this Technical Specification.

3.02.04 Pipes for the Air Service shall conform to the above Clauses 3.02.02 & 3.02.03 and shall be galvanised to IS:4736.

3.02.05 Pipes to be used for the rubber lined construction shall conform the above Clauses 3.02.02 & 3.02.03 and inside surface shall be completely debeaded and made suitable for lining.

3.02.06 Other piping materials shall conform to the following standards.

1) IS:4984 – PE-80 & PN-16-High density polyetheylene pipes.
2) IS:4985 - Class-4 - PVC Pipes.
3) ASTM A-106, Gr. C, Schedule 80 - Seamless carbon steel pipe.
4) ASTM A-312 Grade TP-316 Schedule 40 - Stainless Steel pipes (SS 316)

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	5) ASTM A-312 Grade TP-304 Schedule 40 (min) (ANSI B36.19) – SS 304 6) ASTM A-312 Grade TP-304L Schedule 40 (min) (ANSI B36.19) – SS 304 L 7) ASTM D 3517 & ASTM D 4024 - GRP pipes
3.02.07	*Fittings*: 1) Fittings to be used with carbon steel pipes shall conform to IS:1239 Part-II (Heavy grade) for sizes upto 150 NB. For sizes 200 NB & above steel fittings shall conform to ASTM A 234 Gr. WPB. 2) For stainless steel fittings above 50 NB the same shall conform to ASTM-A-403, GR. WP 304 (316 for sea water application, if any), Class W i.e. the fittings shall be of welded construction strictly in accordance with ASTM-A-403. 3) Unless otherwise specified elbows shall be long radius type. 4) For pipe sizes upto 65 NB long radius forged elbows or seamless bends shall be used. Pipe bends, if used, shall be cold bent to a radius measured to the centre line of pipe of 3 to 5 times the pipe diameter. For steel pipes 80 NB and above, seamless long radius forged elbows are used unless otherwise indicated in the drawings. For pipe size 350 NB and above meter bends may be used. The bend shall be 1½ times the nominal pipe diameter. 90^0 meter bends shall be in 5 pieces (4 cuts) 45^0mitre bends shall be in 4 pieces and $22½^0$ in three pieces. Fabrication of meter bends shall be as detailed in BS 2633/BS534. 5) However inside surface of all the fittings used for the rubber lined application shall be debeaded and made suitable for rubber lining. 6) Galvanized pipe application all the fittings shall be galvanised as per IS:4736. 7) 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. 8) Unless otherwise shown eccentric reducers shall be installed with straight side at the top of piping connection.
3.03.00	**Design of Piping Systems**
3.03.01	Pipes 50 NB and smaller shall have socket welded joints for chlorine line. For water, air and other services where steel pipes are used, joints of this size range shall be screwed/flanged type.
3.03.02	All unlined steel pipes 65 NB and above (other than CI pipes and air service pipes) shall be jointed by butt welding.

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3.03.03	All rubber lined pipes shall have flanged joints.
3.03.04	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.
3.03.05	All the piping flanges and counter flanges & their drilling shall conform to ANSI B 16.5 of relevant pressure & temperature class. However wherever the interference 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 (minimum). However Stainless Steel Flanges shall be fabricated from SS Plates to ASTM-A-240, Gr. 304 (316 For Sea Water Application, if iny) or equivalent
3.03.06	The field joints of internally lined/coated smaller size pipes (diameter 150 to 400 NB) shall be of flanged type to avoid manual coating/lining at joints.
3.03.07	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.
3.03.08	Pipes shall be generally be routed above ground but where specifically indicated/specified the pipe may be laid in trenches or buried. Burried piping shall be generally installed so that the top of pipe is 1.0 meter below the ground level unless otherwise specifically mentioned. Full length of buried piping shall be provided with 100 mm thick sand bed.
3.03.09	Complete supporting system for the pipe line shall be designed, fabricated and supplied by the Bidder. Inside the building, the overhead portion of the pipe line may be supported from the building structures. No support shall be taken from the brick wall. Outdoor, pipes other than buried pipes shall run on steel trestles. Crossing of the road shall be on a pipe bridge with a clear height of at least 7 meters over the road surface. All the steel structure for the pipe bridge, and the supporting posts/trestles along with all necessary hangers clamps, connecting steel, fixing bolts, nuts etc. shall be supplied and erected by the Bidder.
3.03.10	Butt welding edge preparation shall be done as per ANSI B 16.25.
3.03.11	All welding electrodes and welding rods including special ones, if any shall be furnished by the Bidder.

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3.03.12	Mitre bends will not be accepted for steel pipes of 350 NB and below. For sizes above 350 the mitre bends shall conform to BS:534. The bend radius shall be used for all pipes 1.5 times the nominal pipe diameter.
3.03.13	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 pipe line 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.
3.03.14	A detailed Hydraulic transient analysis based on the method of characteristics shall be carried out for such piping system **if included in the scope of supply**. This study shall be carried out by a reputed consultant/Institute. The following shall be based on the results of the hydraulic transient study. • Pump discharge valve closing time and pump stopping sequence. • Conditions arising due to stopping/tripping of pumps • Size, location and quantity of air release valves in the make-up water piping shall be provided by bidder. • Pump discharge valve opening time during start-up condition and pump starting sequence. The report of transient analysis should consist of methodology adopted, characteristics curves/data for various boundary conditions, complete input data used for execution of software for various events and the results of the programme. The report shall be submitted to the Owner for approval. Based on the recommendations of such a study. Bidder shall take corrective measures and provide suitable surge suppression device in the piping system.
3.03.15	Pipe coming under purview of IBR should meet its requirements and getting the IBR approval shall be under Vendors scope
3.03.16	**Internal & External Protection Of Pipes:** 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 A class. Painting and application procedures for over ground Piping shall be as follows:

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	a) For Indoor Piping 1) Surface preparation shall be done either manually or by any other approved method. 2) Primer coat shall consist of one coat of chlorinated rubber based zinc phosphate primer having minimum DFT of 50 microns. 3) Intermediate coat (or under coat) shall consist of one coat of chlorinated rubber based paint pigmented with Titanium dioxide with minimum DFT of 50 microns. 4) Top coat shall consist of one coat of chlorinated rubber paint of approved shade and colour with glossy finish and DFT of 50 microns. Total DFT of paint system shall not be less than 150 microns. b) For Outdoor Piping 1) Surface preparation shall be done by means of sand blasting, which shall conform to Sa 2-1/2 Swiss Standard. 2) Primer coat shall consist of one coat of epoxy resin based zinc phosphate primer having minimum DFT of 100 microns. 3) Intermediate coat (or under coat) shall consist of epoxy resin based paint pigmented with Titanium dioxide with minimum DFT of 100 microns. 4) Top coat shall consist of one coat of epoxy paint suitable pigmented of approved shade and colour with glossy finish and DFT of 100 microns. Additionally finishing coat of polyurethane of minimum DFT of 25 microns shall be provided. The paint may be applied in one coat, in case high built paint is used, otherwise two coats shall be applied. Total DFT shall not be less than 300 microns. Outside surfaces of steel pipes and fittings that are buried underground and laid inside a Hume pipe (in Road/pipe or trench crossings) shall be given protective coating as per Annexure-I enclosed with this section.
4.00.00	**VALVES & GATES**
4.01.00	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. **Unless otherwise**

CLAUSE NO.	TECHNICAL REQUIREMENTS
	specified all the Valves shall be supplied with counter flanges by the Contractor.
4.02.00	(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. Non standard pressure rating shall not be accepted. The pressure and temperature rating of the valve shall not be less than the maximum expected pressure and temperature plus 5% additional margin of the system in which valves are proposed to be installed. The pressure rating of individual piping system component such as valves, flanges etc shall however be not less than that specified. (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.
4.03.00	**Valves in Raw water, Clarified, Filtered and Sea water application:**
4.03.01	Unless otherwise mentioned in tender drawings, either Butterfly type or sluice/gate valves shall be used for isolation purposes.
4.03.02	**Sluice/Gate valves :** a) Sluice /Gate Valves shall conform to BS:5150(BS:5163 PN 16) PN16, 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:14846 /BS:5163). Flanges shall be designed as per ANSI B 16.5 Cl. 150 (min.) to meet with the piping flanges. Valves shall be of outside screw and rising stem type. Gate valves for sizes below 50 NB and below shall conforms to IS:778 Class-2/ANSI B16.34 straight, rising stem; without side screw. For sea water application the Body, Bonnet, Wedge, Yoke etc shall be of ASTM A 439–Gr D2. b) Sluice/Gate valves shall be provided with the following accessories in addition to the standard items: 01) Hand wheel 02) Manual Gear reduction unit operator for valves 200 NB and above 03) Bypass valve for valve of sizes 350 NB and above. 04) Draining arrangement wherever required. 05) Arrow indicating flow direction. 06) Position indicator.

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c) Sluice/Gate Valves shall be provided with back seating bush to facilitate gland renewal during full open condition.

4.03.03 **Butterfly Valves:**

a) The valve rating of butterfly valves shall be selected based on the for the design pressure/temperature.

b) The design standard of butterfly valves shall conform to latest revision of AWWA C –504 or BS: EN:593 or equivalent Standard of required class/rating. Irrespective of design standard adopted (either AWWA C-504 or BS: EN:593), the butterfly valves of shall be POD(proof of design) tested as per AWWA C-504. In case POD test has been conducted in the past, required certified documents, such as GA drawing, cross sectional drawing and test certificate shall be submitted to Owner for approval. In case such test was not conducted in the past, the same shall be conducted for this project as per AWWA C-504 for each design/rating being offered and furnish the documents for approval. Valves used for POD testing valves shall not be supplied.

c) The butterfly valves shall be double flanged type for sizes above 300 mm and for sizes 300 mm and below valve shall be double flanged or lugged wafer type. Fabricated butterfly valves (POD tested) instead of cast body valves are acceptable for larger size (600 mm and above) provided testing features and face to face dimension of the valve are as per the relevant design standard (AWWA C 504 or BS: 5155 as the case may be). In such a case the valve supplier should submit the design calculations for selection of major dimensions such as body, shaft diameter, disc thickness etc

d) The Geometry, overall dimensions, laying length, body shell thickness, shaft diameter, shaft torque value shall be as per design standard adopted and of applicable design class. For Valves of sizes not covered in AWWA C-504 (which are designed as per AWWA C-504), the same shall be extrapolated.

e) For valves designed as per AWWA C-504, valve flanges shall conform to ANSI B16.1 Class 125 for Cast Iron Valves and AWWA C 207 Class E for fabricated type. The counter flanges shall conform to AWWA C-207 Class E. For Valves designed as per BS: EN: 593 the flanges shall conform to relevant standard.

f) The various components of butterfly valves shall be of the following for fresh water application:

i)	Body	:	Cast Iron - ASTM A 48 Cl.40; BS:1452 Gr.220 SG Iron - BS:2789.;Cast Iron IS:210 Gr.FG260. **OR** Cast Steel - ASTM. A 216 GR. WCB; BS:1504 Eq.Gr.

			OR Fabricated Steel as per ASTM A515 Gr.60/80 IS:2062, Gr.B/IS:2002.(for higher size valves)
ii)	Disc.	:	Cast Iron IS:210, Gr.260; Cast Iron – ASTM A 48 Cl.40; BS:1452, Gr.220, SG Iron - BS:2789. **OR** Cast Steel - ASTM A 216 Gr. WCB; BS:1504 Eq.Gr. **OR** Fabricated Steel as per ASTM A515 Gr.60/80 IS:2062, Gr.B/IS:2002 (for higher sizes).
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), Hypalon.

For Condensate polishing plant all butterfly valves shall be of stainless steel construction, SS-316 (for body, disc and shaft). Seat/seat rings should be of Teflon/titanium back up rings. Seal shall also be of Teflon only.

For sea water application:

Austentic Ductile Iron (cast) Butterfly valves

Body & Disc	ASTM A 439 D2 and epoxy coated internals
Shaft	SS - 316
Seat Rings	18-8 Stainless steel
Seal	EPT/BUNA/NEOPRENE / EPDM

g) 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 center 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 affect on the fluid handled and other components of the valves.

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

i) 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.

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j) Manually operated valves shall be provided with reduction gear unit for valves of size 250 NB and above. Valve provided with motorised 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 manual valve operators (Hand wheel or Gear reduction unit) shall be designed as per relevant International Standard.

k) All the butterfly valves shall be provided with an indicator to show the position of the disc.

4.03.04 For Sizes 40 NB and below, Ball valves or Globe Valves may also be provided for the application of Raw/ Clarified/Filtered / water services conforming to the following specifications:

a) Ball Valves

i)	Design Standard	:	BS:5351 Class 150 (min.)
ii)	Type	:	Welded/Flanged ends; Full-bore and 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/ Handlever.		
v)	Suitable stops shall be provided for both the fully open and close condition		
vi)	All the valves shall be provided with an indicator for showing the position of the ball port.		

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b) **Globe Valves**

A)	**50 NB and Below**		
i)	*Design Standard*	:	*IS:778 Class-2*
ii)	Type	:	Straight, rising stem, with outside screw
iii)	Material of Construction		
	Body, Bonnet, stuffing Box and seat rings	:	Leaded Tin Bronze con forming IS:318 Gr.2
	Disc	:	IS:318 Gr 2 / AISI –316
	Stem	:	Stainless steel AISI 316
B)	**50 NB and Above**		
i)	*Design Standard*	:	IS:780/IS:2906/ IS:14846 rating PN 1.0 minimum 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
	Disc	:	Cast iron IS:210 Gr.260/ BS:1452 Gr:14.
	Stem	:	Stainless steel AISI 410/ 13% chrome steel.
	Packing	:	PTFE
	Seat & seat rings	:	13% chromium steel
	Gland & gland nut	:	AISI 420
	Hand wheel	:	Cast iron or Malleable iron.
C)	Back seat shall be provided on the stem or on the disc.		

D)	Renewable disc assembly shall consist of disc holder, disc, disc guide, check nut and disc retaining nut with washer
E)	Disc of globe valve may be provided with renewable rubber seating ring.
F)	Handwheels shall be marked with the word. OPEN or SHUT with arrow to indicate direction of opening or closing.

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

4.04.00 Valves for Decationsed, Deanionsed and Demineralised water application

4.04.01 Butterfly valves or Saunder's patented diaphram valves shall be used for the services of deanionised, decationised and demineralised water application for isolation purposes.

4.04.02 The diaphragm valves shall conform to the following requirements.

i)	Design Standard	:	BS:5156 or equivalent of required rating/class. (minimum rating of valves should be PN 10).
ii)	Type	:	Flanged and lined body ends, sealed bonnet, weir pattern, tight shut off type.
iii)	Material of Construction		
iv)	Body, Bonnet	:	Cast Iron IS:210 Gr.FG.260 or equivalent Or Cast steel ASTM A-216 Gr WCB.
v)	Body lining	:	Soft Natural rubber, Ebonite Polypropylene
vi)	Diaphragm	:	Reinforced rubber, hypalon/approved . equalent
vii)	Handwheel	:	Cast Iron
viii)	Compressor	:	Stainless Steel
ix)	Stem & Bush	:	Stainless Steel

x)	Hand wheels shall be marked with the direction of closure.
xi)	Valves shall be provided with a position indicator to show the open and closed condition.
xii)	Valves provided with pneumatic actuators shall be provided with a handwheel for manual operation. The valves operators shall be designed as per relevant International Standard

4.04.03 The butterfly valves shall conform to Cl.4.03.03 above except to the following requirements.

1. Body shall be lined (minimum 3 mm) with natural rubber, ebonite, polypropylene.
2. Disc shall be lined with PVDF, polypropylene, or natural rubber. Disc of SS-316 is also acceptable.
3. Seat rings shall be of Nitrile rubber or Hypalon.

4.05.00 Valves for Acid & Alkali Services

4.05.01 Valves shall be Saunder's patented diaphragm type. The valves shall conform to Cl. 4.04.02 above except that Diaphragm shall be of reinforced TEFLON, EPDM/Black Butile/approved equivalent for acid services and reinforced Neoprene/Hypalon/ approved equivalent for alkali services.

4.06.00 Valves for Lime Slurry / Solutions & Resin transfer lines

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

4.06.01 The plug valves for lime slurry/solution lines shall conform to the following requirements.

i)	Design Standard	:	BS:5353 Class 150 or Equivalent
ii)	Type	:	Flanged and non lubricated plug valves.
iii)	Material of Construction		
iv)	Body	:	Cast Iron IS:210 Gr.FG.260 or equivalent
v)	Plug	:	Staineless Steel AISI 316
vi)	Body Sleeve or Seat	:	PTFE

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vii)	Seat	:	PTFE
viii)	Gland	:	AISI 304 / AISI 316
ix)	Cover	:	Cast Steel ASTM A216 Gr WCB
x)	Gland Nut		AISI 304 / AISI 316
xi)	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.		
xii)	All valves shall be provided with an indicator for the position of the plug part.		
xiii)	Suitable stops shall be provided for the fully open and fully closed positions of the valve.		
xiv)	Valves of size of 250 NB and above shall be provided with a suitable reduction gear unit.		

4.06.03 In resin transfer line of Condensate Polsihing Plant two way eccentric plug valve as manufactured by De Zurik or approved equal shall be used. The valves, shall have type 316 stainless steel body and bearings, resident faced plug and flanged ends. For service vessel area pressure rating should be in line with system requirement. In case Ball Valves are used in the resin transfer lines, the same shall be of SS-316 construction and pressure rating shall be in line with system requirement.

4.07.00 Valves for Alum Solution and Coagulant aid Solution application

4.07.01 Valves shall be of Saunder's patented diaphragm type.

4.07.02 Diaphragm valves shall conform to the requirements as mentioned in Cl 4.04.02 above.

4.07.03 Ball valves may also be used in PVC pipes (if permitted in specification) for alum and coagulant aid solution application conforming to the following material of construction.

Body, Ball & Stem : PVC

Seat ring & Packing : EPDM (Ethylene propylene rubber)

4.08.00 Valves for Chlorine gas (Wet/Dry) and Chlorinated Water Application

4.08.01 The type of valves shall be as per the schematic (P & ID) flow diagram which is enclosed as a part of the Technical Specification. However, the contractor may offer

the valves in line with the Chlorination Plant Supplier (Manufacturer) recommendations and practice. The Valves in Chlorine gas (Wet/Dry) liquid chlorine and Chlorinated water lines shall be approved by the Chlorine Institute-USA and the Chief Controller of Explosives - INDIA.

4.08.02 The Materials of construction of various types of valves are indicated for the guidelines of the Contractor.

a) Needle Valve (Chlorine gas Shut off Valve)

a)	Body	:	Bronze (Silver plated) / Brass
b)	Needle	:	Monel
c)	Valve seat	:	Teflon / Monel
d)	Stem	:	Monel
e)	Gland / Gland nut	:	Bronze/ Brass
f)	Packing	:	Teflon

b) Ball Valve (Liquid Chlorine)

a)	Body	:	Carbon Steel
b)	Ball	:	PVDF / Monel
c)	Stem	:	Stainless Steel AISI 316 L
d)	Bolts & nuts	:	AISI 316 L
e)	Gland / Gland nut	:	Bronze/ Brass
f)	Seat ring	:	PTFE

c) Angle type needle valve (For tonne container isolation)

a)	Body	:	Bronze (Silver plated) / Brass
b)	Needle	:	Monel
c)	Valve seat	:	Teflon / Monel
d)	Stem	:	Monel

e)	Gland / Gland nut	:	Bronze/ Brass
f)	Packing	:	Teflon

d) Butterfly type Valve /Ball Valves (Isolation of Chlorinated Water in PVC pipes)

a)	Body	:	PVC
b)	Shaft	:	Carbon Steel nickel plated
c)	Disc / Ball	:	PVC
d)	Seating ring	:	Viton
e)	Packing (Ball Valve)	:	PTFE
f)	Bush / O –ring (Butterfly type)	:	EPDM, PVDF

e) Diaphragm Valves (Isolation of Chlorinated water in lined steel pipe):

These valves shall conform to Cl 4.04.02 above.

4.09.00 Valves in Sludge pipe line application

Sluice valve/knife edge type slide valves shall be used in the sludge and drain pipe line.

4.09.01 The Valves shall conform to the following requirements:

i)	Design Standard	:	IS:780/IS:2906 rating 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
	Stem	:	Stainless Steel AISI 420
	Disc	:	Cast Iron IS:210 Gr. FG 260
	Packing	:	PTFE
	Gland & Gland nut	:	AISI 420

	Hand wheel	:	Cast Iron
iv)	The flanged type valves shall have flanges conforming to ANSI-B 16.5 Cl-150.		
v)	The valves shall conform to the other requirements specified in Cl. 4.03.02(b) & 4.03.02(c).		

4.10.00 Valves for Air pipe line application

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

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

4.10.03 Globe valves shall generally conform to Cl. 4.03.12 (b) above.

4.10.04 Ball valves shall conform to the requirements stipulated in Cl.4.03.12 (a) above. However, Body material shall be leaded Tin Bronze (IS:318 Gr.2) or stainless steel (AISI:304/316).

4.10.05 Butterfly valves shall conform to the Cl.4.02.05 to 4.02.09 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).

4.11.00 Non-return valves (Check valves)

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

4.11.02 The valves shall conform to the following specifications.

i)	Design Standard	:	IS:5312, BS:1868, BS:5153 API 594/ API 60(6D) or Equvalent
ii)	Type	:	Flanged Swing check Type or Dual plate type of lugged wafer design
iii)	Material of Construction (For non corrosive application)		
	Body & Cover Hinge Disk/Door	:	Cast Iron : IS:210 Gr. FG 260 Cast Iron BS:1452 Gr.220 or Eqvt
	Hinge Pin and Door/Disc Pin	:	Cast steel ASTM A 216 Gr. WCB. High tensile Brass IS:320 HT 2 or

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			BS:2872 eqvt
	Disc facing ring	:	Stainless steel
	Body Seat ring	:	Stainless steel
	Bearing bushes	:	Leaded Tin Bronze IS:318 Gr.2
	Bolts	:	Carbon Steel
iv)	Material of Construction (For Sea water)		
	Body & Cover Hinge Disk/Door	:	Austenitic Ductile Iron ASTM-A-439, D-2 (Internals epoxy painted).
	Hinge Pin and Door/Disc Pin	:	SS-316
	Disc facing ring	:	SS-316
	Body Seat ring	:	SS-316
	Bearing bushes	:	Leaded Tin Bronze IS:318 Gr.2
	Bolts	:	SS-316
v)	For the application of alum, lime, coagulant aid solution, corrosive water (DM water, Decationised/Deanionised 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.		
vii)	For Hydrochloric 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.		
viii)	For alkali and sulphuric acid services, the complete valve shall be stainless steel construction (AISI-316).		
ix)	Dual Plate type check valves shall be of double flanged. However for smaller sizes upto 150 mm NB, lugged wafer type is also acceptable. The material of construction of spring in dual type valve shall be of INCONEL or better.		

4.11.03 Flanges shall conform to ANSI B 16.5 Cl.150 to match with the piping flanges as specified elsewhere.

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4.11.04	Body shall be permanently marked with an "arrow" inscription indicating the direction of motion of the fluid for all the check valves.
4.11.05	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.
4.11.06	For Chlorine gas and Chlorinated water application check valve of Lift Ball type may be used in PVC construction (in case of PVC pipes). In case of rubber lined pipes, the check valves of swing check type shall be lined construction as referred in Cl 4.11.02 (v) above.
4.12.00	The safety valves / relief valves at the down stream 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.
4.13.00	**Gates**
4.13.01	Design standard for gates shall be IS:3042 or Equivalent. For sizes not covered under IS::3042, the gates shall generally as be per IS:13349.
4.13.02	The gates shall be rectangular or square sluice, rising spindle type conforming to class-1 of IS:3042.
4.13.03	Material of Construction a) Frame and Door : Cast Iron IS:210 Gr.260 b) Spindles, bolts & nuts : M.S. to IS:2062 c) Face & seat rings : Gun metal (as per IS:3042).
4.13.04	All the parts of gates shall be applied with the coats of heavy duty bitumastic paint.
4.13.05	Each of the gates shall be provided with hand wheel, and a position indicator.
4.13.06	The gates for DM plant drains/Condensate Polishing Plant shall be rubber lined to a minimum thickness of 4.5 mm.
4.14.00	**Automatic Air Release Valve**
4.14.01	The automatic air release cum vacuum breaker valves shall be of automatic double air valve with two orifices and two floats conforming to IS14845. The float shall not close the valve at higher air velocities. The Orifice Contact joint with the float shall be leak tight joint. An isolation valve shall be provided for each release valve. The Air release valve in the makeup water pipelines shall be provided with a suitable enclosure with locking arrangement so that the same is not tampered.

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4.14.02 The valve shall efficiently discharge the displaced air automatically form ducts/ pipes while filling them and admit air automatically into the duct / pipes while they are being emptied. The valve shall also automatically release trapped air from ducts/ pipes during normal working at the normal working pressure.

4.14.03 Material of construction of automatic air release valves shall be as follows.

i)	Body & Cover	:	Cast iron IS-210 Gr. FG 260
ii)	Ball, small orifice	:	Nitrile Rubber
iii)	Ball, large orifice	:	Vulcanite(ebonite)
iv)	Splash Cover	:	Cast iron IS-210 Gr. FG 260
v)	Ball seat	:	13% Cr. Stainless steel
vi)	Spindle	:	SS 316
vii)	Gasket		Nitrile Rubber

Note: However, for sea-water the air release valves shall be of body material ASTM-A-439 (D2-NI) and spindle shall be of SS-316.

4.15.00 STRAINERS

4.15.01 Basket Strainers

a) Basket strainers of duplex design shall have the following materials of construction.

i)	Body	:	Fabricated mild steel : IS:2062 (Tested quality) for raw/clarified/filtered water application and Austenitic Ductile Iron to ASTM–A-439 Gr D2 for sea water
ii)	Strainers	:	Wire shall be stainless steel (AISI:316) 18 BWG 30 mesh suitably reinforced. Reinforcement material shall also be of stainless steel (SS-316) construction.
iii)	Drain plugs/ Nuts	:	SS-316

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.

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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 4.0 MWC.

f) Duplex 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)

4.15.02 Y-Type Strainers

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

i)	Body	:	Cast Iron IS:210 Gr. FG 260 for raw/clarified/filtered water application and Austenitic Ductile Iron to ASTM–A-439 Gr D2 for sea water
ii)	Strainers	:	Wire shall be stainless steel (AISI:316) 18 BWG 30 mesh suitably reinforced. Reinforcement material shall also be of stainless steel (SS-316) construction.
iii)	Drain plugs/ Nuts	:	SS-316

b) Y-Type strainers shall also conform to Cl. 4.14.01 (b), (c), (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 3 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.

4.15.03 Strainers for the application of chlorine gas (Wet / Dry) and liquid chlorine shall be of standard make and type of the chlorination plant manufacturer and material of construction shall be suitable for the duty conditions.

4.16.00 Resin Traps

The resin traps for the Ion exchange vessels shall be provided for the collection of Ion exchange resin shall conform to the following:

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	a) The body shall be of mild steel (IS:2062) and lined internally with rubber (Hard/Soft rubber), Saran or polypropylene. The internals (rod and screen) for all resin traps shall be of AISI 316 construction. All screen components shall be welded at each intersection of wire and support rod for good strength, Resin traps screen opening shall not exceed 120 percent of the associated process vessel under drain/backwash collection header nozzle screen opening and shall be suitably selected to retain even the minimum size of the resin selected for the process. b) The resin traps shall be provided with a draining arrangement with a valve for collection of trapped resins. Resin trap body shall have lifting lug for easy handling during maintenance/erection.
4.17.00	**General Requirements for Valves, Gates, Strainers and Resin traps** a) 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. b) In case owner desires, the experience list/feed back from the users shall be made available to owner for any or all the equipments during the detailed engineering phase. c) 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. d) Valves, Strainers etc for the Chlorination Plant shall be got approved by the Chief Controller of Explosives-INDIA, by the contractor. e) Sizes of the valves shall be same as that of the interconnected pipe sizes except for the control valves. f) 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 metre to 1.5 metre 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. 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. g) 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.

h) All the valves, strainers, resin traps etc. shall be provided with external painting as that of the interconnected piping as specified in Clause 3.03.14 above. However, surfaces such as Stainless Steel, aluminium, copper, brass, bronze and other non-ferrous materials shall not be painted. No paint or filter shall be applied until all repairs, hydrostatic tests and final shop inspections are completed, but shall be applied prior to shipment.

5.00.00 TESTING FOR PIPING, VALVES & FITTINGS

5.01.00 TESTS AT SITE

All piping, valves, Gates, resin traps, strainers and other fittings after erection at site shall be tested to hydraulic test pressure of two times the operating pressure or 1.5 times the maximum allowable pressure whichever is higher for a period of two hours.

All valves/gates (Manual/Automatic) shall be operated through-out 100% of the travel manually and as well as from control panel (if applicable) and these should function without any trouble whatsoever.

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ANNEXURE-1

COATING & WRAPPING FOR PIPES

1.00.00 INTENT

This specification covers the supply of material, application, inspection, testing including supervision of coal tar protection tape for MS pipes.

2.00.00 CODES AND STANDARDS

a) AWWA C-203-97 : AWWA standard for coal tar protective coatings linings for steel water pipe lines-Enamel and Tape-Hot applied.

b) SSPC-SPI & SP 10 : Steel structure painting council (SP-I solvent cleaning and SP-10 near white blast cleaning).

c) NACE RP-02-74 : Recommended Practice,, High Voltage Electrical Inspection of pipeline coating prior to installation.

e) IS 10221 : Code of practice for coating and wrapping of underground mild steel pipelines.

3.00.00 SOURCING OF COATING MATERIAL & AGENCY

The Coating material and agency for application of Coating shall meet the requirements stipulated under **"Proveness of Major Equipments"** in Subsection-II of Part-A of Section VI, Technical Specifications. (if applicable)

4.00.00 COATING SYSTEM & THICKNESS

4.01.00 The Coating System & thickness shall conform to the requirements specified in clause 4.02.00 (a) or 4.02.00 (b) below.

4.02.00(a) The wrapping & coating system shall consist of applying pre-wrapping solution on the cleaned surface, followed by the application of anti-corrosion protection tape spirally or circumferentially on the surface keeping proper tension and maintaining good adhesion with an overlap of 12-13mm. The minimum thickness of coating shall be 4.0 (Four) mm.

4.02.00 (b) The wrapping & coating system shall consist of applying the primer, a coat of coal tar enamel having a minimum thickness of 2.4 mm and one wrap of glass fibre mat followed by a coal tar enamel and wrap of glass fibre mat followed immediately by

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	an outer wrap of coal-tar impregnated glass fibre felt. The minimum thickness of coating (without the outer wrap) shall be 4.0 mm.
5.00.00	**TECHNICAL REQUIREMENTS**
5.01.00 (a)	**General (Applicable for Coating system as per 4.02.00 (a))** a) The coating and wrapping operation shall include surface preparations, application of pre-wrapping solution (primer) and application of layer of anti-corrosion protection tape. The above operation shall be performed under the supervision of and performed by personnel skilled in the application of same type of pre-fabricated tapes. b) Inspection of the coating and wrapping of the pipes shall be performed by qualified inspectors.
5.01.00 (b)	**General (Applicable for Coating system as per 4.02.00 (b))** a) The coating and wrapping operation shall include surface preparations, application of primer, heating and applying the coaltar coating and wrapping of glass fibre mat and white wash over external surface of finished coating. The above operation shall be performed under the supervision of and performed by personnel skilled in the application of coaltar enamel coating and wrapping. b) Inspection of the coating and wrapping of the pipes shall be performed by qualified inspectors.
5.02.00	**Surface Preparation** a) Before the pipe is blasted, all oil, grease or other contaminants shall be removed by flushing with a suitable solvent (in accordance with SSPC-SP-I) and wiping with clean rags. The use of dirty or oily rags or dirty solvent will not be permitted. b) Prior to cleaning operation, the pipes shall be visually examined to ensure that all defects, flats and other parts damaged have been repaired or removed. c) The abrasive blast material shall be free of impurities such as clay, dirt, debris, oil, grease, salts or other contamination. d) All metal surfaces shall be cleaned by blasting. Blasting operations shall remove all rust scale and other impurities from the steel surface. The surface shall be

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	blast cleaned to near white metal finish as per SSPC SP10. Shot blast operation, if adopted shall be done using automatic abrasive blasting equipment. e) Pipes shall be visually inspected immediately after every blast cleaning operation for surface defects such as slivers, laminations, leafing, scores, indentation, slugs or any other defects considered injurious to the coating. Such defects shall be reported to OWNER and on permission from OWNER; such defects shall be removed by filling or grinding in such a way as not to "blue" the steel. f) The cleaned and blasted pipe shall be protected from and shall be maintained free of oil, grease and dirt that might fall on the pipe.
5.03.00	**PRIMER** a) The primer shall be cold applied immediately after the pipes have been blasted and cleaned. b) Prior to application of the primer, the drum or the container of the solution is to be shaken well before being used. c) Application of the primer shall be by hand brushing, spraying or other suitable means and shall be in accordance with the instruction for application. It shall be applied at a rate recommended by the MANUFACTURER, in a uniformly thick film free from runs, drips, bubbles, sags, dust, grease or foreign matter. Primer shall completely cover the circumference of the pipe and all surfaces which are to be coated. Any excess of primer shall be brushed out immediately before the primer sets. The priming coat shall not be applied when the pipe is wet or moist. d) During periods of cold weather, when the temperature of the steel is below 7°C or at any time when moisture collects on the steel, the steel shall be warmed to temperature of approx.30-38°C, which shall be maintained long enough to dry the pipe surface prior to priming. e) All missed spots or areas covered with insufficient primer shall be touched up immediately by hand brushing. Primer which has been applied too heavily such as the base of the welds shall be brushed out before the primer sets. f) During the application of the priming coat, the primer of the container shall be stirred regularly.

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g) During or after drying of the primer coat, the pipe shall be handled with care. All reasonable precautions shall be taken to prevent excessive dust deposition on primer pipe.

h) The freshly primed pipe shall be permitted to dry on racks until it is no longer wet, sticky or tacky. The dryness of the primer shall be checked at the bottom of the plate.

i) Pipes on which the primer after being applied becomes contaminated by dust before it is dry or which becomes dead shall be reprimed, or shall be re-cleaned and re-primed. In no case shall third application of primer be made without having removed all the previous coats. The cost of re-cleaning and re-priming shall be borne by the bidder.

5.04.00 Requirement of Pre-Fabricated Tape

5.04.01 Pre-fabricated tape shall conform to the following specification.

Compound	:	Plasticised coal tar base
Reinforcement	:	Synthetic substrate (FRP tissue reinforced with glass fibres).
Separator	:	Plastic
Thickness	:	Minimum 4.0 mm without any tolerance (in one or multiple layers)
Min. Weight	:	1.25 kg/sq.m/mm thickness.
Adhesion Test	:	It should pass as per AWWA-C-203-97 Section-4.6.8 or IS-10221-1982.
Holiday Test Voltage	:	It should pass @ 15 kV (Max.) for 4mm thickness.
Direct Impact Test	:	It should pass as per BIS.DOC.SMDC 29 (3624) and AWWA-C-203 and IS-10221.

Insoluble content in Petrol

as per (%by weight) IS-2796:1996 : 95% minimum

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5.04.02	**Application of Pre-fabricated tape.** a) The tape shall be hot applied. b) The pipe line shall be thoroughly cleaned of all oil and grease by flushing with a suitable solvent such as gasoline or xylene (Kerosine will not be permitted)and wiping with clean rags. The solvent cleaning shall be as per SSPC-SP-1. c) The degreased pipe surface shall be blast cleaned to SSPC-SP-10 with a steel brush to remove rust, oil, grease and old coating, if any, etc. The degree of cleanliness to be achieved shall be same as required in the case of conventional coat and wrap system. d) Then the primer (pre-wrapping solution) shall be applied on the cleaned surface of the pipe with a brush in such a manner that it covers the pipe surface well. e) When the primed pipe surface gets tacky but not DRY, the tape shall be applied spirally on the surface keeping proper tension and maintaining good adhesion with an overlap of 12/13 mm. f) The inside layer of the tape shall be applied on the pipe, while the other surface of the tape (i.e. the substrate side having plastic separator) shall remain outside and face the surrounding atmosphere. g) The tape while being unrolled shall be warmed up by a blow lamp or a gas flame - the surface to be applied on the pipe being heated. The heating shall be done just to soften the compound when a film shall appear on surface - Excessive heating is to be avoided. h) Sufficient time (at least 48 hours) is to be allowed before undertaking adhesion test.
5.05.00	**Requirements of Coal Tar Enamel**
5.05.01	Preparation I) The coal tar enamel, prior to being cut, shall have its surface freed from all contamination of whatever nature and shall be cut into pieces. ii) Enamel shall be delivered to the heating kettles entirely free of all contaminants including, pieces of metal, wood, grass, leaves, sand or gravel.
5.05.02	Heating

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	i) The coal tar enamel shall be heated in the kettles provided in sufficient number to maintain a continuous supply of hot enamel. Kettles shall be of the mechanically agitated type. ii) The kettles or patch pots shall be equipped with fuel oil, kerosene or gas burners. iii) Kettles or patch pots from which enamel is drawn into the coating machine shall be introduction of, and inclusion, of other undesirable matter which will affect the application or the property of the coating. These strainers shall be located where they can be easily cleaned. iv) Each kettle shall be equipped with an accurate easily readable thermometer. v) While heating, flames from the burners shall be kept low until the enamel on the bottom of the kettle has melted and then agitators shall be started. The flames shall be increased gradually until about one half of the charge has been melted. Full heat shall then be applied until the optimum application temperature has been reached as per instructions of the MANUFACTURER of the enamel. The burners shall than be adjusted to maintain the optimum application temperature of enamel. vi) Enamel in patch-pots shall be heated with the same care as described above. vii) All enamel conveying lines shall be insulated or heated if required using suitable means to maintain the application temperature of coal tar enamel. viii) The maximum temperature to which the enamel can be heated and the maximum time the enamel may be held in the kettles at application temperature shall be in accordance with the enamel manufacturer's recommendations. ix) Coal tar enamel preparation and supply shall be as per AWWA-C-203-97.
5.05.03	Interruption i) In the event of an interruption or short shut-down due to weather conditions or other unavoidable causes, the burner flames shall be decreased immediately. The temperature of the charge shall be reduced to approximately 40 degree C less than the application temperature until operation starts-up again. The kettle lids shall be kept tightly closed during

the shut-down period and the mechanical agitators kept in continuous operation. The enamel shall be drained into suitable clean containers.

ii) Care shall be exercised to ensure that the enamel in the mechanically agitated kettles is brought back to the optimum temperature before application is resumed. Enamel which has been previously heated to application temperature then drawn from the kettle or patch-pot may be reheated provided it has been kept clean.

5.05.04 Coating Of Straight Sections of Pipes (Coaltar Enamel, Inner Wraps and Outer wrap)

i) Enamel shall be applied by pouring on the revolving pipe and spreading to the specified thickness. Enamel shall be applied so that each spiral resulting from the spreading operation shall overlap the preceding spiral producing a continuous unbroken layer free from defects, skips or holidays. Operators shall be required to make all necessary adjustments to ensure a continuous layer of enamel without undue loss of temperature at point of application.

ii) Defects such as bubbling or foaming shall be a cause for shutting down operations until air pockets have been removed from pumps and supply lines and required adjustment have been completed.

iii) The first coat of coal tar enamel, glass-fibre mat shall be applied in a continuous end-feed machine, or in a lathe-type machine or by other suitable wrap-application equipment. The roll of glass-fibre mat shall be under tension sufficient to embed the mat in the enamel before the later sets or cools. The second coat of hot coal-tar enamel shall then be applied simultaneously with the second layer of glass-fibre mat in manner similar to the one described above. The impregnated outer wrap shall then be applied immediately behind the glass fibre reinforcement in a tight uniform spiral.

iv) The overlap at the edges of all wrappings shall be atleast 13 mm. The wrapper shall be applied neatly and smoothly with bleed out between laps and shall be free of wrinkler and buckles.

v) The coating shall be continuous for the full length of the pipe, however cut-back of maximum length of 225 ± 25 mm on each end of the line pipe shall be provided.

vi) When the protrusion of weld seam interferes with this thickness, the thickness of the coating above weld seam shall meet the requirements specified in AWWA-C-203-91.

5.05.05 Coating & Wrapping of Field Joints, Bends & Fittings

I) In general the procedure to be followed for surface preparation, priming and Coating & Wrapping shall be the same as that specified for straight sections of the pipe except that the application of the coal tar enamel & inner & outer wraps may be manual. However the total thickness of coating & wrapping of the field joints, bends& fittings shall not be less than that of the straight section of the pipe.

ii) At all the field erected joints, the overlap between the two pipe pieces or bends shall not be less than 50 mm.

5.05.06 White Wash

The final white wash coat over the outer wrap shall be applied immediately following final inspection and acceptance of the coating and wrapping on each pipe.

5.05.07 Materials

a) *Primer*

The primer shall be fast drying synthetic primer for cold application certified to meet AWWA-C-203.

b) Coal Tar Enamel

The coal tar enamel shall compose of a specially processed coal tar pitch combined with inert mineral filler. The coal tar enamel shall conform to AWWA-C-203. The enamel shall contain no asphalt of either petroleum or natural base.

c) Inner Wraps

The inner wrap glass fibre reinforcement material shall have a nominal thickness of 0.5 mm (0.020 inch) and shall conform to AWWA C-203. The glass fibre reinforcement material shall be reinforced in the longitudinal direction.

d) Outer Wrap

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The outer wrap material shall be a coal tar impregnated asbestos felt or glass fibre felt. The material shall conform to the requirements of AWWAC-203-91 Section-2.4.

Samples of the proposed fibre glass reinforcement and impregnated outer wrap along with test certificates as per AWWA C-203 shall be submitted to the OWNER for approval prior to the start of the coating operations.

e) The white wash used as a final coat shall be manufactured in accordance with the "White Wash Formula" as specified in AWWA C-203, Section 2.6.

5.06.00 Inspection

In addition to the requirements specified in Sub-section III-E of Part-B of this Technical Specification, following shall also apply.

5.06.01 General

a) The Owner representative shall test the coating and any repair subsequently made to it. The testing shall be carried out at prior to laying of pipes in the trench.

b) Final acceptance of all coating and wrapping work shall be determined by Owner's representative Pipes which have been cleaned and primed or coated and wrapped without having been inspected and approved by the Owner's inspector shall be rejected.

5.06.02 Holiday Detection

a) All coated and wrapped pipes shall be subjected to a test with an electric holiday detector as specified in AWWA-C-203-97.

b) The holiday detector shall be supplied, correctly operated and always maintained in good working condition along with adequate supply of spare parts. Any delay caused by the incorrect functioning of the holiday detector will not be entertained.

c) The operating voltage of the detector shall be determined by NACE RP-02-74.

d) Any pipe having three (3) or more holidays shall be rejected. Similarly any pipe having any one holiday bigger than 0.1 square metres shall be rejected. Any defective places shall be plainly marked with chalk immediately after they are detected visually or by the holiday detector.