01.02 Water Supply Facilities

01.02.01 Scope of work

The scope of work shall include design, engineering, fabrication, manufacturing, assembly & supply, erection / construction / laying, commissioning, testing & performance guarantee tests etc of plant & equipment and piping etc of complete water supply facilities including mechanical, civil & structural works, electrics, instrumentation, automation, telecommunication, material handling & hoisting equipment etc as specified and required for compressors, blowers and other equipment as specified herein as turnkey basis.

The scope of work shall include the following activities:

i) Design, engineering, preparation & submission of all drawings for mechanical, civil, structural, piping, electrical, instrumentation & other facilities.

ii) Preparation of construction & erection drawings.

iii) Supply of all technical literature, drawings & documents, general arrangement drawings, assembly & sub-assembly drawings of all the plant & equipment, as-built drawings, operation & maintenance manuals, manufacturing drawings, etc.

iv) Submission of all drawings at (iii) above, design calculations, data sheets for various equipments, pipeline sizing calculation and calculation for sizing of various sub-systems and integrated systems for approval of Purchaser/ Consultant and finalizing the same as per approval of Purchaser/ Consultant. The approval of the same however does not absolve the contractor from his responsibilities.

v) Manufacture / fabrication, assembly, shop testing, painting, packing, supply, sequential delivery FOR site, unloading, unpacking, storage at site, handling of equipment between storage and construction site, construction & erection as per approved drawings, site-testing, painting, commissioning and fulfillment of guarantee performance of all plant & equipment, sub-systems & integrated system of water supply facilities covering cooling water systems for the Compressed Air Station, associated civil & structural works, handling & hoisting equipment, electrics, instrumentation & control, illumination, telecommunication in accordance with the water system requirements of the proposed plant.

vi) Supply of pipeline supports, thrust blocks/ anchor blocks, structural stockades, bridges, R.C.C. pedestals etc. for over head / on-ground /underground pipelines.

vii) Supply of commissioning spares & consumables; a list thereof shall be submitted by the bidder.

viii) Tender shall submit an itemized price-list of two years operation and maintenance spares.

ix) Supply of special tools, tackles for construction, erection operation and repair & maintenance of the plant & equipment.

x) All necessary connections for hook-up with Purchaser's system at battery limits.

xi) Supply of erection, testing & commissioning equipment and material.

xii) Piping network flushing fluids, chemicals & consumables.

xiii) First fill of oils, lubricants, filter media, resins, chemicals reagents and other consumables.

xiv) Inspection and performance testing of individual equipment and system as a whole.

xv) Participation in design conference with the Purchaser & Consultant as and when called for.

Water supply system/ sub-systems shall be complete in all respects and any equipment or material not specifically mentioned in this specification, but required for safe, efficient & smooth operation and guaranteed performance of the plant shall be deemed to be included under the scope of work of the Contractor.

05.02.02 **Battery Limit**

a) Industrial water

Industrial quality make-up water will be made availably to the successful Bidder at one point at a pressure of approx 1.5 kg/ cm^2 (g) only near ESPs. The top of the pipeline (carbon steel) shall be approximately 1.2 m below the area ground level.

Bidder shall extend the same from battery limit with an isolation valves and flowmeter in a RCC valve-pit to their proposed system. Bidder shall indicate the make-up water quantity requirement, pipe size, end connection, MOC of pipeline, etc. at the battery limit.

05.02.03 **Specification and Description of Work**

Water System Facilities

Water system shall in general include the following facilities:-

a) Cooling water system,
b) Make-up water system,
c) Water conditioning system,
d) Interconnected pipelines,

a) Cooling Water System

01. For cooling of plant and equipment, their shall be a separate Cooling Water Re-circulation System with pumps, cooling towers, valves and interconnected piping.

02. Tenderer may provide groups of pumps for the Compressors, blowers & other plant & equipment inside the Compressed Air Station or any separate house near cooling tower.

03 The tenderer shall provide three pumps (2W+1SB) to cool the compressors, Blowers other plant & equipment. One working pump should stop when one working compressor is stopped.

04 Cooling tower (FRP) are to be provided / installed over the cold well. Cold well should be designed in such a way that its IL (invert level) shall be 500mm above the surrounding FGL.

05 Cold well shall have two compartments and the pumps can draw water from any compartment. One compartment can be cleaned by maintenance personnel without stopping the pumps. Overflow and drain (with valve) connections are to be provided in each chamber and these are to be connected to the nearest drain by a pipe.

06 Capacity (active capacity) of the cold well shall be equal to 10 minutes recirculation rate of the cooling water system.

07 Stand by pump should start automatically if any working pump trips or fails to start.

08 All working pumps should trip and stand by pump should not start when the water level in the cold well is at minimum level.

09 Following instruments along with necessary interlocks to be provided by the tenderer.

i) Pressure gauge (with 6” dial) on suction, delivery side of each pump.

ii) Pressure gauge (with 6” dial) on delivery header of the cooling water supply pipeline

iii) Pressure gauge (with 6” dial) on the make up water line near the T.O.P.

iv) Flowmeter, magnetic type, to be provided on the make up water line near T.O.P. This meter shall show instantaneous flow as well as cumulative flow.

v) Flowmeter, magnetic type, to be provided on the delivery header of the cooling water pumps.

vi) Level measuring instruments, radar type, is to be provided in each compartment of the cold well. This should show continuous level in the gauge.

vii) Temperature measurement on the hot water header going to cooling tower and also in the cold well.

b) Make- up Water System

1. Make-up water for cold sump of open industrial water circuits is to be tapped from the existing industrial water network and shall be taken to the cooling water circulation system through a pipe network. Motor operated valve is to be provided on the make up water pipe which will open automatically based on the levels in the cold sump. The bidder shall provide isolation valve (gate valve) prior to as well as after the motor operated valve and a bypass valve (gate valve) for the motor operated valve.
2. Online booster shall not be accepted. A makeup water sump with pumps and piping (pump house and sump are to be provided by the bidder), if required, shall be provided to convey the make up water to the cooling water recirculation system.

c) Water Conditioning Systems

(1) To prevent the circulation water system from corrosion and scale formation and to bring the make up water to the condition suitable for the cooling water requirement of the plant & equipment, there shall be a water conditioning facility as per system requirement.

(2) It shall consist of dosing tanks, pumps, valves, pipes, fitting, pipe supports and associated civil, electrical, instrumentation.

(3) These pumps may also be housed in the Compressed Air Station or any separate house near cooling tower.

(4) The Tenderer shall furnish the details of chemical dosing proposed for the system.

(5) The Tenderer shall include in the scope of supply three months chemicals requirement for the chemical conditioning system.

d) Interconnected Pipelines

Industrial water for make-up water supply and general plant usage will be met through the proposed pipeline to be laid from the tapping point to these units.

Water lines shall generally be laid overground, preferably on structural trestles.

The water systems will generally comprise the following main units:

a) Open Indirect Industrial Water Cycle:

- Cooling tower
- Pump sets
- Interconnecting piping
- Chemical conditioning System
- Electrics, instrumentation & control system

b) Miscellaneous and Common Facilities:

- Interunit pipelines

01.02.04 **Description of Cooling Water Systems**

For cooling of plant and equipment, there shall be a separate Cooling Water Re-circulation System with pumps, cooling towers and piping network.

The hot water from the consumers shall be cooled in RCC induced draft evaporative cooling towers (having RCC basin).

Cooled water from cooling tower will be collected in cold water RCC sump for recirculation.

Supply cooling water temperature shall be at 32-34 deg C.

Make-up water shall be added in the cold well to make-up the losses in the system.

The cooling water system to be provided shall have the capacity to supply cooling water to all the plant & equipment (including stand-by equipment) at a time.

All the pump motors in the pump house shall be preferably LT motors, the pump selection shall be made accordingly.

01.02.05 Equipment specification.

DESIGN CRITERIA FOR COOLING TOWERS

The cooling towers shall be multi-cell mechanical induced draft type (cross flow/counter flow type). The design wet bulb temperature of the site is 29 deg C. the approach of cold water to design wet bulb temperature shall be fixed based on the requirements.

The cooling towers shall be located near the re-circulating water pump house with necessary clearance from the adjoining structures and communication facilities.

The number of cells in each cooling tower shall be selected in such a manner that one no. of cell is spare and can be taken out for maintenance.

No. of installed Cell in Cooling Tower

= No. of working Cell (n)+ 1 No. Standby Cell (1)
= n + 1

The cooling towers and the accessories shall be designed and constructed in accordance with the latest applications provisions of Indian or International Standards in general and the following in particular.

PTC – 23 “ASME Performance Test Code for “atmospheric water cooling equipment”.

Cooling tower institute of USA, Bulletin, ATP - 105 for “Acceptance Test Procedure”

IS: 401 for “Code of practice for preservation of timer”

The cooling towers design shall provide towers suitable for reliable operation in the climatic conditions prevailing at the site. In addition, the tower design shall include the following features for reliable operation and fog reduction under varying seasonal conditions:

- Large air to water volume ratio
- Highly effective draft eliminator design
- High fan cylinder air exit height

- Ability to function well with the fans operating continuously at design airflow under all operating conditions.
- Capability to adjust to the seasonal variations of circulating water flows.

The towers shall be designed to withstand the wind load and seismic load for the site. The tower layout shall facilitate location of fan drive motor on that side of the cylinder which will be upwind most of the time.

The cooling towers shall be complete in all respects and shall broadly conform to the following requirements.

Drift eliminator to limit the drift losses to a maximum of 0.2%.

The cooling tower basin shall be of RCC construction and shall be constructed by the Contractor. The capacity of the basin shall be designed for approximately 10 minutes circulating water quantity. Each basin chamber shall be provided with a sludge pit with isolating valve complete with extended spindle and head stock. Each basin chamber shall be provided with an overflow of suitable chamber there shall be a cold water outlet sump. In the connection between basin chamber and outlet sump, there shall be screens with galvanized angle frame, along with a spare screen for each cell.

Fan decks shall be provided with drainage away from the fan cylinder and shall extend the full width of the cooling tower covering the water distribution system. The fan cylinder shall be of RCC/FRP construction and shall be of velocity recovery venturi design.

The cooling tower shall be provided with a stairway located at each end of the tower for access from ground level to the fan deck. The tower will be provided with one or two longitudinal walkways, with handrails located at the cooling tower basin curb level.

The tower shall be provided with complete water distribution system including piping, flow control valves and distribution nozzles. Header isolating valves for the tower and water distribution valves for each cell shall be provided.

The tower shall be equipped with suitable material handling devices of appropriate capacity for removal and handling of equipment from the fan deck to the ground level.

Each fan assembly shall be provided with vibration limit switches to de-energize the motor in the event of excessive vibration.

Cooling tower fan shall be multiple axial flow type, specially designed for low noise level and vibration free operation. The bolts, nuts and other hardware used for fixing the individual blades to the fan hub shall be selected with min. 15% margin over the power required at motor output terminal for the duty conditions.

Cooling tower fan shall be driven through right angle heavy duty, industrial type reduction gear assembly. Reductions gears shall be of oil bath, positive lubricate type, specially designed for service factor of 2 over fan rated brake power.

The drive shaft shall be designed for high safety factor and the drive shaft assembly shall be statically and dynamically balanced.

The fill and eliminators shall be built and arranged to permit ease of handling and removal form the tower. The fill and eliminator members shall be

securely retained in position to prevent excessive sagging or falling out of position. All fill supports shall be of ample size to properly support their respective loads.

Proper illumination facilities for the fan deck and stair cases shall be provided. Cooling tower fan controls shall be located in the pump house.

MATERIALS OF CONSTRUCTION FOR RCC COOLING TOWER

Sl. No	Component	Material recommended
1	Basin	R.C.C.
2	Structural members, stairways, cell partition and fan deck	R.C.C.
3	Fan cylinder	RCC / FRP
4	Fill	PVC / timber (temp>70°C)
5	Support grids	Stainless steel wire mesh
6	Drift eliminator	AC sheet/ PVC
7	Fan blades	FRP/Aluminum Alloy
8	Spray nozzles	Polypropylene
9	Fan hub	MS Galvanised with GRP cover
10	Drive shaft	SS- 304
11	Fasteners and hard wares	SS (AISI 304)
12	Base frame for motor	MS Galvanised

Valves

Gate valves shall be of rising spindle type. For non-rubber lined valves, the valves for shut off shall be gate type made of cast iron or gun metal and shall be of flanged ends for size above 50mm. Non return valves shall be of swing check type suitable for installation in both horizontal and vertical lines. Valves shall have indicators for `ON' and `OFF' position.

Motor operated valve shall be complete with electric motor, starter, necessary gear drive, position limit switches, torque switches and all accessories as required. The valves shall also have hand wheel for manual operation.

Valves shall be designed, manufactured, tested and marked as per relevant Indian Standards/ reputed International Standards and design codes.

Each valve shall be supplied with a hand wheel/lever/wrench for operation. For motor actuated valves, provision shall be made for manual operation in the event of power failure.

All the valves provided with hand wheel/lever shall be clearly marked with “OPEN” and “CLOSED” positions and an arrow to indicate the direction of

opening/closing.

Gate, butterfly and non-return valves shall be provided with bypass arrangement as per applicable standards. Bypass arrangement may be integral with the valve or connected between pipes.

Unless otherwise specified, the dimensions and drilling of end flanges of flanged valves shall conform to ANSI B16.1, Class 125 cast iron flanges. Flanges shall be at right angles to the axis of the bore and concentric with the bore.

Valves shall be suitable for frequent operation as well as for operation after periods of prolonged idleness in either open or closed positions.

1. Butterfly valves shall be
   Up to 65NB = Wafer type,
   80NB and above =Double flanged,
   200NB and above =Double flanged & Gear operated (with self locking at any position).

2. Check valves shall be
   Upto 40NB = Lift check,
   50NB and above =Double flanged, swing check valve.

3. Sluice valves shall be
   125NB and above = Gear operated.

SPECIFICATION FOR GATE VALVE

MANUAL OPERATION/ PNEUMATIC OPERATION/ MOTOR OPERATED

1	Type	Rising spindle type sluice valve for water works up to 100 deg.C
2	Body and cover	Cl, IS : 210 FG 260
3	Disc	Cl, IS : 210 FG 260
4	Handwheel	CI, IS : 210 FG 260
5	Pin	Stainless Steel, AISI-410
6	Stem	SS, IS:6603, 12 Cr 13 04Cr 18 Ni 10
7	Gaskets	Neoprene rubber
8	Gland packing	Rubber
9	Gear	Alloy steel, IS :1570 40Ni2Cr1MO28Gr B
10	Gear housing	Cast steel, IS :1030,230-450W
11	Pinion and shaft	SS, IS :6603
12	End connections	Below 50 mm - Screwed. 50 mm & above- flanged end, to be drilled as per IS:6392-1971 (RA 1988) table 17/11
13	Pressure rating	PN = 1.6 N / mm^2
14	Hydrostatic testing	For PN 1.6: Body : 24 kg/cm2g Seat/Back seat : 16 kg/cm2g
15	Flange facing	ANSI B 16.5 CL 150
16	Bolts & nuts	IS:1364 Part 1&3,1992, Class 4.6/4
17	Operation	Up to DN100 manually operated (hand wheel with open and close direction indication), DN 125 and above manually gear operated
18	Test certificates	For material / Hydro testing required
19	Mechanical position Indicator	To be provided (to know the amount table position stopper of opening/closure) & lock to prevent over

		travel
20	Manufacturing standard	IS:14846-2000

SPECIFICATION FOR BUTTERFLY VALVES

Manual Operation / Pneumatic Operation/Motor Operated

1	Type	Flanged Type Butterfly valve for water supply Pipe lines
2	Body and cover	Cl, IS : 210 FG 260
3	Disc	SS, IS: 3444-1987, Gr 6/7
4	Seat, body/disk	EPDM/Neoprene
5	Pin	SS AISI-410
6	Spindle	SS, IS:6603 – 72, 15 Cr 16 Ni 2
7	Bolting internal	SS
8	Bolting, external	Carbon Steel, (HT)
9	End connections	Flanged- DN80 - DN500, Fabricated,Cast Body- Beyond DN600 Flanged/ Lugged type
10	Pressure rating	PN = 1.6 N/mm2
11	Manufacturing Standard	IS-13095,1991/AWWA:C-504/ BS:5155/ IPSS-1-06-012 / API 609
12	Hydro static testing	Body:24 kg/cm2 Seat:16 kg/cm2
13	Test certificates	Required for material/hydro test
14	Service	Water
15	Max. operating temp	100 Deg 0C
16	Type of operation	Upto DN125- Lever operated Beyond DN125- Gear operated
17	Operation	Manual / Pneumatic(As and where specifically mentioned)
Remarks- All valves above DN600 shall be supplied with SS 304 gaskets with CAF fillers.		

SPECIFICATION FOR AIR RELEASE VALVE

Air release valves shall be cast iron, single large orifice type, with flanged ends. Air release valve shall conform to IS: 14845-2000.

1	Type	Air release valves shall be cast iron, type S1 & S2 upto diameter 50mm and type DS1 above diameter 50mm up to 200mm. Air release valve shall conform to IS: 14845-2000.
2	Body	CI FG 210 as per IS:210
3	Body seat ring	Gun metal IS:318 LTB-2
3	Vulcanite ball	Vulcanite Ebonite
4	Disc	Gun metal IS:318 LTB-2
5	Stem	13% Cr SS IS:1570 /SS, IS 6603, 04Cr17
6	Disc nut	Gun metal IS:318 LTB-2
7	Bolts/studs, nuts	Carbon steel IS:1367
8	Gland	CI FG 200 as per IS:210
9	Gland packing	Graphited asbestos/ Jute /hemp
10	Air release nipple	Gun metal IS:318 LTB-2

11	Gasket	Compressed asbestos Fiber 3 mm thick
12	Rubber ball	Vulcanite Ebonite
13	End connection	Screwed up-to DN40 and flanged for DN50 & above
14	Pressure rating	PN 1.6 N/mm2
15	Test pressure	Body : 24 kg/cm2 Seat : 16 kg/cm2 Test duration : 30 minutes

SPECIFICATION FOR BALL VALVE / FULL BORE / 2 WAY / 3 WAY

1	Type	three piece, Reduced bore, floating ball, PTFE seated
2	Body, Cover & Gland	CS as per ASTM A216 WCB/ A105
3	Ball	SS , ASTM A 351, Gr. CF 8M
4	Stem	AISI 316
5	Fasteners	HT, SS 304 only
6	Gland Packing	35% Carbon Filled PTFE/ Graphite
7	End connection	Socket welded / Flanged (Refer Detailed Valve List)
8	Pressure rating	Class # 150
9	Manufacturing Standard	BS 5353/API 599/ BS 5159/ BS 5351
10	Test certificates	Required for material/hydro test
11	Service	For instrument fitting, air vent and for regulation purposes.
12	Max. operating temp	100 Deg ^{0}C
13) Remarks- Socket weld connection with nipple pipe of 100mm welded on all openings		

SPECIFICATION FOR CI/BRONZE PLUG VALVES

1	Type	DN 65 and above: C.I. Two way, lubricated type, tapered plug : Sizes upto DN50: Bronze, T port 3 way lubricated type tapered plug
2	Body, Cover & Gland	CI as per IS:210-1993 FG 220
3	Plug	CI as per IS:210-1993 FG 220/ Bronze as per IS:318 LTB-2
4	Fasteners	Black Hexagonal bolt with nut as per IS:1364 Part 1 & 3,1992, class 4.6/4
5	Gland Packing	Rubberised Asbestos
6	Gaskets	CAF
7	End connection	Screwed end upto DN50, NPT/ Flanged end for DN65 & above as per IS: 6392-1971 (RA'88) with matching flanges, table-17.
8	Pressure rating	PN = 1.6 N/mm2
9	Manufacturing Standard	BS 5353/API 599
1	Hydro static	Body:24 kg/cm2

0	testing	Seat:17.4 kg/cm2
11	Test certificates	Required for material/hydro test
12	Service	Cooling water for Blast furnace stove and stove valves
13	Max. operating temp	50 deg C
14	Gear arrangement	Worm gear of C.S./forged steel
Note: 1. Type of threading for screwed end will be as per IS:554-1999. 2. Plug valve of size DN200 shall be provided with worm gear arrangement.		

SPECIFICATION FOR SWING CHECK VALVE

1	Type	Conventional swing Check Valve
2	Body	CI FG 260 as per IS:210
3	Plate	CI FG 260 as per IS:210
4	Hinge pin	AISI SS 410
5	Eye Bolt	Carbon Steel
6	Seat ring	Bronze to Bronze
7	Door face	Bronze to Bronze
8	Body Test Pressure	24 kg/cm2
9	Seat Test Pressure	16 kg/cm2
10	Design Standard	As per BS: 5153
11	Dimensions	As per IS
12	Testing	As per IS
13	Special features required	1. Arrow indicating the flow direction. 2.Embossed name plate giving details of tag No. size, etc.
14	End Connections	Flanged

Electric Actuators

Electric actuators of valves shall be complete with electric motor, necessary gear drive, torque limit switches, position limit switches and terminal board.

Micro-switch shall be provided on the valves for disconnecting power supply which will operate when the valve is operated manually.

All motor operated valves shall have de-clutchable manual override along with the position indicators. The motorised valve shall be designed in such a way that it is possible to remove the actuator from the valve without requiring shutdown.

All limit switches shall be dust and water proof. All motors shall be suitable for DOL starting.

Motors shall be capable to start and run-up with the driven mechanism/equipment connected at a minimum of 85% of the rated voltage at the terminals.

All motors shall be capable of operating satisfactorily at full load for 5 minutes without injurious heating with 75% of the rated voltage at its terminals.

Starting torque shall be less than 160% of the rated torque. Starting current shall be less than or equal to six times the rated current.

Four-pole motors shall be used for all general applications unless specific drive requirement calls for.

Sluice Gates

Sluice gates are used as a means of flow isolation in channels and on ends of pipes entering wet walls. Sluice gates are used against a wall between two basins or between a pipe and an open channel.

Sluice gates have been usually located when the influent channel enters the wet well and can be operated to isolate the section of the wet wall for subsequent dewatering and maintenance/repairs.

Sluice gates shall be designed and manufactured as per IS: 3042-1965/ IS: 13349-1992 or, AWWA C501. Sluice gates shall be of rising spindle type.

DESIGN CRITERIA FOR PUMPS

HORIZONTAL PUMPS

All the pumps provided in the pump house shall be horizontal centrifugal type with flooded suction. In the event of space constraints, the use of vertical centrifugal, non-clog submersible pumps may be permitted. As far as practicable, pumps of reputed indigenous makes shall be preferred. Pump type shall be HSC type only.

The horizontal pumps shall be mounted on a common base plate with the motor and shall be directly coupled to the motor thorough a flexible coupling without any gear reducer.

The pumps (horizontal centrifugal) will be designed, manufactured and tested as per IS: 1520-1980, IS: 5120-1977 R.A.1991, IS: 9137-1978 R.A.1993 or as per international standards acceptable to the Purchaser and will be suitable for the required duty conditions and capacities.

The pumps and their auxiliary equipment shall be suitable for the required duty conditions and shall be designed and constructed for continuous duty at full load.

The centrifugal pumps shall be suitable for a capacity range of 25% to 125% of duty point capacity.

The motor capacity shall have a margin over its BHP absorbed at the pump shaft at duty point and the margin shall be 25% for motors of rating upto 15kW, 20% for motors of rating 18.5kW to 160kW and 15% for motors of rating 200kW and above. The above margin shall be in addition to temperature derating.

The pumps of kW rating more than 250 kW shall be of synchronous speed 1000 rpm/750 rpm.

The selection of motor shall be based on delivery valve in fully open condition. No Negative tolerance on the performance of the pump.

The equipment and auxiliaries shall be designed for quick and economical maintenance. The equipment shall be easily dismantable without disturbing the suction and delivery pipe connections.

The equipment design shall incorporate provisions for reduction in noise level.

The rotating elements of the pumps shall be checked for critical speed in bending as well as in torsion. The critical speeds shall be at least 30% away

from the normal speeds for units with flexible shafts and at least 20% away from the maximum operating speed in case of stiff shafts.

All passages inside the pump casing and impellers, which may be inaccessible to machining, shall be ground to a smooth finish as far as practicable.

The direction of rotation shall be clearly marked either by incorporating it on the casing or by separate metal plate arrow securely fitted to the casing.

- The head – Vs – discharge characteristics of the pump shall be continuously rising form the duty point to the shut off point without any zone of instability. The required duty range for a pump shall be on the stable portion of its head capacity curve close to the best efficiency point. The head developed at the best efficiency point shall be close to the required differential pressure so that throttling is not required at pump discharge. The power-Vs- discharge characteristics shall be non-overloading type. The shut-off head shall be minimum 20% or 15 mWC more than the rated head of the pump.

- The pump flow rating shall have 10 % margin over the process flow value.

- The pump shall be so selected and installed that the available NPSH is not lower than the required NPSH even in the most adverse operating conditions.

- The pump shall be of proven make and design having material of construction which is the best of its kind for the particular application and shall be manufactured using best engineering practices under strict quality control. Each pump shall be tested as per the standards stipulated elsewhere in this document. The test shall include hydrostatic test, static and dynamic balancing tests, performance tests material tests and motor routine tests.

- The pump shaft and bearing shall be adequately sized to take the unbalanced forced due to mal-operation. The pump gland shall ensure proper sealing without excessive tightening of the packing. Proper cooling and flushing arrangement for the gland shall be provided wherever required.

- All moving parts of the pump shall be adequately guarded to prevent any injury to operating personnel.

- Pumps shall be designed and installed keeping in view the easy accessibility of its parts for maintenance. All end suction pumps shall be of back-pull-out design and shall be provided with spacer coupling of adequate length.

- Mechanical seals shall be provided at all pumps envisaged for closed loop circuit.

- Minimum no. of standby pump shall be provided for each group of clear water pumps and drainage pumps as specified in the design criteria for pump house.

- An isolating valve shall be provided on the suction line of each pump and another isolating valve together with a non-return valve shall be provided at the delivery line of each pump. Each pump shall be provided with

local indication of pressure on suction side and local indication and signaling of pressure on delivery side.

- The suction pipeline shall be laid at a constant down ward slope from pump centre line to the suction chamber. Reducers used in the line shall be eccentric type to keep the top of the suction line straight.

- Each pump shall be provided with adequate safety interlocks including overload and dry running protection.

- Dismantling joints shall be provided on the delivery side of large size pumps to facilitate quick maintenance, wherever required.

- All pumps shall be provided with suitable lifting attachments and each pump installation shall have suitable handling facilities.

- A clear minimum gap of 800 mm shall be maintained between the pump and the adjacent piping, other equipment or structures for proper movement. In case the height of the top most part of the pump from the working floor is more than 1.0 m, the minimum clearance shall be increased to 1000 mm.

- The details of pumps should match with the drive motors throughout the working life of these equipments and to meet operational requirement. High-speed motors of 3000 rpm shall not be used, as for as practicable. Working hour meter shall be provided on control panels to monitor conditions and subsequent ageing / reduced efficiency, etc.

- Vibration readings, etc. of new installation shall be supplied.

- Pumps shall be installed and commissioned as per manufacturer's instructions. A continuous running for 72 hours shall be required before final acceptance is given to the pumping installation.

MATERIAL OF CONSTRUCTION FOR PUMPS

A) HORIZONTAL PUMPS:

Sl. No	ITEM	MATERIAL
a)	Casing	CI IS: 210 FG260
b)	Impeller	CF8M
c)	Shaft	EN 8
d)	Shaft sleeve	SS410
e)	Wearing rings	CI FG 220
f)	Shims & packings	Brass IS: 442
g)	Neck ring	CI FG 260
h)	Lantern ring	CI FG 220
i)	Gland	CI FG 220
j)	Bearing end cover	CI FG 220
k)	Bearing Housing	CI FG 220
l)	Coupling Pump & motor	CI FG 260
m)	'O' rings	Nitrile Rubber
n)	Sleeve nuts	SS 410
o)	Cowl nuts	SS410
p)	Base plate	MS Fabricated

Design criteria for pipelines

Pipe specification and pipe support span details

Thickness of pipe shall be as per IS:1239 Part-I, Heavy for DN150 and below and IS:3589 for DN200 and above and shall be selected as given below:

DN200, DN250, DN300 =6.35 mm
DN350, DN400, DN450 =7.14mm
DN500, DN600 =7.925mm.

Mitre bend shall be used in the pipes of size DN100 and above. Mitre bends are to be made from the parent pipe. Ready made fittings are to be used for the pipes of size DN80 and below.

Criteria for selection of pipe sizes:-

Pipe Diameter	Velocity range
Upto DN 150 mm	0.9 to 1.5 m/s
DN 200 mm to 450 mm	1.5 to 1.8 m/s
DN 500 mm to 1200 mm	1.8 to 2.2 m/s
Above 1200 mm	2.2 to 2.5 m/s

TABLE FOR MAXIMUM SPAN OF SUPPORTS

Nominal pipe size (mm)	Maximum span for liquid services (m)
DN 15 & below	1.5
DN 20, 25, 32	2.0
DN 40, 50, 65	3.0
DN 80, 100, 150	4.0
DN 200, 250	6.0
DN 300, 350	7.0

Note: Vertical pipe work shall be clamped at intervals of 3.5m (approx.) and at the base of each riser. Maximum span at the place of turning shall be 0.7 times of normal span.

01.02.06 Erection, Testing and Commissioning

1. The erection of all plant and equipment shall be carried out according to the latest engineering practices and according to the drawings, specifications, Instructions etc. duly approved by the Purchaser/Consultant.

2. The welding work should be carried out as per the approved WPS and PQR.

3. The Contractor shall supply all required manpower, tools and related equipment, all hoisting equipment, all necessary scaffoldings, all necessary transporting equipment, consumables. Construction and erection materials, petrol, diesel oil, kerosene, solvents, sealing compound, tapes, brazing and soldering materials, welding and brazing gases, erection bolts, nuts and packing sheets/compounds, temporary supports, wooden blocks, spacers, templates, jute and cotton

wastes, sand/emery paper etc. as required for the satisfactory completion of work.

4. After erection, all equipment having moving part, subject to pressures or voltages shall be given trial operation. The trial operation shall consist of 72 hours of continuous operation. All modifications and rectifications required during the trial operation or required for proper operation shall be done at his own cost by the Contractor as accepted by the Purchaser/ Consultant.

5. Rotating equipment shall be checked for proper direction of rotation and shaft alignment. Equipment subject to pressures shall be carefully examined for leakage. All equipment, such as pressure taps, temperature measurement connections, flow measurement devices etc. shall be provided by the bidder.

6. On completion of the work, the bidder shall remove and dispose off all rubbish and other unsightly materials caused by his working to a distance of five kilometer from the Compressed Air Station area or as directed by the Purchaser and thereby leaving the premises in good, clean, safe and operable condition.

7. Before giving call for final inspection, all the documents shall be furnished to the Purchaser. The record of manufacturing details, inspection and tests carried out by the successful Bidder shall be made available to the final inspecting authority. However, approval and final inspection at the manufacturing works shall not relieve the successful Bidder of responsibility of replacing at his cost any defective part/material which may be detected by the purchaser during erection and commissioning or guarantee period.

8. All materials required for fabrication, construction, testing and inspection shall be supplied by the bidder. No material shall be free issue to the bidder.

9. No equipment or part item shall be dispatched without final inspection and issuance of inspection certificate.

10. All equipment, assemblies, sub-assemblies shall be shop tested as per relevant standards and the test certificates shall be submitted by the supplier.

11. Erection, testing & commissioning of various equipments and piping etc shall be done also inline with details given in various chapters of GTS.

01.02.07 **Painting**

The Contractor shall follow the painting procedure as mentioned in GTS.

01.02.08 **Preferred Makes**

The Contractor shall follow the list of preffered makes as per the General Technical Specification. However, makes of any other item, not mentioned in GTS, shall be as per approval of the Purchaser /the Consultant.

01.02.09 **Drawings/Documents to be furnished along with the tender**

The Bidder shall submit the following drawings/ documents along with the tender: -

1. Scheme of the complete water supply system with descriptive and illustrative literature.
2. Process flow diagram indicating the water consumption figures complete with temperature, pressure and quality requirements.
3. P&IDs of each circuit of the complete water supply system showing all the consumers, flow rate, pipe diameters, broad parameters of each equipment, instruments, interlocks, water losses etc.
4. Write -up detailing the control logic for the entire water system.
5. Duly filled in data sheets for various pumps, cooling towers, automatic filters, valves and other equipments as applicable in line with in the GTS.
6. Pipeline materials and specifications considered for various systems.
7. Layout drawing showing the battery limits of make –up water, drinking water, fire fighting water (both inlet & outlets) and the pipeline route to various consumers including requirement of make-up water, drinking water and fire fighting water at battery limits.
8. General arrangement drawings of cooling water pumps inside compressed air station showing tentative dispositions of various equipment and piping.
9. Catalogues, literatures and GA drawings of all equipments and valves.
10. List of special tools and tackles.
11. List of commissioning spares.
12. List of spares for two years of normal operation and maintenance with item wise prices.
13. Specification and capacity of all equipment, valves etc. offered by the Tenderer.
14. Details of various drives, instruments, handling & hoisting facilities, air conditioning & ventilation facilities, etc.
15. Tentative Bill of Quantities covering all equipments, valves, strainers, pipelines, etc. and associated civil, structural, electrics, instrumentation, handling & hoisting facilities, air conditioning and ventilation facilities etc.

01.02.10 **Drawings/Documents to be Furnished by the Successful tenderer for Approval**

1. Process flow diagram indicating the water consumption figures complete with temperature, pressure and quality requirements.
2. Process & instrumentation diagrams for the water systems indicating location of all instruments, alarms and interlocks functions using ISA symbols.

3. GA drawings showing plan, elevation and sectional views of the water system including pumps, sump / tank (including civil, and other facilities) showing dispositions of various equipment and piping.
4. All equipment and piping sizing calculations.
5. General arrangement and cross-sectional drawings, characteristics curves and technical details of all the equipments (pumps, cooling tower, sluice gates, automatic filters, fire hydrants, valves etc.).
6. Layout of piping system indicating pipe routing, location of supports, valves and other fittings as required.
7. Data sheets, characteristic curves and technical details of all the equipments, valves and piping.
8. List of instruments comprising bill of materials and instrumentation data sheets.
9. List of safety interlocks.
10. Test procedures for preliminary and final acceptance tests.
11. Quality Assurance Plan.
12. Test certificates for the following:

- Material test certificate for all major equipment and their components.
- Hydraulic test of equipment, pipe fittings & valves.
- Static and dynamic balancing of all rotary parts/ equipments

13. Any other drawing/ documents as required by the Purchaser.

05.02.11 Drawings / Documents to be Furnished by the Successful Bidder for Reference and Record

1. The successful Bidder shall submit required sets of all the approved drawings, documents and manuals for Purchaser's record and use. After erection of equipment, the Contractor shall submit one set of linen tracings/ reproducible in required number of prints along with soft copies in CD (in AutoCAD format) of each "As built drawings".
2. Operating and maintenance manual.
3. Spare parts recommendation and price list.
4. Instruction for erection, testing and commissioning.
5. Manufacturer's test certificates.
6. Lubrication schedule and quantity and quality of lubricant for one year's normal operation.
7. Various equipment assembly drawings and bill of material.
8. Welding procedure.
9. Hydraulic test logs.
10. Equipment GA drawings and bill of materials.
11. Characteristics curves of the pumps, motors and other equipments.
12. Operation and maintenance manuals for all equipments, valves and complete water system along with soft copies.
13. Test and calibration certificates.
14. Warranty/ guarantee certificates.
15. Technical literature, catalogues and manufacturer's drawings for all brought out equipment, valves and other items.
16. All inspection/ test report/ certificates.
17. Any other drawing/ documents as required by the Purchaser/Consultant.