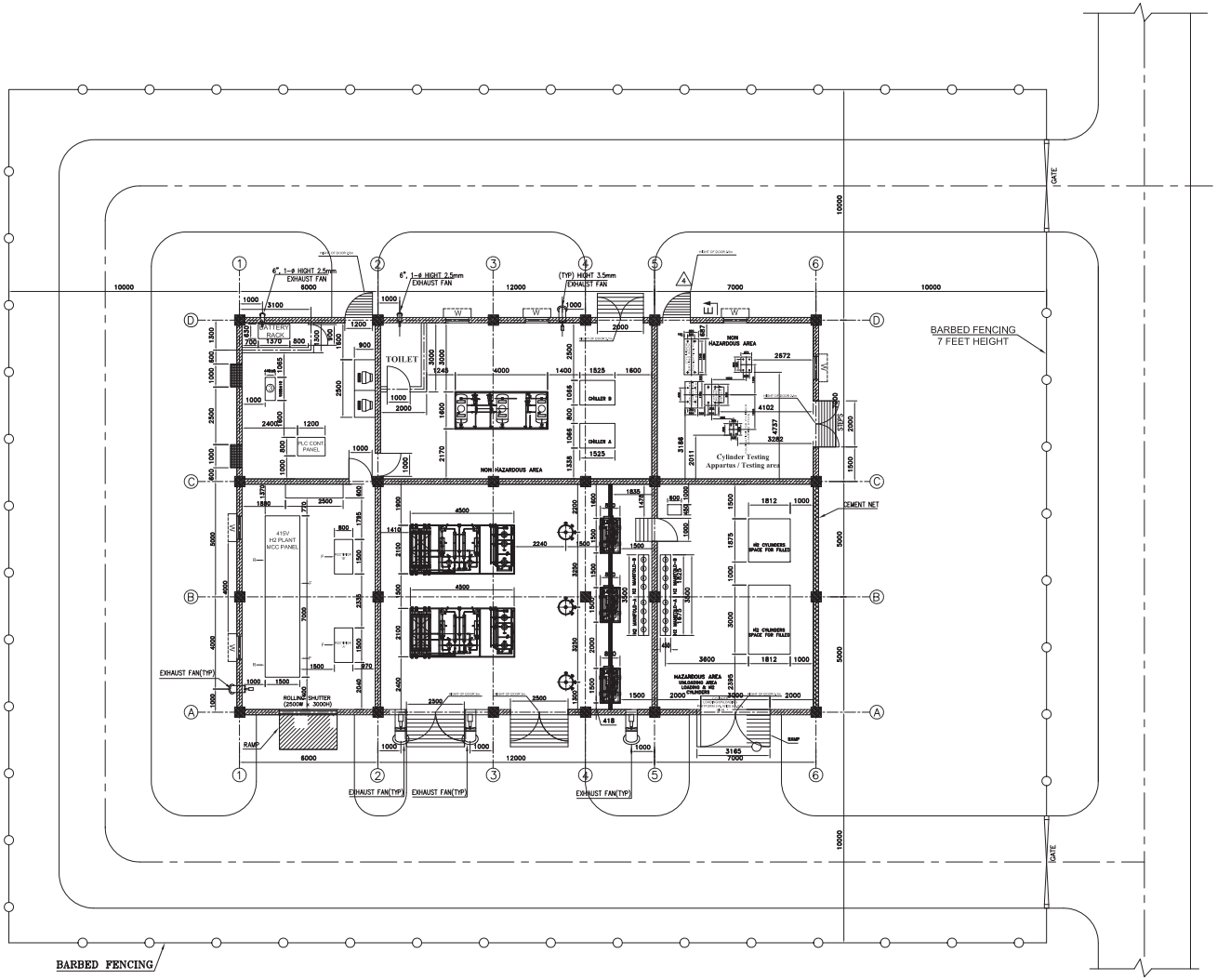


NOTE:–EQUIPMENT LAYOUT FOR HYDROGEN GENERATION PLANT BIPOLAR TYPE

CUSTOMER:
BHARTIYA RAIL BIJLEE COMPANY LIMITED

CONSULTANT:
NATIONAL THERMAL POWER CORPORATION

PROJECT:
4X250 MW,NABINAGAR TPP

BHARAT HEAVY ELECTRICALS LIMITED
PROJECTS ENGINEERING MANAGEMENT,NOIDA

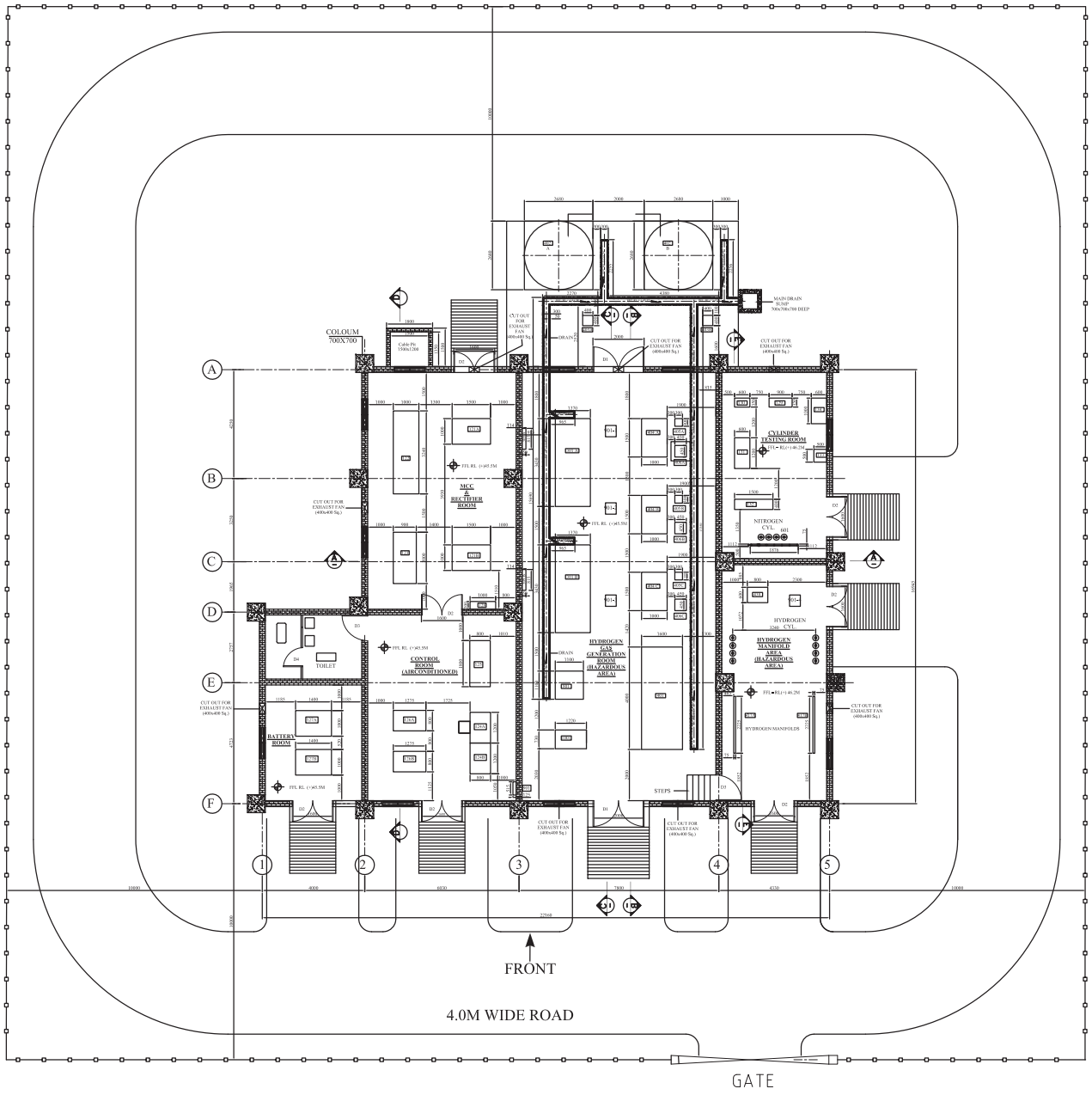
DEPT.	CODE		SCALE	WEIGHT(KG)	REF DRG.	ITEM
--	A		1:1	–	–	–

CONTRACTOR:

	NAME	SIGN	DATE
PREP			
CHKD		Sd	
APPD			

TITLE:– EQUIPMENT LAYOUT FOR H2 GENERATION PLANT

DEPT.	CARD CODE	DRAWING NO.	REV
SIGN	–		0
DATE		NO. OF SHEETS: –	



NOTE:–EQUIPMENT LAYOUT FOR HYDROGEN GENERATION PLANT UNIPOLAR TYPE

CUSTOMER:
BHARTIYA RAIL BIJLEE COMPANY LIMITED

CONSULTANT:
NATIONAL THERMAL POWER CORPORATION

PROJECT:
4X250 MW,NABINAGAR TPP

BHARAT HEAVY ELECTRICALS LIMITED
PROJECTS ENGINEERING MANAGEMENT,NOIDA

DEPT.	CODE	SCALE	WEIGHT(KG)	REF DRG.	ITEM
--	A	1:1	–	–	–

CONTRACTOR:

	NAME	SIGN	DATE
PREP			
CHKD		Sd	
APPD			

TITLE:– EQUIPMENT LAYOUT FOR H2 GENERATION PLANT

DEPT.	CARD CODE	DRAWING NO.	REV
SIGN	–		0
DATE		NO. OF SHEETS:–	

SECTION – C2

SPECIFIC TECHNICAL REQUIREMENT (ELECTRICAL)

PROJECT : NABINAGAR TPS (X250 MW)

SPECIFIC ELECTRICAL REQUIREMENT

SL.NO.	MOTOR	UNIT	TECHNICAL PARAMETERS
1	DESIGN AMBIENT TEMP	DEG. C	50
2	VOLTAGE SUPPLY AND VARIATION	VOLT	415±10%
3	FREQUENCY WITH VARIATION	Hz	50+ 3% & - 5%
4	COMBINED VOLTAGE & FREQUENCY VARIATION		+/-10%
5	MAX ACCEPTABLE RATING OF MOTOR AT 415 V	KW	200
6	SYSTEM FAULT LEVEL AND ITS DUARTION	KA	45kA, 1sec
7	SUITABILITY OF TERMINAL BOX FOR FAULT LEVEL AND DURATION		45 KA, 0.25 SEC
8	CLASS OF INSULATION & TEMP RISE LIMITED TO		Class B or Better
9	MIN. STARTING VOLTAGE		85%
10	MOTOR RATING FOR SINGLE PHASE SUPPLY		200W & Below
11	MAXIMUM LOCKED ROTOR CURRENT (EXCLUDING IS TOLERANCE)	% OF FLC	600%
12	ACCEPTABLE NOISE LEVEL	DB	85dB at 1.5m
13	TYPE OF STARTER PROVIDED IN MCC		DOL
14	DOP OF ENCLOSURE		IP-54 for Indoor & IPW-55 for outdoor
15	SPACE HEATER REQUIREMENT	<30kW	Above 30kW
16	PAINT SHADE		RAL 5012 (Blue)

ELECTRICAL SCOPE BETWEEN BHEL AND VENDOR (R0) ANNEXURE-4

PROJECT: NABINAGAR TPS (4X250 MW) **PACKAGE: HYDROGEN GENERATION PLANT**

S.NO	DETAILS	SCOPE SUPPLY	SCOPE E&C	REMARKS
1	415V MCC	Vendor	Vendor	BHEL/NTPC will provide two numbers 415V AC supply feeders of required rating. Any other Voltage level (AC/DC) required will be derived by the vendor.
2	Local push button station (for motors)	Vendor	Vendor	Located near the motor. Any other type of PB required shall be indicated by the bidder.
3	Power cables, ordinary control cables and screened control cables between equipments supplied by vendor.	Vendor	Vendor	REFER DETAILED SECTION D-2
4.	Power cables, ordinary control cables and screened control cables between equipments supplied by vendor & BHEL/NTPC.	Vendor	Vendor	
5	Any special type of cable like compensating. Co-axial, prefab, MICC and fibre optical	Vendor	Vendor	
6	Complete Illumination System	Vendor	Vendor	
7	Cabling material [cable trays, accessories and cable tray-supporting system (Bolted type), conduits, Marshalling Boxes/Junction Boxes) for cabling as require for the plant.	Vendor	Vendor	
8	Equipment earthing including earthing material & Lightning Protection system including Lightning Protection Material	Vendor	Vendor	
9	Motors with Base plate and foundation hardware for motors.	Vendor	Vendor	1. Makes shall be subject to customer/BHEL approval at contract stage.
10	Cable glands and lugs for equipment supplied by vendor	Vendor	Vendor	1. Double compression Ni-Cr plated brass glands. 2. Solder less crimping type heavy-duty tinned copper lugs for power cables. 3. Heavy duty tinned copper lugs for control cables.
11	a) Input cable schedules b) Cable interconnection details. c) Cable block diagram	Vendor Vendor Vendor	Vendor Vendor Vendor	
12	Equipment layout drawings.	Vendor	-	Layout details between vendor supplied equipment and installation drawings by vendor
13	Electrical equipment GA drawing	Vendor	-	
14	**Mandatory spares for electrical portion**	Vendor		List attached (ANNEXURE-B)

LOAD TITLE	RATING (KW / A)		UNIT (U)/STN (S)	Nos.		VOLTAGE CODE*	FEEDER CODE**	EMER. LOAD (Y)	CONT.(C)/ INTT.(I)	STARTING TIME >5 SEC (Y)	LOCATION	BOARD NO.	CABLE		BLOCK CABLE DRG. No.	CONTROL CODE	REMARKS	LOAD No.
	NAME PLATE	MAX. CONT. DEMAND (MCR)		RUNNING	STANDBY								SIZE CODE	NOs				
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

ANNEXURE - 5

NOTES: 1. COLUMN 1 TO 12 & 18 SHALL BE FILLED BY THE REQUISITIONER (ORIGINATING AGENCY); REMAINING COLUMNS ARE TO BE FILLED UP BY PEM (ELECTRICAL)

2. ABBREVIATIONS : * VOLTAGE CODE (7):- (ac) A=11 KV, B=6.6 KV, C=3.3 KV, D=415 V, E=240 V (1 PH), F=110 V (cc): G=220 V, H=110 V, J=48 V, K=+24V, L=-24 V

: ** FEEDER CODE (8):- U=UNIDIRECTIONAL STARTER, B=BI-DIRECTIONAL STARTER, S=SUPPLY FEEDER, D=SUPPLY FEEDER (CONTACTER CONTROLLED)

LOAD DATA (ELECTRICAL)	JOB NO.	300	ORIGINATING AGENCY		PEM (ELECTRICAL)
	PROJECT TITLE	4X250 MW, NABINAGAR THERMAL POWER PLANT	NAME		DATA FILLED UP ON
	SYSTEM / S	HYDROGEN GEN. PLANT	SIGN.		DATA ENTERED ON
	DEPTT. / SECTION	MAX - WC	SHEET 1 OF 1	REV. 00	DE'S SIGN. & DATE

SECTION – D1

DESIGN REQUIREMENTS MECHANICAL

NOTE: - Some of the design requirement specified in section D1 may not be applicable to the bidder design. These requirements shall be accepted as per manufacturer standard practice.

TECHNICAL WRITE-UP FOR HYDROGEN GENERATION PLANT

CLAUSE NO.	TECHNICAL REQUIREMENTS
	HYDROGEN GENERATION PLANT
1.00.00	**GENERAL PLANT DESIGN CRITERIA**
	a.) To be designed for continuous, as well for as two shift or one shift operation.
	b.) The scheme shall be based on manufacturer's standard. Hydrogen generation plant offered can either be of unipolar design or bipolar design as per manufacturers standard practice.
	c) Total Plant Capacity to be sized as follows: Leakage rate per generator = "A" NM^3/day Requirement of one generator filling = "B" NM^3. Number of Units = C Hydrogen generation plant Capacity = [C*1.5* A + B/30]/12 NM^3/hr
	d) The Plant capacity would be based on the Criteria detailed out above. However, total plant capacity in no case shall not be less than 9 NM3/hr with two streams of 50% Capacity each of minimum 45 NM3/hr.
	e) Hydrogen purity to be maintained at gas manifolds 99.9%
	f) Moisture content in hydrogen: - 0.05 gm/m^3 (max.)
	g) The Complete Hydrogen generation plant system, equipments, layout etc. shall be designed as per the Explosives Authority and the bidder shall obtain the approval from Chief controller of Explosives - India and other statutory authorities for the design and installation of the plant.
	h) Description of various components of Hydrogen generation plant has been discussed below. Some of the components specified here in may not be applicable for bipolar design. For bipolar design, the same need not be supplied, if it is not applicable as per manufacturers standard practice.
2.00.00	**GENERAL OPERATIONAL CRITERIA/PHILOSOPHY**
	a.) To be designed for Continuous duty.
	b.) To be designed for parallel operation of both streams.
	c.) Flexibility to operate electrolyser in part load.
	d.) Complete operation from remote control panel/OWS.
	e.) To trip the plant in case of high hydrogen level inside the building suitable numbers of hydrogen gas detectors to be provided by the bidder for each of the room.
	f.) Set pressure to be maintained with help of back pressure regulation valve.

CLAUSE NO.	TECHNICAL REQUIREMENTS
	g.) Automatic operation of standby compressor as and when required. h.) To provide alarm & tripping of compressor based on suction conditions.
3.00.00	**CONSTRUCTION DETAILS OF EQUIPMENT**
3.01.00	**Electrolyser / Generator (as applicable)** a.) Cells in electrolyser/ generator shall be connected to each other. Further for Unipolar design, there shall be provision to isolate any one of them Cells in electrolyser . The Cells in electrolyser / generator shall be of corrosion resistant material. b.) The electrolyser/ generator to be designed to operate at part load of normal capacity without any disconnection and operation interruption and shall produce the hydrogen gas of specified purity and dryness. c.) All measuring instruments, controllers and control valves shall be provided. d.) Safety devices are to be provided on each collecting pipe to release gas pressure in case it goes above the limits. e.) To be designed so that it can be dismantled, cleaned, and reassembled easily. f.) Proper sealing shall be provided by the Bidder while crossing the wall to avoid any gas leakage to Rectifier Room. g.) Each electrolyser/ generator shall be fitted with the following instrumentation. (1.) In unipolar design one explosion proof temperature switch in each cell for electrolyser temperature high alarm on the control panel. In case of bipolar design one explosion proof temperature switch in each generator module for electrolyser temperature high alarm on the control panel. (2.) A local pneumatic temperature controller, controlled through PLC, to maintain the electrolyser temperature to a preset value by controlling cooling water flow to the electrolyser through the temperature control valve. (3.) One temperature gauge for local indication for electrolyte temperature. (4.) One off-line specific gravity measuring instrument.
3.02.00	**Rectifier (if applicable)** Two nos. of rectifier (one for each electrolyser) to cater to the load of each of the electrolyse. The rectifier equipment shall be complete in all respects with air-cooled

CLAUSE NO.	TECHNICAL REQUIREMENTS
	rectifier transformer, thyristor converter, electronic control and annunciation, fillers choke etc mounted in suitable panels.
3.03.00	**Gas washing Tanks (if applicable)** One for each electrolyser with manometers at inlet and outlet, temperature gauge, level switches for controlling the level of DM water in the tank etc.
3.04.00	**Demineralised water tank** a.) One number tank of Capacity adequate for 5 days normal requirement of hydrogen gas generation on continuous basis at rated capacity of 40 NM3/hr. b.) To be fitted with removable drain connections, level switches/ transmitter, level indicators etc.
3.05.00	**Caustic solution mixing tank (if applicable)** (i) Capacity - Suitable to fill one electrolyser (ii) Material - High Density PVC (iii) Accessories - Removable cover, motor operated pump, instrument as required (iv) Pump (if applicable) - Suitable to pump alkali upto the cells with discharge flexible hose, differential pressure gauge across suction filter, pressure gauge at pump discharge etc.
3.06.00	**Hydrogen gas Holders (for unipolar design)** (i) Number — Two (2) numbers (one for filling, one for supply to compressor) (ii) Capacity of each gas holder — Minimum of 10 M^3. (iii) Material — IS-2062/2002 or equivalent (iv) To be designed for outdoor duty (v) To provided with two (2) Seal pots for each gas holders (vi) Accessories such as Wire rope, Counter weight, guide pulley required to suspend the gas holders, steel stairs four-way motorised valves, flame proof low & high level switches for interlock and control, float type level indicators, etc. vii) Venting of hydrogen shall be trough flame arrestor.

CLAUSE NO.	TECHNICAL REQUIREMENTS
3.07.00	**De-oxy unit (if applicable)** Numbers: 1 (To handle both the streams and capable to remove oxygen as impurity) Accessories: Heater with temperature control device, gas cooler, filter, necessary instruments etc.
3.08.00	**Hydrogen compressors and drives,** (i) Number: 3x50% as specified in the scope (two working & one standby) (ii) Capacity of each compressor: 125% of each stream (iii) Design delivery Pressure: 150 kg/cm^2 (g) (iv) Type: Preferably Oil free, Piston or Diaphragm type. (v) Piston type: Of proven design (vi) Diaphragm type: Triple diaphragm failure detection system. The side and oil side diaphragms shall be of stainless steel. (vii) Drive cage: Constant speed Sq. cage flame proof type Electric motor suitable for group-II-C location as per IS:2148 Clause-I Div.-I of NEC. (viii) Activated carbon filters: 2 x100% and required in case of oil lubricated compressor (ix) All metal to metal joints shall be provided with "O" rings of suitable grade material. (x) To provide auxiliaries such as built in relief valves, Pressure and temperature gauges after every compression stages, mechanical lubricator, built in automatic unloader devices, Water cooled inter coolers after every compression stage, flow switches, pressure gauges in coolant line, sight flow indicators in coolant line, V belt drive with pulleys, a transfer switch to allow operation of standby compressor automatically, suction filters, scrubber to remove any traces of entrapped electrolyte, separator and filters, suitable protection device to prevent suction of water from gas holders as a back-up to low level switch provided on the gas holders for compressor TRIP, Mist Eliminators One number on-line hydrogen purity analyser at the suction etc. (xi) To make arrangement for continuously monitoring hydrogen purity before compressor and before filling of gas into cylinders and to provide suitable alarm and automatic tripping of plant in case, hydrogen purity falls below the preset level.

CLAUSE NO.	TECHNICAL REQUIREMENTS
3.09.00	**Drying system for Hydrogen gas(if applicable)**
	a.) To provide twin tower moisture separating columns of Regenerative design alongwith instruments.
	b.) To provide valves arrangement to suit operation of one Column & another under regeneration. The operation shall be automatic based on PLC/ microprocessor command.
3.10.00	**Back Pressure regulating valve**
	a.) Spring loaded disc operated self actuating type back pressure regulating valve to maintain 150 kg/cm2 (g) pressure on the compressor discharge.
	b.) To be provided with accessories such as Pressure sensing element, controller etc.
3.11.00	**Cylinder Manifold**
	a.) To provide one dual cylinder filling manifold, arranged for two banks of minimum four cylinders each.
	b.) To provide accessories such as Isolating valves, safety valves, Pressure gauges, pressure switch (To shut-off compressors beyond set pressure) "ON-LINE" Hydrogen purity analyser, trace oxygen analyser, moisture analyser at cylinder manifold, records of hydrogen purity and moisture content, & one number PORTABLE hydrogen gas purity testing kit.
3.12.00	**Flushing System**
3.12.01	To be provided with necessary connection with proper isolation devices, nitrogen cylinders, valves, manifolds piping etc to enable purging the system with nitrogen commissioning and each maintenance work.
3.13.00	Hydrogen leak detection system:
3.13.01	Hydrogen leak detection and interlock system shall be provided in generator/ compressor rooms and hydrogen filling area for alarm and trip of Hydrogen generation plant.
3.14.00	Air Compressors (If required)
	In case bidder's Hydrogen generation plant requires compressed air, 2X100% capacity air compressors need to be provided by the bidder. If Instrument quality compressed air is required, in such case 2X100% capacity air drying plant also needs to be provided.
3.14.00	**Piping**
	a.) All Pipe to conform to ASA pressure piping code, and seam less type.

CLAUSE NO.	TECHNICAL REQUIREMENTS
	b.) All high pressure joints shall of ferrule/ welded construction. c.) All vents to be fitted with flame arrestor. d.) All high pressure drains to be terminated through H2 traps and all low pressure drains to be terminated through U-bends. e.) Cooling water pipe be minimum 80 NB size.
4.00.00	**VENTILATION SYSTEM**
	a.) It shall consist of adequate number of roof exhausters, wall mounted exhaust fans, ducting (if required), drives & other electrical accessories ducting supports and supporting system, rain protection cowl, bird screens, vibration isolators nuts & bolts, grouting frame, transition piece etc. as required to complete the system. b.) The air quantity of ventilation system shall be estimated based on minimum number of air changes shall be less than 30 air changes per hour. The exhaust air shall be discharged at a suitable height from the room. c.) Bidder to provide louvers for fresh air supply for the building. d.) Bifurcated type of axial flow fans for exhausting air/fumes shall be provided for hydrogen generation plant area and shall be of flame proof construction with inlet and outlet dampers. However, ducts and all other parts like blades etc. shall be epoxy painted.
5.00.00	**HYDROGEN AND ~~CO2~~ N_2 GAS CYLINDERS**
5.01.00	Adequate quantity of gas cylinders shall be supplied and installed as described in relevant [redacted] Sub-Sections of technical specification.
6.00.00	**Control and Instrumentation**
6.01.01	All necessary instruments such as transmitters/temperature elements / sensors / switches / gauges etc. shall be provided by the Contractor for safe, efficient & reliable operation and maintenance of the H2 generation plant. All instrument devices shall be provided with explosion proof enclosure as described in NEC (USA) Article 500, Class-I, Div.-I as specified in relevant Control and Instrumentation Sub-Section of Technical Specification. For further details refer to the requirements specified in control & instrumentation Sub-Section of Technical Specification. The control panel shall be microprocessor/ PLC based.
7.00.00	**PAINTING**
7.01.00	All the Piping, Valves and Equipments of this system shall be protected against external corrosion by providing suitable painting as described elsewhere in the specification.

CLAUSE NO.	TECHNICAL REQUIREMENTS

EQUIPMENT SIZING CRITERIA

1.01.00 All the piping systems and equipment supplied under this package shall be designed to operate without replacement and with normal maintenance for a plant service life of 30 years, and shall withstand the operating parameter fluctuations and cycling which can be normally expected during this period.

1.02.00 For all L.P. piping system covered under this specification, sizing and system design shall be to the requirements of relevant codes and standard indicated elsewhere. In addition to this, requirements of any statutory code as applicable shall also be taken into consideration.

1.03.00 Inside diameters of piping shall be calculated for the flow requirements of various systems. The velocities for calculating the inside diameters shall be limited to the following:

(a) **Water Application**

Water Velocity in m/sec Pipe Size		**Below 50 mm**	**50-150 mm**	**200 mm & above**
(a)	Pump suction	-----	1.2-1.5	1.2-1.8
(b)	Pump discharge and recirculation	1.2-1.8	1.8-2.4	2.1-2.5
(c)	Header	-----	1.5-2.4	2.1-2.4

Pipe line 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.

WILLIAM & HAZEN formula shall be used for calculating the friction loss in piping systems with the following "C" value:

(i)	Carbon steel pipe	100
(ii)	C.I Pipe/ Ductile Iron	100
(iii)	Rubberlined steel pipe	120
(iv)	Stainless steel pipe	100

For calculating the required pump head for pump selection , atleast 10% margin shall be taken over the pipe friction losses and static head shall be calculated from the minimum water level of the tank/ sump/ reservoir from which the pumps draw water.

CLAUSE NO.	TECHNICAL REQUIREMENTS
	(b) **Compressed Air Application** Compressed air 6.0 - m/sec.
1.04.00	The pipes shall be sized for the worst (i.e. maximum flow, temp. and pressure values) operating conditions.
1.05.00	Based on the inside dia. so established, thickness calculation shall be made as per ANSI B 31.1 OD and thickness of pipes shall than be selected as per ANSI B 36.10/IS-1239 Heavy grade/IS-3589/ASTM-A-53/API-5L/ANSI B 36.19 as the case may be.
1.06.00	Corrosion allowance of 1.6 mm will be added to the calculated thickness being considered.
1.07.00	Bend thinning allowance/manufacturing allowance etc. shall be as per the requirement of the design code provision.
1.08.00	All high points in piping system shall be provided with vents alongwith valves. All low points shall be provided with drains alongwith valves. Drain lines shall be adequately sized so as to clear condensate in the lines. Material for drain and vent lines shall be compatible with that of the parent pipe material.
1.09.00	Material of construction for pipes carrying various fluids shall be as specified elsewhere.
1.10.00	Compressed air pipe work shall be adequately drained to prevent internal moisture accumulation and moisture traps shall be provided at strategic locations in the piping systems.
1.11.00	Depending upon the size and system pressure, joints in compressed air pipe work shall be screwed or flanged. The flange shall be welded with the parent pipe at shop and shall be hot dip galvanized before despatch to site. Alternatively, the flanges on GI pipes may be screwed-on flanges also.
1.12.00	Threaded joints shall be provided with Teflon sealant tapes.
1.13.00	Following types of valves shall be used for the system/service indicated.

SYSTEM	TYPES OF VALVES					
	Butterfly	Gate	Globe	Check	Ball	Plug
Water	x	x	x	x	x	
Air / H_2		x	x	x	x	
Drains & vents		x	x	x		
Fuel oil (if any)		x	x	x	x	x

CLAUSE NO.	TECHNICAL REQUIREMENTS
1.14.00	Recirculation pipes alongwith valves, break-down orifices etc. shall be provided for important pumping systems as indicated in respective process and instrumentation diagrams (P&IDs). The recirculation pipe shall be sized for minimum 30%design flow of single pump operation or the recommended flow of the pump manufacturer whichever is higher.
2.00.00	**TECHNICAL SPECIFICATION**
2.01.00	**GENERAL** Specific technical requirements of low pressure piping, fittings, supports, valves, specialities and tanks etc. have been covered under this Sub-section. It includes details pertaining to design and material of construction for piping, fittings, valves, equipment, etc. cleaning/surface preparation application of primer and painting on overground piping. It also includes detailed technical requirement of laying underground/buried piping including water proofing/anti corrosive protection. It also covers design, engineering, manufacturing, fabrication, technical details of piping, valves, specialities, piping hangers / supports, tanks etc.
2.02.00	**Pipes and fittings**
2.02.01	All low pressure piping systems shall be capable of withstanding the maximum pressure in the corresponding lines at the relevant temperatures. However, the minimum thickness as specified in the following clauses and or respective codes for pipes and fittings shall be adhered to. The bidder shall furnish the pipe sizing/ thickness calculation as per the criteria mentioned above under LP piping equipment sizing criteria of this Technical Specification.
2.02.02	Piping and fittings coming under the purview of IBR shall be designed satisfying the requirements of IBR as a minimum.
2.02.03	Supporting arrangement of piping systems shall be properly designed for systems where hydraulic shocks and pressure surges may arise in the system during operation. Bidder should provide necessary protective arrangement like anchor blocks/anchor bolt etc. for the safeguard of the piping systems under above mentioned conditions. The requirement will be, however, worked out by the contractor and he will submit the detailed drawings for thrust/anchor block to the Employer. External, and internal, attachments to piping shall be designed so as not to cause flattening of pipes and excessive localised bending stresses.
2.02.04	Bends, loops, off sets, expansion or flexible joints shall be used as required in order to prevent overstressing the piping system and to provide adequate flexibility. Flexibility analysis (using software packages such as Caesar-II etc.) shall be carried out for sufficiently long piping (straight run more than 300M).
2.02.05	Wherever Bidder's piping coming under this specification, terminates at an equipments or terminal point not included in this specification, the reaction and the thermal movement imposed by bidder's piping on equipment terminal point shall be within limits to be approved by the Employer.

CLAUSE NO.	TECHNICAL REQUIREMENTS
2.02.06	The hot lines shall be supported with flexible connections to permit axial and lateral movements. Flexibility analysis shall be carried out for pipelines which have considerable straight run as indicated above and necessary loops/ expansion joint etc. shall be provided as may be necessary depending on layout.
2.02.07	Piping and fittings shall be manufactured by an approved manufacturer of repute. They should be truly cylindrical of clear internal diameter, of uniform thickness, smooth and strong, free from dents, cracks and holes and other defects.
2.02.08	For rubber lined ERW pipes, beads shall be removed.
2.02.09	Inspection holes shall be provided at suitable locations for pipes 800 Nb and above as required for periodic observations and inspection purposes.
2.02.10	At all intersection joints, it is Contractor's responsibility to design and provide suitable reinforcements as per the applicable codes and standards.
2.02.11	For large size pipes/ducts, at high point and bends/change of direction of flow, air release valves shall be provided. Sizing criteria for air release valves shall be generally on the basis of valve size to pipe diameter ratio of 1:8. Requirement shall be decided as per relevant code. Transient analysis /surge analysis where ever specified and required shall be conducted in order to determine the location , number and size of the Air-Release valve on certain long distance/high volume piping systems, if applicable within the scope of work of the package.
2.03.00	**Material**
2.03.01	Alternate materials offered by Bidder against those specified. shall either be equal to or superior to those specified, The responsibility for establishing equality or superiority of the alternate materials offered rests entirely with the Bidder and any standard code required for establishing the same shall be in English language.
2.03.02	No extra credit would be given to offers containing materials superior to those specified. Likewise no extra credit would be given to offers containing pipe thickness more than specified.
2.03.03	All materials shall be new and procured directly from the manufacturers. Materials procured from traders or stockists are not acceptable.
2.03.04	All materials shall be certified by proper material test certificates. All material test certificates shall carry proper heat number or other acceptable references to enable identification of the certificate that certifies the material.
2.03.05	Material of construction for pipes carrying various fluids shall be as follows:
	1 Raw water, ash water, circulating water, aux. cooling water, clarified water. service water, air pre-heater wash water, clarifier sludge and — IS-2062 Gr. B/ASTM A-36/ASTM A-53 type 'E' Gr.B / IS-3589 Gr. 410 /IS-1239 Heavy. For equipment cooling water system

CLAUSE NO.	TECHNICAL REQUIREMENTS		
		equipment cooling water including both primary & secondary circuit (DMCW, pH-corrected & ACW, drain water	wherever DM water is used or alkaline solution is used for pipes 50NB and below, pipe material shall be stainless steel to ASTM A312 Gr. 304 sch. 40 Seamless.
	2	Demineralised water, ~~(condenser make up water, Boiler fill and Deaerator Fill water, equipment cooling water piping from overhead tank to suction header of DMCW pumps and chemical dosing system to primary circuit of equipment~~	Stainless steel to ASTM A-312, Gr.304 welded for sizes above 50mm NB Stainless steel to ASTM A312, Gr. 304 sch. 40 Seamless for sizes 50mm and below cooling water (DMCW System), ECW overhead tank make-up water
	3	Drinking water	ASTM A-53 type E Gr. B galvanised/ IS 1239 heavy galvanised/IS 3589 Gr 410 galvanised to IS- 4736 or equivalent.
	4.	Instrument air & plant air, HYDROGEN	ASTM A-53 type E Gr. B galvanised/ IS 1239 heavy galvanised/IS 3589 Gr 410 galvanised to IS- 4736 or equivalent.
	6.	Oil piping	API 5L
2.03.06	In water lines, pipes upto 150mm Nb shall conform to ANSI B36.10/ASTM-A-53, Type-E Gr.B /IS:1239 Gr. Heavy and minimum selected thickness shall not be less than IS:1239 Grade Heavy except for demineralised water, drinking water and condensate spill lines.		
2.03.07	Pipes of above 150mm Nb shall be to AWWA-C200/ANSI B 36.10/ASTM A-53/IS 3589. Pipe to be fabricated by the bidder shall be rolled and butt welded from plates conforming to ASTM A-53 type 'E' Gr. B/IS 2062 Gr.B/ASTM-A-36. However, larger pipes, i.e. 1000mm Nb and above shall be made from plates conforming to ASTM A		

CLAUSE NO.	TECHNICAL REQUIREMENTS
	36/IS 2062 Gr.B and shall meet the requirements of AWWA-M-11 (for deflection & buckling criteria considering water filled pipe as well as vacuum condition that may prevail during transient/surge conditions, truck-load, rail-load and weight density for compacted soil or any other load as the case may be).
2.03.08	In demineralised water service, the pipes upto 50 Nb shall be of stainless steel ASTM A 312, Gr. 304 sch. 40 Seamless. The size for these pipe shall be to ANSI B 36.19. These shall be socket welded. The material for pipe from 65mm NB upto and including 400 NB shall be to ASTM A 312, Gr. 304 (welded). In no case the thickness of fittings shall be less than parent pipe thickness. Bidder/Contractor shall note that stainless steel pipe offered as per a particular code shall conform to that code in all respects i.e. Dimension, tolerances, manufacturing methods, material, heat treatment, testing requirements, etc. unless otherwise mentioned elsewhere in the specification.
2.03.09	Instrument air, Plant (service) air lines and Drinking water lines shall be to ASTM A 53 type E grade B/ANSI B 36. 10/IS 3589, Gr. 410 / IS:1239 Heavy (in case thickness calculated is more than gr. Heavy, ANSI B 36.10 Schedule numbers shall be followed) and galvanised to IS 4736 or any equivalent internationally reputed standard. The material of the pipes shall be to ASTM A 53 type 'E' Gr. B / IS:3589, Gr. 410 / IS:1239 Gr. Heavy. The fittings shall be of either same as parent material or malleable iron to IS-1879 (galvanised).
2.03.10	Spiral welded pipes as per API-5L/IS-3589 are also acceptable for pipe of size above 150 NB. However minimum thickness of the pipes shall be as elaborated in above clauses.
2.03.11	Condensate lines shall be to ASTM A 106 Gr. B and dimension to ANSI B 36.10 schedule "standard" as minimum to be maintained
2.04.00	**Piping layout**
2.04.01	Piping shall be grouped together where practicable and routed to present a neat appearance.
2.04.02	Piping routing shall be such as to provide sufficient clearance for removal and maintenance of equipment, easy access to valves, instruments and other accessories. The piping shall not encroach on the withdrawal space of various equipments.
2.04.03	Over head piping shall have a normal minimum vertical clearance of 2.5 meters above walkways and working areas and 8M above roadways/railways. When several pipe lines are laid parallel, flanged joints must be staggered. Welded and flanged joints should as far as possible be located at one third span from supports. If the support is situated right under the welded joints this joint must be reinforced with a strap. Flanged and welded joints must be avoided in the middle of the span. Valves should be located in such a manner so as to ensure their convenient operation from the floor or the nearest platform.

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2.04.04	Pipe lines of NB 50 size and below are regarded as field run piping. It is Bidder's responsibility to plan suitable layouts for these system insitu. Bidder shall prepare drawings indicating the layout of field run pipe work. These drawings shall be approved by Project Manager to the installation of the field run pipe work. Based on these approved layouts the Bidder shall prepare the BOQ of field run-pipes and submit to Employer for approval.
2.04.05	All piping shall be routed so as to avoid interference with other pipes and their hangers and supports, electrical cable trays, ventilation ducting, structural members, equipment etc. Adequate clearance shall be ensured with respect to the above to accommodate insulation and pipe movements, if any.
2.04.06	Piping shall generally be routed above ground but where specifically indicated/approved by the Project Manager the pipes may be arranged in trenches or buried. Pipes at working temperature above the ambient shall however not be buried.
2.04.07	Sufficient up stream and down stream lengths shall be provided for flow measuring devices, control valves and other specialities.
2.04.08	All local instruments shall be located on pipe lines as to render them observable from the nearest available platforms.
2.04.09	Openings provided in the wall for pipelines must be closed with bricks and mortar with 10-12 mm clearance between brick work and pipe after taking care of insulation and thermal movement, if any. The clear space must be filled with felt or asbestos or approved filling compound.
2.05.00	**Slope/Drains and Vents**
2.05.01	Suitable slope shall be provided for all pipelines towards drain points. It is Bidder responsibility to identify the requirements of drains and vents, and supply the necessary pipe work, valves, fittings, hangers and supports etc. In addition to the system requirement all low points in the pipelines shall be provided with suitable draining arrangement and all high points shall be provided with vent connections where air or gas pockets may occur. Vent for use during hydrostatic test shall be plugged after the completion of the test. Vent shall not be less than 15mm size. Drains shall be provided at low points and at pockets in piping such that complete drainage of all systems is possible. Drain shall not be less than 15mm for line size upto 150mm, not less than 20mm upto 300mm and not less than 25mm for 350mm to 600mm pipes and not less than 50mm for 600mm and above pipes.
2.05.02	Air piping shall be sloped so that any part of the system can be drained through the shut-off drain valve or drain plugs.
2.06.00	**Pipe Joints** In general all water lines 65mm nb and above, are to be joined generally by butt welding except the locations where valves/fittings are to be installed with flanged connections and 50mm and below by socket welding unless mentioned otherwise

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	specifically. All air lines shall be of screwed connection and rubber lined pipes of flanged connections.
2.06.01	**Screwed**
	(a) Threading of pipes shall be carried out after bending, heat treatment etc. If not possible, threading may be done prior to these operations but proper care should be taken to protect them from damage. Threads shall be to ANSI B 2.1 (taper) NPT/IS:554 unless specified otherwise.
	(b) Galvanised pipe shall generally be joined by screwing into sockets. The exposed threaded portion on the outside of the pipes shall be given a zinc silicate coating. Galvanised pipes shall not be joined by welding. Screwed ends of GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead before jointing. For galvanized pipe sizes above 150 mm NB, screw & socket jointing as per ASTM-A-865 shall be employed for both pipe-to-pipe and pipe-to-fitting jointing. For pipe to fitting connection since no direct threading can be done on the fittings (supplied as per ASTM-A-234 Gr. WPB and ANSI B-16.9) necessary straight pipe lengths acting as match pieces shall be welded to the fitting at both ends and subsequently the free ends of the straight lengths shall be threaded as per ASTM A-865 for jointing with main pipe. Once welding of fittings with match pieces and threading of free ends of match pieces are over, the entire fabricated piece shall be galvanised, or in case match pipes and fittings are already galvanised before the above mentioned fabrication then suitable application of Zinc-Silicate paste adequately at the welded surface (both in side & out side) after welding with zinc rich electrode, alongwith the nascent threaded metal portions at both free ends given the same application of Zinc Silicate paste. Alternatively flanged jointing may be employed for pipe sizes 150 NB and above. However, the bidder shall ensure the galvanized pipe joints do not fail during hydrotest.
	(c) Teflon tapes shall be used to seal out screwed joints and shall be applied to the male threads only. Threaded parts shall be wiped clean of oil or grease with appropriate solvent if necessary and allowing proper time for drying before applying the sealant. Pipe ends shall be reamed and all chips shall be removed. Screwed flanges shall be attached by screwing the pipe through the flange and the pipe and flange shall be refaced accurately.
	(d) For pipe sizes from 350 mm NB to 550 mm nb (including 350 NB & 550 NB) the GI pipes shall be of flanged connection. However, the pipes after welding of flanges shall be completely galvanised. Any site welding done on galvanised pipes shall be done with zinc-rich special electrodes and the welded surfaces whether inside or outside shall be coated with zinc-silicate paste. Seal welding of flanges with zinc-rich electrode will be permitted only when any flange is leak-prone during hydrotesting.
	(e) For pipe sizes 600 mm NB and above, the GI pipes shall be of welded connection (with zinc-rich special electrodes) followed by application of zinc silicate coating at welded surfaces both inside and outside the pipe, except for the last blank/blind flange, or, equipment connection where application of

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	zinc-silicate paste after welding cannot be done due to inaccessibility of the inside welded surface and where galvanic protection has been impaired due to welding of pipe-to-pipe joint. Thus the last erection joint shall be flanged joint.
2.06.02	**Welded** (a) For making up welded joints (butt weld or socket weld) the welding shall be performed by manual shielded metal arc process in accordance with the requirements specified elsewhere in the spec. Any welder employed for carrying butt welding shall be qualified as per ASME section IX for the type of joints he is going to weld. Jointing by butt weld, or socket weld shall depend upon the respective piping material specifications.
2.06.03	**Flanged** (a) Flanged connections for pipes are to be kept to the minimum and used only for connections to vessel, equipments, flanged valves and other fittings like strainer/traps/orifices etc. for ease of connection and maintenance etc. Rubber lined pipes shall be flange joined only. (b) All flanged valves intended for installation on steel piping system, shall have their flanges drilled to ANSI B 16.5 (or equivalent) and according to the pressure class stated in their respective piping material specification. (c) Drilling on flanges of flanged valves must correspond to the drilling of flanges on the piping system on which the valves are installed.
2.07.00	**Bends/elbows/mitre bends/ Tees/ Reducers & other fittings**
2.07.01	Unless otherwise specified elbows shall be of long radius type.
2.07.02	For pipe sizes upto 65Nb, long radius forged elbows or seamless pipe 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.
2.07.03	For steel pipes 80 Nb and above, seamless long radius forged elbows shall be used. For pipe size 350Nb and above mitre bends may be used for all pipes except rubber lined pipes. The bend radius shall be 1½ times the nominal pipe diameter. 90 deg. bends (mitre) shall be in 4 pieces (3 cuts) and 45 deg. mitre bends shall be in 3 pieces 22½ deg. Fabrication of mitre bends shall be as detailed in BS 2633/BS534.
2.07.04	Mitre bends are not acceptable in case of rubber lined mild steel pipes.
2.07.05	For pipe fittings such as reducers and tees, the material shall be to ASTM-A-234 Gr. WPB up to 300 NB. For pipe reducers and tees above 300 NB, the fittings may be fabricated conforming to parent pipe material. Provision of compensation pads shall be kept as per ANSI B 31.1. The fitting shall conform to the dimensional standard of ANSI B-16.9.

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	However, for pipes up to 150 NB, pipe fittings may be supplied with material and dimension conforming to IS 1239 in case parent pipes also conform to IS 1239. For pipes, above 1200 NB, reducer and tees shall be to dimensional standard of AWWA-C-208.
2.07.06	Stainless steel fittings shall conform to either ASTM-A-182, Gr. 304 (316 for Sea water application, if any) or ASTM-A-403, Gr. WP 304 (316 for Sea water application, if any) Class-S, for sizes upto and including 50mm NB, i.e., the fitting shall be of seamless construction. However, for stainless steel fittings above 50mm 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.
2.07.07	In no case, the thickness of fittings shall be less than the thickness of parent pipe, irrespective of material of construction.
2.08.00	**Flanges**
2.08.01	Flanges shall be slip on type. Welding of flanges in tension is not permitted.,
2.08.02	All flanges and-flanged drilling shall be to ANSI B 16.5/BS EN-1092 of relevant pressure/temperature class. Flanges shall be fabricated from steel plates conforming to ASTM A 105/IS 2062 Gr. B. However stainless steel flanges shall be fabricated from SS plates to ASTM-A-240, Gr. 304 (316 for Sea water application, if any) or equivalent.
2.09.00	**Specific technical requirement of laying buried pipe with anti corrosive treatment** The pipe in general shall be laid with the top of the pipe minimum 1.0 (one) metre below finished general ground level.
2.09.01	**Trenching** (a) The trench shall be cut true to the line and level and shall follow the gradient of the pipeline. The width of the trench shall be sufficient to give free working space on each side of the pipe. Trenches shall conform to IS 5822. (b) Free access shall be provided for the welding of the circumferential joints by increasing the width and depth of the trench at these points. There should be no obstruction to the welder from any side so that good welded joint is obtained. (c) The free working space shall conform to IS:5822. The trench shall be excavated so as to provide minimum cover of 1000mm between the top of the pipe and finished grade. (d) Prior to lowering and laying pipe in any trench, the Bidder shall backfill and compact the bottom of the trench or excavation in accordance with IS:5822 to provide an acceptable bed for placing the pipe.

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	(e) Coating and Wrapping shall be done as under
2.09.02	**Preparation and cleaning of piping**
	(a) The pipeline shall be thoroughly cleaned of all rust, grease, dirt, weld scales and weld burrs etc. moisture or other foreign matter by power cleaning method such as sand blasting, power tool cleaning, etc.. Grease or heavy oil shall be removed by washing with a volatile solvent such as gasoline. Kerosene will not be permitted for cleaning. This cleaning operation shall be immediately followed by priming with the mechanical priming machine.
	(b) Certain inaccessible portions of the pipeline(which otherwise not possible to be cleaned by power cleaning methods) may be scrubbed manually with a stiff wire brush and scrapped where necessary with specific permission of the Project Manager.
	(c) The cleaning and priming operation shall be carried out at site. The entire pipe length shall be cleaned but the ends of the pipes shall be left without coating for a distance of 230mm for joints, which shall be coated manually at site after laying, welding and testing the pipe.
	(d) On the internal surface for pipes 1000 Nb and above, a coat of primer followed by a hot coal-tar enamel or coal tar epoxy painting (cold) shall be applied as found suitable for systems handling other than Sea-water/corrosive water or fluid. However, for pipes handling Sea-water the internal pipe surface shall be Poly-urethane coated with DFT of 2000 micron (minimum) for pipes of all sizes generally following the guidelines of AWWA-C-222.
2.09.03	**Coating and wrapping**
	(a) Burried piping shall be coated and wrapped, as per specification, after completion of welded and/or flanged connections, and after completion and approval of Hydro testing. Materials to be used for coating and wrapping of underground pipelines are :
	(1) Coating primer (coal tar primer)
	(2) Coating enamel (coal tar enamel)
	(3) Wrapping materials.
	(b) All primer/coating/wrapping materials and methods of application shall conform to IS:10221 except asphalt/bitumen material. Materials (primer/coating/wrapping) as per AWWA-C-203 are also acceptable.
	(c) Protective coating shall consist of coal tar primer, coal tar enamel coating, glass fibre, tissue inner wrap followed by glass fibre or coal tar impregnated kraft outer wrap or finish coat.

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	(d) Number of coats and wraps, minimum thickness for each layer of application shall be as per IS-10221. Number of. coats and wraps shall be decided based on soil corrosivity/ resistivity as indicated in IS-10221. Soil data-for this purpose shall be made available. (e) Total thickness of completed coating shall not be less than 4.0 mm. (f) Alternatively, the anti-corrosive protection can consist of anti-corrosive protection Coal-tar tapes. Material and application of tapes shall conform to AWWA-C-203. These-tapes shall be applied hot over the cold coal tar primer. The total thickness of the finished protective coating shall be 4.0 mm minimum.
2.09.04	**Trench bed preparation and back filling** Prior to lowering and laying pipe in any excavated trench, the bottom of the trench may require to be back filled and compacted (or as the case may be) to provide an acceptable bed for placing the pipe. Bed preparation in general shall be as per IS:5822.
2.09.05	**Laying of galvanised steel (GI) pipes** All the joints shall be screwed with socket or flanged. Screwed ends of GI pipes shall be thoroughly cleaned and painted with a mixture of red and white lead before jointing Threaded portion on either side of the socket joint shall be applied with Zinc silicate paste. All the provisions for trenching' bed preparation' laying the pipe application of primer' coating' wrapping with tapes and back filling etc. as indicated for "laying of buried piping" and " anti corrosive protection for buried piping" are applicable for buried galvanised steel (GI) pipes also.
2.10.00	**Cleaning and flushing**
2.10.01	All piping shall, be cleaned by the Bidder before and after erection to remove grease, dirt, dust, scale and welding slag.
2.10.02	Before erection all pipework, assemblies, sub-assemblies, fittings, and components, etc. shall be thoroughly cleaned internally and externally by blast cleaning or by power driven wire brushes and followed by air-blowing. The brushes shall be of the same or similar material as the metal being cleaned. Cleaning of Galvanised pipes shall be done in such a manner that the coating on MS pipe is not affected.
2.10.03	After erection, all water lines shall be mass flushed with water. The cleaning velocities in water lines shall be 1.2-1.5 times the operating velocities in the pipelines.
2.10.04	All compressed air pipework shall be cleaned by blowing compressed air .

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2.11.00	**Surface preparation and painting** Pipes shall be cleaned both internally and externally thoroughly by blast-cleaning or power tool cleaning method as indicated above. However the internal surfaces of pipes handling sea water are to be grit blasted in accordance with SSPC-SP10. In case of oil piping, cleaning will have to be done by pickling. No painting is required on galvanized pipe surface or galvanized steel surface. However, necessary colour banding for identification as per colour code shall be done. **External surface of piping shall be cleaned and prepared as indicated below.**
2.11.01	**Primer painting** (a) After the surface is prepared two coats of red oxide (zinc chromate) primer conforming to IS-2074 or equivalent shall be applied for non-coastal environment. However, for coastal/saline environment the primer shall be two (2) coats of epoxy based zinc phosphate primer with DFT of 50 micron. Primer shall be applied by brushing to ensure a continuous film without holidays. Primer coat shall be immediately applied without any time lag after the surface preparation. (b) Any equipment which has been given the shop coat of primer shall be carefully examined after its erection in the field and shall be treated with a touch up coat of primer wherever the shop coat has been abraded, removed or damaged during transit/erection, or defaced during welding.
2.11.02	**Finish painting** (a) Paint to be used shall be synthetic enamel paint conforming to IS-2932 or equivalent for non-coastal environment. Finish painting shall be carried out in three coats consisting of one intermediate coat and two finishing coats. Dry film thickness (DFT) of painting inclusive of primer thickness shall be at least 150 micron. (b) For coastal environment or saline atmosphere, the painting to be applied over primed surface shall be as follows: Intermediate coat = Epoxy based TiO2 pigmented paint with minimum DFT of 50 micron. Finished coat = Epoxy based finish paint of DFT as 50 micron minimum. (c) The primed surface shall be cleaned of dust/dirt/grease etc. without scratching or in any way damaging the primer coat. The intermediate coat shall be allowed to dry before applying the finish coat or as recommended by paint manufacturer. (d) Paint shall be applied by brushing. It shall be ensured that brush marks are a minimum and the requirements of workmanship is as specified in IS-1477.

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	(e) Paint used shall be stirred frequently to keep the pigment in suspension. Paint shall be of the ready mix type in original sealed containers as packed by the paint manufacturer. No thinners shall be permitted. (f) No painting shall be done in frost/foggy weather or when the humidity is high to cause-condensation on the surface to be painted. (g) The dry film thickness (DFT) after the painting shall not be less than 150 microns, in either case (i.e. coastal environment or Non-coastal environment).
2.11.03	**Other requirements** (a) Paint manufacturers instructions shall be followed in method of application, handling, drying time etc. (b) The colour of the finish paint shall be as per approved colour coding. (c) If finish paint was applied in shop, one coat of finish paint shall be applied at site. (d) The dry film thickness of paint shall not be less than 0.15 mm.
2.11.04	Colour code for identification The pipes shall be colour painted/banded for identification as per the approved colour coding scheme and shall be generally as per IS-9404.
2.12.00	**Specification for hangers and supports**
2.12.01	All supports and parts shall conform to the requirement of power piping code ANSI B 31.1 or approved equivalent.
2.12.02	While designing supports for rubber lined pipes special consideration should be given. Any kind of welding on these pipes is not allowed after rubber lining.
2.12.03	Hanger for piping 65mm Nb and larger and all spring support assemblies regardless of size shall be completely engineered in conformance with the provisions of power piping code ANSI B 31.1.
2.12.04	Hangers, saddles, supports etc. shall be fabricated from plates/pipes sections conforming to ASTM A 53/IS:2062/IS:226/or equivalent. They shall be designed to provide the required supporting effects and allow pipe line movements as necessary. The structural steel work shall be as per IS:800/BS:4360. Insulation protection saddles shall be used at support point of all insulated piping.
2.12.05	The support shall be so interspaced as to minimise sagging of the pipes and to keep them with in permissible limits where pipes are full with the conveying media.
2.12.06	The maximum spans of the supports of straight length shall not exceed the recommended values indicated in ANSI B 31.1.

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2.12.07	All pipe supports shall be designed to provide an absolute minimum head room of 2.5 m from floor in passages/walkways.
2.12.08	At all sliding surfaces of supports suitable arrangement is to be provided to minimise sliding friction.
2.12.09	In case of non-coastal environment, all components of hangers/supports shall be provided with two coats of primer (red oxide paint) at shop before dispatch to site. After erection they shall be given finish coat of Long Oil Synthetic enamel to IS:2932 of total DFT 100 to 140 microns. CLH & VLH will be primed with Epoxy Zinc rich primer of 50 micron followed by finish painting of Aliphatic Acrylic Polyurethane or equivalent of DFT 65 microns. However, for coastal / saline environment all hangers and supports shall be given a primer coat of chlorinated rubber based zinc phosphate primer of DFT 50 micron, followed by 2 coats having one intermediate coat and other finish coat of chlorinated rubber based TiO2 pigmented paint of DFT 50 micron each.
2.13.00	**Design/Construction/Material Particulars of Gate/ Globe/Check Valves/ Globe Stop Valve/Butterfly valve**
2.13.01	**GENERAL** (a) All valves shall be suitable for the service conditions i.e flow, temperature and pressure, at which they are required to operate. (b) The valves as well as all accessories shall be designed for easy disassembly and maintenance. (c) Valves to be installed outside shall be required to have the stem properly protected against atmospheric corrosion. (d) All rising stem valves shall be provided with back seat to permit repacking (of glands) with valves in operation. All valves shall preferably be of outside screw and yoke type. (e) All valves shall be closed by rotating the hand wheel in the clockwise direction when looking at the face of the handwheel. In case where the handwheel is not directly attached to the valve spindle suitable gearing shall be introduced. (f) All valves shall have indicators or direction clearly marked on the hand-wheel so that the valves opening/closing can be readily determined. (g) Special attention shall be given to operating mechanism for large size valves with a view to obtaining quick and easy operation ensuring that a minimum of maintenance is required. For valves of size 350mm and above either bevel or spur gearing shall be provided to facilitate manual operation. (h) The valves coming in vacuum lines shall be of extended gland type and/or water sealed.

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	(i) The actuator-operated valves shall be designed on the basis of the following: (1) The internal parts shall be suitable to support the pressure caused by the actuators; (2) The valve-actuator unit shall be suitably stiff so as not to cause vibrations, misalignments, etc. (3) All actuator operated valves shall be provided with hand operated gearing mechanism also. (4) All actuators operated valves shall open/ close fully within time required by the process but not later than 60 seconds after actuators starts. (j) Valves coming under the purview of IBR shall meet IBR requirements. (k) Gate/sluice valves shall be used for isolation of flow. Gate valves shall be provided with the following accessories in addition to other standard items : (1) Hand wheel (2) Position indicator (for above 50 mm NB valve size) (3) Bypass valves and gear operators for valves of size 350 NB & above. (4) Draining arrangement wherever required. (l) Globe valves shall be used for regulation purposes. They shall be provided with hand wheel, position indicator, draining arrangement (wherever required) and arrow indicating flow direction. (m) Check valves shall be used for non-return service. They shall be swing. check type or double door (Dual plate)check type with a permanent arrow inscription on the valve body indicating the fluid flow direction. In long distance pipes lines with possibility of surge-occurence, dual plate check valves are preferable for its spring controlled opening /closing of flaps/doors against flow reversals. However, dual plate check valves shall not be used for sizes more than 600mm NB (n) All gate and globe valves shall be provided with back seating arrangement to enable on line changing of gland packing. (o) All gate and globe valves shall be rising stem type and shall have limit switches for full OPEN and full CLOSED indication wherever required. This will include motor-operated valves also wherever required. In such cases the limit switches shall form an integral part of the valve. Stop-gap arrangement in this respect is not acceptable.

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	(p) All valves shall be provided with embossed name plate giving details such as tag number, type, size etc. (q) Wherever required valves shall be provided with chain operator, extension spindles and floor stands or any other arrangement approved by Employer so that they can be operated with ease from the nearest operating floor. Wherever necessary for safety purpose locking device shall be provided. Further, necessary small platforms for facilitating easy valve operation shall be provided by the contractor wherever necessary in consultation with project manager within the bid price at no extra cost to employer. (r) All valves except those with rising stems, shall be provided with continuous mechanical position indicators; rising stem valves shall have only visual indication through plastic/metallic stem cover for sizes above 50 mm nominal bore. (s) For CI gate, globe and check valves wherever thickness of body/bonnet is not mentioned in the valves standards, thickness mentioned in IS- 1538 for fitting shall be applicable.
2.13.02	**VALVE BODY MATERIAL** Valve body material for various services shall be as follows: Valve body material for non-sea water application like Raw water, Ash watermake-up and handling water, service water, clarified water, DM cooling water (pH corrected) & drinking water shall be cast iron for sizes 65NB and above ; gun-metal for sizes 50 Nb and below. For compressed air application, valve material shall be galvanised cast carbon steel or forged carbon steel per sizes 65 mm NB & above and Gun metal for sizes 50 NB and below. Valve body material for sea-water application (if applicable) like circulating water, sea-water make-up to circulating water, secondary circuit auxiliary cooling water of ECW system, etc. shall be Austenitic Ductile Iron (D2-Ni) for sizes 65 NB and above; stainless steel (SS 316) for sizes 50mm NB and below. DM water : SS body and disc alongwith SS internals. Condensate : Cast Carbon Steel / Forged Carbon Steel.
2.13.03	The design, material, construction, manufacture, inspection, testing and performance of valves shall comply with all currently applicable statutes, regulations and safety codes in the locality where the valves will be installed. The valves shall conform to the latest editions of applicable codes and standards as mentioned elsewhere. Nothing in this specification shall be construed to relieve the Bidder of his responsibility. Valves in general shall conform to the requirements of the following standards.

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	Standards and Codes	
	AWWA-C-504	Rubber seated butterfly valves.
	BS-5155/EN-593	Cast iron and carbon steel butterfly valves for general purpose.
	IS-778	Gun-metal gate, globe and check valves for general purpose.
	BS-5154	Copper alloy globe/globe stop and check and gate valves for general purpose.
	IS-780	Sluice valves for water works purpose (50-300 mm size)
	IS-2906	Sluice valves for water works purpose (350-1200 mm size)
	IS-5150	Cast iron wedge and double disc gate for general purpose.
	BS-5152	Specification for cast iron globe valves.
	BS-5153	Cast iron check valves for general purpose.
	IS-5312	Swing check type reflux (non-return) valves.
	ANSI B 16.34	Standard for valves.
	API-594	Standard for Dual-check valves.
	API-600	Steel gate valves.
	ANSI-B-16.10	Valves face to face and other relevant dimension.
	API-598	Valves inspection test.
2.13.04	**End Connections**	
	The end connections, shall comply with the following :	
	Socket welding (SW) - ANSI B 16.11	
	Butt Welding (BW) - ANSI B 16.25.	
	Threaded (SC) - ANSI B 2.1	
	Flanged (FL) - ANSI B 16.5& AWWA-C-207(steel flanges), ANSI B 16.1 (Cast Iron flanges)	
2.13.05	All cast iron\ ductile-Ni iron body valves (gate, globe and non-return) shall have flanged end connections, (screwed ends for Ductile D.2NI body valves are not acceptable).	

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2.13.06	All steel and stainless steel body valves of sizes 65 mm and above shall have flanged or butt weldings ends. Valves of sizes below 65mm shall have flanged or socket welded ends. Compatibility of welding between valve body material and connecting pipe material is a pre-requisite in case of butt-welded joints.
2.13.07	All gun metal body valves shall have screwed ends.
2.13.08	All flanged end valves/specialities. shall be furnished alongwith matching counter flanges, fasteners, gaskets etc. as required to complete the joints.
2.14.00	**Check Valves**
2.14.01	Check valves shall comply with the following characteristics: (a) For bore greater than 2" the valves must be swing check type or dual plate check type suitable for installation in all positions (vertical and horizontal); (b) For bore smaller than or equal to 2" the valves must be of the piston type to be installed, in horizontal position. (c) In the case of swing check valves, the body seat shall be inclined at such an angle from the vertical as will facilitate closing and prevent chatter.
2.14.02	Drilling on flanges of flanged valves must correspond to the drilling on flanges of the piping system on which the valves are to be installed.
2.14.03	All flanged valves intended for installation in steel piping systems shall have their flanges drilled to ANSI B 16.5 (or equivalent) and according to the pressure class.
2.14.04	Counter flanges to be installed on air pipes shall be screwed-on type irrespective of size.
2.15.00	**Globe Valves**
2.15.01	The globe valves shall have the following characteristics: Straight conveyed flow. right angle preferably, the valves shall be of the vertical stem type.
2.15.02	Globe valves shall preferably have radiused or spherical seating and discs shall be free to revolve on the spindle.
2.15.03	The pressure shall preferably be under the disc of the valve. However, globe valves, with pressure over the disc shall also be accepted provided (i) no possibility exists that flow from above the disc can remove either the disc from stem or component from disc (ii) manual globe valves can easily be operated by hand. If the fluid load on the top of the disc is higher than 40-60 KN, bypass valve shall be provided which permits the downstream system to be pressurised before the globe valve is opened.

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	(i) The actuator-operated valves shall be designed on the basis of the following: (1) The internal parts shall be suitable to support the pressure caused by the actuators; (2) The valve-actuator unit shall be suitably stiff so as not to cause vibrations, misalignments, etc. (3) All actuator operated valves shall be provided with hand operated gearing mechanism also. (4) All actuators operated valves shall open/ close fully within time required by the process but not later than 60 seconds after actuators starts. (j) Valves coming under the purview of IBR shall meet IBR requirements. (k) Gate/sluice valves shall be used for isolation of flow. Gate valves shall be provided with the following accessories in addition to other standard items : (1) Hand wheel (2) Position indicator (for above 50 mm NB valve size) (3) Bypass valves and gear operators for valves of size 350 NB & above. (4) Draining arrangement wherever required. (l) Globe valves shall be used for regulation purposes. They shall be provided with hand wheel, position indicator, draining arrangement (wherever required) and arrow indicating flow direction. (m) Check valves shall be used for non-return service. They shall be swing. check type or double door (Dual plate)check type with a permanent arrow inscription on the valve body indicating the fluid flow direction. In long distance pipes lines with possibility of surge-occurence, dual plate check valves are preferable for its spring controlled opening /closing of flaps/doors against flow reversals. However, dual plate check valves shall not be used for sizes more than 600mm NB (n) All gate and globe valves shall be provided with back seating arrangement to enable on line changing of gland packing. (o) All gate and globe valves shall be rising stem type and shall have limit switches for full OPEN and full CLOSED indication wherever required. This will include motor-operated valves also wherever required. In such cases the limit switches shall form an integral part of the valve. Stop-gap arrangement in this respect is not acceptable.

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	(p) All valves shall be provided with embossed name plate giving details such as tag number, type, size etc. (q) Wherever required valves shall be provided with chain operator, extension spindles and floor stands or any other arrangement approved by Employer so that they can be operated with ease from the nearest operating floor. Wherever necessary for safety purpose locking device shall be provided. Further, necessary small platforms for facilitating easy valve operation shall be provided by the contractor wherever necessary in consultation with project manager within the bid price at no extra cost to employer. (r) All valves except those with rising stems, shall be provided with continuous mechanical position indicators; rising stem valves shall have only visual indication through plastic/metallic stem cover for sizes above 50 mm nominal bore. (s) For CI gate, globe and check valves wherever thickness of body/bonnet is not mentioned in the valves standards, thickness mentioned in IS- 1538 for fitting shall be applicable.
2.13.02	**VALVE BODY MATERIAL** Valve body material for various services shall be as follows: Valve body material for non-sea water application like Raw water, Ash watermake-up and handling water, service water, clarified water, DM cooling water (pH corrected) & drinking water shall be cast iron for sizes 65NB and above ; gun-metal for sizes 50 Nb and below. For compressed air application, valve material shall be galvanised cast carbon steel or forged carbon steel per sizes 65 mm NB & above and Gun metal for sizes 50 NB and below. Valve body material for sea-water application (if applicable) like circulating water, sea-water make-up to circulating water, secondary circuit auxiliary cooling water of ECW system, etc. shall be Austenitic Ductile Iron (D2-Ni) for sizes 65 NB and above; stainless steel (SS 316) for sizes 50mm NB and below. DM water : SS body and disc alongwith SS internals. Condensate : Cast Carbon Steel / Forged Carbon Steel.
2.13.03	The design, material, construction, manufacture, inspection, testing and performance of valves shall comply with all currently applicable statutes, regulations and safety codes in the locality where the valves will be installed. The valves shall conform to the latest editions of applicable codes and standards as mentioned elsewhere. Nothing in this specification shall be construed to relieve the Bidder of his responsibility. Valves in general shall conform to the requirements of the following standards.

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2.15.04	Globe valves with Nb smaller than or equal to 2" shall be of the integral type. Valves of this type shall be so as to permit the easiest disassembly of the internals (stem and disc).
2.15.05	For the regulating valves, valves with regulating plug & parabolic outline disc type is preferred.
2.15.06	All motorised globe valves with regulating plug for which indication of percentage (%) opening are required in the control room shall be provided with necessary position transmitter.
2.16.00	**Gate valves** All gate valves shall be of the full-way type, and when in the full open position the bore of the valve shall not be constricted by any part of the gate. Gate valves shall be of the solid/elastic or articulated wedge disc and rising stem type.
2.17.00	**Air Release Valve** (a) The air release valves shall be of automatic double air valve with two orifices and two floats. The float shall not close the valve at higher air velocities. The orifice contact joint with the float shall be leak tight joint. (b) The valve shall efficiently discharge the displaced air automatically from ducts/pipes while filling them and admit air automatically into the ducts/pipes while they are being emptied. The valve shall also automatically release trapped air from ducts/pipes during operation at the normal working pressure. (c) Body material of automatic air release valves shall comply generally with BS 1452 Gr. 14/IS:210 Gr. FG 260. and spindle shall conform to high tensile brass for water other than Sea-water. 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. (d) Air release valves shall not have any integral isolation device within them. Each Air release valve shall be mounted, preceded by a separate isolation gate/ butterfly valve.
2.18.00	**Butterfly valves**
2.18.01	**Design/Construction** (a) The valves shall be designed for the design pressure/temperature of the system on which it is installed and in accordance with AWWA-C-504, EN-593 or any other approved equivalent standard latest edition. Fabricated steel (IS:2062 Gr B) butterfly valves instead of cast Iron body valves are also acceptable for size above 300 mm NB diameter for water application other than Sea-water / corrosive water. In such a case, however, the bidder will

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	have to necessarily submit thickness calculations, in order to establish the integrity of the fabricated valve body under the system operating pressure condition. Bidder has to clearly indicate the material offered in the bid. No change shall be entertained during detailed engg. (1) The valves shall be suitable for installation in any position (horizontal/vertical etc.) and shall be of double-flanged construction. However for sizes 150 NB and below the valves may be lugged Wafer construction. (2) The seals, both on the body (sleeve) and on the disc shall be of the material specified. Necessary shaft seal shall be provided and adequately designed to ensure no leakage across the seal. This seal shall be designed so that they will allow replacement without removal of the valve shaft. The sealing ring on the disk shall be continuous type and easily replaceable. (3) For all types of valves, the design with shaft eccentric to the disc is preferred. The shaft shall be solid type and shall pivot on bushings. Bushings/sleeve type bearings shall be contained in the hub of valve body. The bearing shall be self-lubricated type with low coefficient of friction and should not have any harmful effect on water and on valve components. (4) The design of the shaft shall be such that it will safely sustain maximum differential pressure across the closed valve. The shaft and any key (taper pin etc.) for transmitting the torque between shaft and disc shall be capable of withstanding the maximum torque required to operate the valve. However, the shaft diameter shall not be less than the minimum shaft diameter specified in relevant code. Necessary Torque Calculation and the torque class selected on the basis of the same shall be furnished to the Employer for information. (5) The disc shall rotate from the full open to the tight shut position. The disc shall be contoured to ensure the least possible resistance to flow and shall be suitable for throttling operation. While the disc is in the throttled position, valve shall not create any noise or vibration. (6) The operating mechanism shall be mounted directly on or supported from the valve body. (7) All valves shall be complete with: position indicator (located in a visible place) arrow indicating the flow direction; adjustable mechanical stop limiting devices to prevent over travel of valve disc in open/close position. all valves shall be "tight shut off"