NEELACHAL ISPAT NIGAM LIMITED
IRON AND STEEL PLANT
KALINGA NAGAR INDUSTRIAL COMPLEX
DUBURI, ORISSA - 755026

GENERAL SPECIFICATION

FOR

FLUID SYSTEM

(GS-04)

NINL-PHASE-II

MECON LIMITED
RANCHI - 834002
INDIA

NO.MEC/GS/Q693/11/40/04, Rev.0 **MARCH, 2006**

01. **WATER SYSTEM**

01.01 **PUMP HOUSE**

01.01.01 **Design criteria for pump house**

The layout of the various equipment inside the pump house shall be designed by the tenderer keeping in view the safety of the personnel and accessibility of equipment.

The Pump house shall be of Civil construction. Equipment layout including design load data, equipment foundation size, layout of pump house, details of electrics, cable layout etc shall be furnished by the tenderer.

Structural platform with ladder shall be provided so that the valves can be easily accessible of operation and maintenance.

The makeup water shall be drawn into the sump through a float and motorized valve. An isolation valve shall be provided upstream of the float valve.

The sump/suction chamber shall be designed as per the standard of Hydraulic Institute. Sump model tests shall be conducted, if necessary. The sump/suction chamber shall have two compartments with provisions to tank to divert the entire flow form the cooling tower/ settling tank to either of other compartments when one of the compartments is under repair/maintenance. Cast iron sluice gates shall be provided for isolation of the compartments.

The pump house shall be provided with proper ventilation, electrics, illumination, instrumentation, telecommunication, wall clock and hoisting and handling equipment.

All the controls for the recirculation system and cooling tower shall be provided and the control panel shall depict the working condition of various units.

The electrics of the pump house shall be designed as per the contract specification given in the relevant chapter.

The capacity of the hoisting and handling equipment shall be selected in such a manner that it is able to handle the single heaviest load. Cranes/monorails with hoist shall be provided as indicated in the relevant chapter.

The pump house shall be provided with suitable ventilation facilities. The details of ventilation shall be as per the write-up of air conditioning and ventilation described in relevant chapter.

The pump house shall be provided with necessary illumination facilities along with portable lamps. The details of illuminations have been given in the relevant chapter.

The pump house shall be provided with a telephone and wall clock.

All the cold water and hot water pumps shall be of horizontal, centrifugal type an shall have flooded suction. Each pump shall be complete in all respects comprising the following:

Electric motor may be mounted on the common base plate. The capacity of the prime mover shall have a pump, margin of 15 % over the BHP absorbed by the pump, operating at rated parameters.

Flexible coupling and coupling guard.

Foundation bolts, nuts, washers etc.

Mild steel matching flanges bolts, nuts, gasket etc. required at the suction and delivery flanges along with the pipe reducers.

Each pump shall have independent suction. The delivery line of each pump shall be connected to the main header. The following flow velocities shall be maintained for the pump suction and delivery branches.

Diameter	Suction side	Delivery side
Upto 250 mm	1 to 1.2 m/s	1.5 to 2.0 m/s
Above 250 mm	1.2 to 1.5 m/s	2.0 to 2.5 m/s

Each pump shall be provided with a Butterfly valve on the suction side and a non-return valve (Dual plate zip check type) and delivery valve on the delivery side.

Each pump shall be provided with local indication of pressure on suction side and local indication and signaling of pressure on delivery side

Each header shall be provided with suitable number of valves for isolating and maintenance purpose.

Each header shall be provided with local indication of pressure and indication, recording and signaling of flow and temperature, which shall be depicted on the panel of the control room.

Minimum two drainage pumps (one working and one standby) of vertical non-clog type centrifugal pumps, of suitable capacity shall be provided to drain out the leakage/seepage water. The drainage pumps shall operate on water levels in the sump. In case of drainage pumps and other special type of vertical pumps, the pumps shall include the electric motor suitable or vertical mounting, motor stool, base plate with

accessories and fixing bolts, flexible coupling, shaft enclosing pipe column assembly, bearings, lubrication gaskets and washers pressure gauges, strainer at suction side etc. the characteristics of the prime mover shall be same as described under the main pumps.

All the valves of diameter 450 mm and above and the valves requiring remote control operation shall be electrically / Pneumatically operated. Electrically operated valves shall have provision for manual operation also. All Manual valves of sizes of 125 and above shall be gear operated.

Dismantling / Rubber Expansion joints near the pumps on both suction and delivery lines and compensates on the main header shall be provided wherever necessary.

Suitable chemical and biocide dosing facilities shall be provided in the suction chambers of the pump houses so as to prevent biological growth, 'scale/ corrosion if any of the circulating water system. The facilities shall consist of chemical storage tanks of suitable storage time, dosing pumps (metering type) one working and one reserve. The dosing system shall be complete in all respects with tanks, pumps, valves, supports agitators and necessary pipe-work.

The pipe network and valves within the pump house shall be adequately supported so as to avoid undue stress on the pumps.

01.02 PIPE WORK

01.02.01 Design Criteria For Pipe Work

The term pipe work referred herein generally cover pipes, fittings (such as bends, tees, reducers, plugs, nipples, sockets, unions, flanges, crosses etc.)., valves of various types and functions (such as gate glove butterfly, plug, check diaphragm, electrically operated, pressure reducing valves, etc.) strainers, filters, hoses, hose couplings hose clamps, hose nozzles, fire hydrant assemblies, pipe supports, corrosion protection etc.

Pipe work is intended to convey fluids such as different qualities of water and industrial effluents.

The pipe work shall be designed, manufactures, assembled and tested as per the latest standards, codes and recommendations of the Indian Standard Institution. SNSI, ASTM, AWWA, or other equivalent national standards. Pipe work shall be complete in all respects including all accessories essential for proper installation, operation and maintenance, even though such items are not specification mentioned in the specification.

Piping system shall be designed with high degree of reliability so that the systems perform the duty of fluid handling without any failure under all conditions of plan operation.

Piping layout must follow good engineering practice. Proper attention shall be paid to obtain full functional requirement of the piping system with a layout which provides sufficient clearance for other equipment and operating personnel, convenient supporting points and neat appearance.

Complete design of piping system shall be subject to approval by the Owner.

The design shall take into account the effect of internal/external pressure, thermal expansion, self weight of piping, support reactions, surge and water hammer, earthquake and wind effects at site, corrosion and erosion etc. and any other effects dictated by good engineering practices.

Piping systems shall not impose undue forces on equipment terminals.

Mild steel / Carbon steel pipelines shall be used in general for water supply facilities and special quality pipes such as GI/ Cast Iron for drinking and PVC/ MS rubber lined HDPE Pipes for corrosive fluids.

Pipelines shall be laid over ground on the structural trestle as far as possible.

As far as possible all the pipelines shall be laid together along the piping corridor. The piping corridor shall be parallel to and by the side of roads.

All the pipes network shall be provided with manually operated valves for isolation/controlling purpose. Valves for size 125 mm and above and be gear operated and valves of size above 450 mm shall be electrically operated.

The pipe network shall be provided with air release valves at high points and drain valves at the lower points.

Pipeline passing under or through equipment foundations or walls of buildings or any other inaccessible structure shall be provided with steel encasing pipes for easy insertion and removal.

All the pressure pipes shall be laid with a nominal slope and the gravity network with slope of self-cleaning velocities.

Continuous welding MS pipes shall be used for water supply facilities and pipe flanged at regular intervals and at bends shall be used for slurry and other corrosive fluid services. For drinking water, screwed and socked GI pipelines shall be used up-to 150-mm dia.

Except where otherwise specified, all piping shall have butt welded connections with a minimum of flanged joints for connections to equipment. Branches shall in general, be formed by welding.

Provision shall be made for branches for cleaning and flushing of pipelines wherever necessary.

Manholes shall be provided in the gravity pipe networks and the distance between two manholes shall be 30-50 m depending upon the pipe size.

Compensators shall be provided on the over-ground pipe network to take care of thermal expansion.

Wherever over-ground pipelines are crossing roads and railway tracks, they shall be laid on pipe bridges to provide the necessary clearance for the traffic movement. This should take in to account the various type of vehicles likely to move in the plant.

Valves provided on the over-ground pipe network shall be provided with steel structural platforms and access ladders.

Walk-able platforms with necessary hand rails shall be provided by the side of overhead slime troughs and open gravity network, wherever necessary.

Provision shall be made for support of piping which may be disconnected during maintenance work. All large pipes and all long pipes shall have at least two supports each arranged in such a way that any length of piping or valve may be removed without any additional supports being required.

Pipe supports shall be capable of supporting the pipelines under all conditions of operation.

All the buried pipelines shall be laid with a nominal slope towards the drain point.

All the buried pipelines shall be laid as far as possible at a depth of about 1000 mm, below finished ground level (i.e. the top of the pipelines shall be 1.0 m below the finished ground level).

Isolation /control valves drain valves, air release valve provided on the buried pipe network shall be housed in suitably sized covered valve pit and the valve pits shall be of self draining type.

Wherever the buried pipelines are crossing the roads and tracks, they shall be suitable encased with mild steel pipes or reinforced concrete casing pipes and the different sizes of the encasing pipes shall be as given below :

Encased pipe diameter	Encasing pipe Flanged pipe size (mm)	Diameter for welded pipe size (mm)
Upto 100	300	250
150	400	300
200	500	400
300	600	400
350	600	500
400	700	600
500	800	700
600	900	800
700	1000	900
800	1100	1000
900	1200	1100
1000	1400	1200

In case a number of pipes are crossing road or track, these pipes shall be laid in a reinforced concrete culvert having easy access.

Mechanical cleaning and anticorrosive protection of underground MS pipelines shall conform to IS: 10221 – 1982. The anticorrosive protection of pipelines shall consist of the following activities in sequence.

i) Application of one coat of coal tar primer

ii) Application of one coat of coal tar enamel

iii) One wrap of fiber glass tissue

iv) Application of one coat of tar enamel one layer of fiberglass tissue impregnated in coal.

v) Application of the final coat of a water-resistant white wash.

Alternatively Multilayer coating tape shall consist of:

1) Thermofisible HMHPDE inner wrap of fiber glass and HMHDPE film, coal tar.
2) Final outer wrap of enamel impregnated fiber glass or HMHDPE film.

RCC manholes with removable covers shall be provided for the buried gravity network and the maximum distance between two manholes shall be 30 to 50 mm depending upon the pipe size. Manholes of adequate size shall be provided at all pipe junctions.

Where the pipelines cannot be laid overhead on stockades and are crossing roads and tracks at too many points in a given area, the pipeline may be laid in walk-able tunnels.

Pipelines in tunnels shall be provided with isolating valves, air release valves and drain valves, which are easily accessible for operation and maintenance. Gland type of Compensators shall be provided on these pipelines wherever necessary.

Pipelines in tunnels shall be suitable ventilated and illuminated. There shall be minimum two entries for the tunnel. Each tunnel shall be provided with at-least two vertical centrifugal, non-clog type drainage pumps (one working and one standby) and these pumps shall operate automatically based on the liquid levels. Each tunnel shall be provided with at least a monorail and hoist for erection and maintenance purposes. Minimum height of the tunnel shall be of 2.0 m and suitable walkway aisles shall be provided for each tunnel.

Pipelines within the shop buildings shall be laid overhead supported form the building columns/side walls/cranes girder etc. wherever this is not possible, the pipelines shall be laid either in tunnel or in pipe trenches (covered with removable slabs of chequered plates).

Wherever pipelines are crossing form one bay to another parallel bay, they shall be laid in tunnel or supported form the gable end.

01.02.02 **Pipe Specification**

A) Black Pipes DN 15 to DN 50 :

1. End condition : Bevel Ends
2. Class : Schedule 80
3. Material : ASTM.A.53 Gr:B
4. Manufacturing : Seamless

B) Carbon Steel Pipes DN 65 to DN150 as per IS:1239-1990(R.A.-2004) :

1. End condition : Bevel Ends
2. Class : Heavy
3. Material : As per IS: 1387, 1967
4. Manufacturing : ERW process
5. Thickness : As per IS: 1239

C) Pipes above DN 150 as per IS:3589-1991:

1. End condition : Beveled ends for butt welding
2. Material : Carbon steel, Gr. Fe 410
3. Manufacturing : ERW/EFW/SW process

D) Carbon Steel G.I(Galvanised Iron) Pipes DN 15 to DN 150 as per IS: 1239-2004:

1. End condition : Screwed upto DN50,Beveled ends for all the sizes above DN 50.
2. Grade : Heavy
3. Material : Carbon steel, Gr. Fe 410
4. Manufacturing : ERW/EFW/SW process

01.02.03 Dimensional Performance and End Finishes

Tolerance on outside diameter of the pipe and specified thickness shall conform to the limits laid down in IS:3589-1991. Finish pipe shall not deviate from straightness by more than 0.2% of the total length.

Pipes to be butt welded shall be supplied with ends beveled to an angle of 30 degrees (+ 5 degree – 0 degree).

Pipelines shall be laid over-ground on structural trestle as far as possible.

As far as possible all the pipelines shall be laid together along the piping corridor. The piping corridor shall be parallel to and by the side of roads.

All the pipes in network shall be provided with manually operated valves for isolation/controlling purpose. Valves for size 125 mm and above shall be gear operated.

The pipe network shall be provided with air release valves at high points and drain valves at the lower points.

01.03. **EFFLUENT TREATMENT PLANT (ETP) FOR G.C.P**

01.03.01 **General**

Effluent treatment plant shall essentially comprise, but not be limited to the following units/facilities:

Sl. No.	Description	Qty (Nos.)
1	Inlet slurry launder of carbon steel construction with walk-way, hand-rails and structural support.	1
2	Flash mixer complete with mixer blade, shaft, gearbox, motor, base plate, supports, etc.	2
3	Manual bar screen	1
4	Sluice gates	2
5	High-rate thickeners complete with raker arm, lifting device, feed well, approach bridge, drive motor gear box, limit switches, common base plate, etc	2
6	Under flow slurry pumps and slurry recirculation pumps in Ni-hard construction complete with drive motor, base plate coupling, coupling guards, bolts, nuts, gaskets, etc. with provision for compressed air agitator at bottom	4+4
7	Sludge storage tank with agitator mechanism complete with paddle, shaft , motor, gear-box, base-plate, platforms, handrails, etc.	1
8	Flocculent agitator with MSRL tank, drive motor, etc	2
9	Metering pump with drive motor	4
10	Slurry disposal pump in Ni-hard construction complete with drive motor, coupling, etc.	1
11	Plug valves, ball valves, gate valves, and non-return valves	1 lot
12	Carbon steel slurry pipelines(heavy grade), service water pipelines (medium grade) and drinking water pipelines (GI, medium grade)	1 lot
13	Weighing machine in chemical house	1
14	Sealing water pumps/ Flushing water pumps	As required
15	Material handling facilities	As per TS
16	Instrumentation as required	1 lot
17	Structural supports, hand railing, etc. as required	1 lot
18	Electrics as per T.S.	1 lot

01.03.02 Broad design Guide-lines.

- **Slurry launder**
  Carbon steel launder complete with walk-way, hand rails and structural support, shall be provided at the discharge point of Gas Cleaning Plant up-to the ETP. The cross-section and the slope with available level constraints shall be so designed as to ensure a self cleaning velocity (min. 1.5m/s) to avoid deposition of the solids at the launder bottom. The minimum free board shall be 300 mm to avoid spillage of slurry during the plant operation.
- **Flash mixer.**
  Two units of RCC flash mixers (one for each unit of HR thickener) with structural ladders, platforms, hand-rails, etc. shall be provided to allow 60 sec. mixing time with the dosing chemical. The out-flow channel with the walk-ways of removable chequered plates leading to the thickener shall be provided with gates to control/cut-off the supply of thickeners. Local type pH measurements shall be provided before and after the chemical dosing.

- **Thickeners**
  Each thickener shall have the capacity to treat 70% the total effluent from Gas Cleaning Plant. The thickener shall be of central drive type. The racker arm mechanism with gear reduction unit shall be provided. In the event of racker arm getting jammed, audio visual signal shall be available at the sludge pump house control panel. The racker arm shall be provided with lifting device (electro-mechanical type) and hydraulically operated rake drive with planetary gear box. Working position of the thickener shall also be depicted in the pump-house. After encountering max. Torque limit, the rocker arm shall lift automatically to 300mm and continue to rotate in the lifted position. At the preset torque level, the rocker arm drive motor shall trip.

  Sludge chamber shall be provided with manually operated valves to connect the pump suction lines. Portable type local pH meter shall be provided to measure the pH of the clarified water.

- **Miscellaneous Requirement**
  Following facilities shall be provided:
  (i) Flocculants preparation & Dosing tanks:
    - Two preparation tank s of SS-304 construction with manual feeding system.
    - Two nos. holding cum dosing tank of 24 hrs capacity of MSRL construction.
    - Screw type dosing pumps with SS internal shall be provided (one working + one stand-by) for each circuit.
    - Each of the solution preparation / holding tank shall be provided with mechanical agitator with electric drive.

- The agitator of the solution tanks, sludge tanks, shall be both local and remote control.

(ii) Pumps : following group of pumps shall be provided

- Under flow recirculating pumps (1 working + 1 stand-by) for each HRT.
- Slurry transfer pumps from storage tank to vacuum filtration plant-2 (1W+1R)
- Flushing pumps (1W+1R).
- Gland sealing pumps (1W+1R).

(iii) Miscellaneous

- All valves for slurry operation shall be lubricated plug valves.
- The unintentional tripping of the drive motors. Jamming of valves etc shall be accompanied by visual signal at control panel.
- Thickener overflow channel sizing shall be done on 200% overloading.

Design Parameters of Slurry for GCP

i)	Flow rate	: m3/h
ii)	Total suspended solids	: 3000-5000 ppm
iii)	pH	: 7.3-801
iv)	Temperature	: 50-60 deg. Celsius
v)	Pressure at discharge point (battery limit of the Bidder)	: by gravity at about +10m level.

vi) Analysis of suspended solids

a) Fe_2O_3	: 71.42%
b) SiO_2	: 5%
c) Al_2O_3	: 1.4%
d) CaO	: 6 %
e) MgO	: 3.2%
f) P	: 0.016%
g) S	: 0.483%

vii) Approx. particle size distribution

< 10 micron	: 30%
10 to 40 micron	: 35%
40-60 micron	: 15%
> 60 micron	: 20%

01.03.03 **Performance Guarantee & Penalties**

After completion of erection, cold tests and hot trial runs and fulfillment of performance of individual equipment and system, the integrated system performance guarantee tests shall be conducted by the Contractor to establish the rated output, quantity of treated effluent and power consumption of the Effluent Treatment Plant.

The performance guarantee tests shall be completed within a time schedule to be mutually agreed upon between the Purchaser and the contractor. Details of the performance tests, test procedures and test schedules for the demonstration of the performance guarantee shall be submitted to the Purchaser and shall be mutually agreed upon.

Should the performance values fall below acceptable level, the unit/sub unit/equipment shall be rejected by the Purchaser and the Contractor shall be liable, at the option of the Purchaser, either to replace the unit/sub unit/equipment or to pay compensation in addition to the liquidated damage as per the contractor or as may be agreed upon.

The following, system performance value shall be guaranteed by the Contractor:

- The flow rate at the battery limit of the outlet of the ETP shall be ____m^3/h.
- Total suspended solids (TSS) content of the treated effluent from the ETP shall not exceed 100 ppm. Hardness < 1000 mg/I, Chloride < 3000 mg/I.
- Energy consumed as measured at motor control centre of the ETP shall not exceed the values quoted during the tender stage.

No negative tolerance shall be permissible on capacity and quality of the treated effluent from the ETP. Further, no positive tolerance shall be permissible for power consumption of the plant.

01.03.04 **Slurry Transfer Pumps**

Slurry transfer pumps shall be provided to pump the settled sludge from the HR Thickener to sludge storage tank/sludge sump of the sludge dewatering plant. The number of standby pumps shall not be less than two. The capacity of the pumps shall be decided by the tenderer depending on the quantity of sludge generated. The sludge pump shall operate continuously and accordingly sizing of the pipeline shall be done.

Each sludge pump shall be able to pump sludge from Sludge storage tank. Sludge pumps and sludge pipelines shall be provided with suitable flushing connection from industrial water pipeline network.

Sludge pump shall be of horizontal centrifugal, type with single end suction and tangential discharge nozzle and shall be suitable for either front or back pull out disassembly. The impeller width and volute areas, dictate by the design capacity shall be so as to offer no restriction to the passage of solids. Provision shall be made for ready access to wearing parts or renewal.

01.03.05 **Slurry Piping:**

Flanged carbon steel pipes shall be used for transportation of slurry. The pipe thickness shall be chosen taking into consideration the abrasive characteristics of the solids in the slurry. The thickness shall be as per thickness schedule for sludge pipelines.

The pipe sizing shall be decided based on the critical velocities and the abrasive characteristics of the solids in the slurry. The velocity shall be such that no solids settle in the pipelines.

The slurry pipelines shall be laid under a nominal slope. The slurry pipe network shall be provided with necessary shut off valves, air release valves, compensators etc.

The slurry pipelines shall be laid over ground or in covered channels / tunnels. Slurry pipelines shall have flanged connection at an interval of 8 meters. All bends shall be of flanged type connections only.

If the nature of slurry being transported is very abrasive, the pipelines shall be provided with suitable wear resistant lining and the details for the same shall be furnished.

The slurry pipelines shall be provided with flushing and drainage facilities.

Flushing pipeline size should be more than the line to be flushed. Size of the flushing pipeline shall be one size higher. (DF>DL).

All fittings should be forged and should have long radius (3Dm), thickness of pipe shall be one size higher than normal pipe thickness.

Flow meter at under flow discharge pipeline shall be provided .

Provision of emergency unloading of slurry from thickener by road tanker shall be envisaged.

Sealing water shall be provided at least 1.5kg/cm2 higher than the pump operating pressure. Separate pumps (1w+1R) shall be provided.

Underflow of each thickener shall be collected at common storage tank (Min. retaining time-2 hrs.) with agitator and shall be pumped with a higher capacity / high head slurry pump.

The diameter of slurry pipe leading to sludge pond shall not be less than 80 mm.

Dedicated shall pump shall be provided of under flow slurry of thickener. (1W+1R) pumps shall be provided for each system.

Duplicate slurry pipelines shall be provided from the effluent treatment plant to sludge dewatering plant.

01.04. **HOISTING & HANDLING EQUIPMENT:**

Adequate number of manually operated hoists/ electrically operated hoist/Elect. Under slung cranes / EOT cranes shall be provided in the pump house/Slag Granulation plant for easy maintenance at erection of equipment.

Hoisting and handling equipment shall be provided for lifting individual loads weighing 200 kg an over.

The type of lifting device shall be selected based on amount of load to be lifted, height of lift and frequency or operation and the layout of the equipment to be lifted. In general if the load of be lifted is 1000kg or more and /or height of lift is 8m and more, power operated handling equipment shall be provided.

01.05. **CHEMICAL DOSING SYSTEM FOR RECIRCULATION WATER SYSTEM**:

01.05.01 **Deposit Control Agents**

Tenderer shall indicate the trade name, composition, appearance, odour, pH optimal, pH after dosage, solubility gravity dosage, feeding dosage, solubility, specific gravity dosage, feeding procedure at feeding points of the deposit control agent.

01.05.02 **Corrosion Inhibitors**

Suitable corrosion inhibitors shall be used for the control of corrosion n open re-circulating cooling water systems. The corrosion inhibitor shall be fed to the re-circulating water, wherever found necessary, by means of a metering pump. Corrosion resistant feeding equipment shall be used.

Tenderer shall furnish the trade name, composition, appearance, specific gravity ,pH recommended dosage, optimal pH after dosage, solubility, freezing point, feeding procedure and feeding points of the corrosion inhibitor.

01.05.03 **Antifoulants**

Suitable anti-foulants shall be applied for the prevention and removal of iron oxide and other metallic oxides in the water re-circulating systems wherever found necessary. The anti-foulant shall have good dispersing properties.

Tenderer shall furnish the trade name, composition appearance, pH specific gravity, solubility, freezing point, recommended dosing rate, feeding procedure and feeding points of the anti-foulants.

01.05.04 **Biocides**

Suitable biocides shall be provided for the control of bacterial, fungal and algal growth in the re-circulating cooling water systems. The biocides shall have good solubilising and dispersing properties to ensure good distribution throughout the system and efficient penetration of the slime masses, to the encountered. Dosing rate and dosing points shall be judiciously selected taking the following factors into consideration:

i) The nature and extent of the anticipated microbiological contamination for the different re-circulating water systems.

ii) The type and volume of systems to be treated.

iii) Quality of the makeup water

iv) The degree of recommended control of microbiological contamination.

v) Retention time in the system.

Tenderer shall furnish the trade name, composition, appearance, odour pH, solubility, freezing point, recommended dosage and procedure of feeding for the biocide.

01.06 SPARES & CONSUMBALES

01.06.01 Commissioning Spares

Commissioning spares as required shall be in the scope of supply of the Purchaser along with the equipment. It shall cover requirement of trial runs and part testing also.

01.06.02 Consumables.

The Contractor shall supply consumables like first/initial fill of lubricants, oils, grease, chemical, resins etc. as required to complete the plant till commissioning. The scope of consumables shall include electrodes, shims, packing bolts, nuts, gaskets, rivets, washers etc.

The Contractor shall also indicate the annual requirement of all consumables.

01.06.03 Operating, Maintenance and Capital Spares

The supply of spare parts as necessary and as recommended the respective manufacturer for two years of reliable and trouble free operation and maintenance of all equipment under this package shall be supplied by the Contractor.

01.06.04 Special Erection/Maintenance Tools and Tackles.

The Contractor shall supply a complete and unused set of all the special tools and tackles including required number of tool boxes as required for erection, maintenance, overhaul or complete replacement of the equipment and components required for the plant.

All the tools shall be supplied in separate containers clearly marked with the name of the equipment for which they are intended.

01.06.05 Completeness

The parameters in respect of the equipments or accessories shall be as per requirement for operating the main plant and the accessories in an efficient and trouble free way.

Any equipment, fittings, materials or supplies which may not be specifically mentioned in the specification or drawings but which are necessary for smooth and normal operation of the plant and equipment under this package shall be provided for an rendered to by the Tenderer without any extra cost. The plant must be complete in all respects and shall be in perfect running conditions to comply with the guaranteed performance.

01.07. PRELIMINARY ACCEPTANCE

01.07.01 General

Before the start of the system/plant, the following conditions shall be fulfilled.

The plant and equipment shall be subjected to tests to prove satisfactory performance as individual equipment and also as a system on the whole.

Plant and equipment erected shall conform to the approved process flow diagram/schemes and drawings.

All machines shall be installed correctly as per manufacture's instructions and drawings or as directed at site by Purchaser.

01.07.02 Plant/ System startup.

Equipment/system shall be started under the supervision of equipment supplier's engineers, who may make such adjustments to establish guaranteed performance.

Detailed startup procedure shall be agreed upon between Purchaser and the Tenderer before the tests.

01.08. **DRAWINGS,DOCUMENTS FOR COOLING SYSTEM FROM CONTRACTOR.**

01.08.01 **Drawings/Documents for approval:**

a) A comprehensive write up indicating all the technical features of high pressure stack cooling recirculation system and BF proper cooling system.

b) Fluid balance diagram with parameters, pipe sizing calculations at Battery limit.

c) Detailed P& I Diagram.

2. Water hydraulic flow diagram with calculations.

3. Process Instrumentation for chemical dosing diagrams including interlocks.

4. Design calculations for chemical dosing, drainage facilities.

5. Design calculations supporting the selection of all the equipment with number and specifications giving the material of construction of important member of the equipment.

6. Pressure drop calculations of piping network.

7. Complete layout drawings within the battery limit showing overall dimensions of individual units, pipe network, channels/launders, drains, manholes, valve pits, roads, culverts, walkway bridges, brick paving, protection bunds, sludge ponds, fencing boundary with gates etc. as required.

8. Dimensional general arrangement drawing with plans and cross sectional views of all units, buildings facilities, incorporating all equipment pipe-work monorails, ladders, stair cases, platforms, walkways access doors, etc. complete in all respect with clearance clearly shown between the equipment and the building walls.

9. Dimensional GA drg. of all the equipments giving bill of materials including material specifications.

10. Complete layout and profile drawings of all the pipelines, launders, channels etc. Indicating the flow rate, diameter, elevation, consumption points with rate of draw-off, location of valves, valve chambers, manholes, supports and supporting arrangement, encasing pipe etc

11. Performance data and predicted characteristic curves of equipment.

12. List of spares parts for two years operation and maintenance.

01.08.02. **Drgs/Documents Required for Reference**

1. Test certificates for all equipment.

2. Civil engineering assignment drgs. Giving load data, layout of piping and cable channels for equipment foundation design as well as design of channels.

3. List of initial fill of lubricants, consumables special tools and tackles.

4. Operation and maintenance manuals for plant and equipment.

5. Catalogues/literature of equipment.

6. Reproducible/literature of equipment.

7. As built drgs. Upon installation and commissioning incorporating revision/modifications, if any done during execution of the contract.

01.08.03. **Drgs/documents required for inspection**

1. Manufacture's guarantee test certificate.

2. Material test certificates for major component

3. Predicted performance/characteristic curves of equipment.

4. Assembly drawing of equipment indicting pat list bill of material and material specification.

01.09 **PUMPS**

01.09.01 **General**

- All the pumps provided in the pump house shall be horizontal centrifugal type with flooded suction. Drainage pumps installed in sump pits shall be horizontal, centrifugal type with priming tank arrangement. 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 preferably HSC, ESTD(BPO) type pumps are acceptable on case to case basis.

- The horizontal pumps shall be mounted on a common base plate with the motor thorough a flexible coupling without any gear reducer. In case of slurry pumps use of fluid coupling may be permitted. The motor capacity shall have margin of 20 % over its BHP absorbed at the pump shaft at the duty point. the pumps shall be complete with companion flanges, bolts, nuts, foundation bolts, etc.

- 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 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 one standby pump shall be provided for each group of clear water pumps and drainage pumps. The group of Pumps for scale water or other abrasive slurries shall be provided with at least two standby units. Special abrasion resistant material shall be used for these pumps and the design shall allow easy replacement of parts subject to wear and tear.

- 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. Pressure gauges shall be provided at the suction and delivery flange of each pump.

- 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 700 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 this equipment 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.

01.09.02. **Shop testing of pumps**

- All materials, casting and forging shall be of tested quality.

- Pump casing shall be of robust construction and hydrostatically tested at 200% of the rated pressure of 150 % shut off pressure, whichever is higher. The test pressure shall be maintained for at least 15 minutes.
  - The impellers along with any other unmachined rotating parts shall be tested for proper balancing in order to avoid undue vibration during operation.

- Performance tests shall be carried on each centrifugal pump. Performance test shall be made to determine the following.

  a) The discharge against a specified head when running at a specified speed under a specific suction head.

  b) The power absorbed by the pump at the shaft (BHP) under the above-specified conditions.

  c) Efficiency of the pump under the above specified conditions.

  d) Variation of required NPSH with discharge.

- The pump accessories like bearings, couplings etc. shall be subject to shop tests as per manufacturer standards.

- The materials of construction of various components of all equipment and material covered under the scope of his specification shall be certified by the contractor with regard to their compliance to specifications laid down for them under relevant clauses of applicable standards and /or the manufacturing drawings of the contractor duly approved by the purchaser. Formal material test certificates to the effect shall be issued by the contractor.

- All test results and certificates including material test certificates shall be submitted for approval to the purchaser before dispatch of equipment.

01.09.03 **Material of construction for pumps**

A) Horizontal Pumps

Sl. No	ITEM	MATERIAL
1	IMPELLER	Cast Steel , ASTM A 216, WCB
2	CASING	CAST IRON (IS 210 FG 260)
3	CASING RING	CAST IRON (IS 210 FG 260)
4	SHAFT	C-40
5	SHAFT SLEEVE	SS – 410
6	GLAND	CAST IRON
7	BASE FRAME	M.S FABRICATED
8	FLANGES	M.S

B) Vertical Pumps:

Sl.No.	ITEM	MATERIAL
1	IMPELLER	CS ASTM A 216, WCB
2	CASING	CAST IRON (IS 210 FG 260)
3	CASING RING	CAST IRON (IS 210 FG 260)
4	SHAFT	C-40
5	SHAFT SLEEVE	SS – 410
6	GLAND	CAST IRON
7	BASE FRAME	M.S FABRICATED
8	COMPANION FLANGES	M.S
9	COLUMN PIPE	M.S
10	SUCTION STRAINER	M.S GALVANISED

C) Material of Construction for SGP Pumps:

Sl.No.	ITEM	MATERIAL
1	COVER AND FRAME PLATE	CAST IRON
2	THROAT BRUSH	27% Cr
3	FRAME AND COVER PLATE LINER	NATURAL RUBBER
4	FRAME PLATE LINER INSERT	27% Cr
5	VOLUTE LINER	27% Cr
6	IMPELLER	27% Cr
7	SHAFT	EN8
8	SHAFT SLEEVE	420c/CA 40
9	STUFFING BOX	CAST IRON
10	GLAND	316SS/CF8M
11	BASE	CAST IRON (IS 210 FG 260)
12	BEARING HOUSING	CAST IRON
13	OTHER BOLTS	MILD STEEL(CAD PLATED)

01.09.04 **Specification for SGP Pumps:**

The following pumps will be acceptable for SGP application

- Vertical cantilever Slurry pumps fully assembled with belt drive arrangement and electric motor.
- Submersible pumps fully assembled with electric motor Trash.
- Pumps with reverse overhead mounted electric motor and V-belt drive, c/w common base frame for pump motor, and drive assembly. Outboard bearings and jack shaft arrangement on pump and motor.
- Periodically the bottom of the sump may have 600 to 1000 mm of accumulated solids (Granulated Slag) build up. The pump selected must be capable of starting and running under these conditions.

01.09.05 **Technical Specification for Diesel Engine Driven Pumpset**

01.09.05.01 **General**

- The diesel engine shall be complete with all standard accessories, battery sets, battery charger, instruments & control panel, base frame etc.

- The diesel engine shall be compression ignition mechanical direct injection type, capable of being started by a battery powered electric starter motor, and shall accept full load within 15 seconds from the receipt of signal to start.

- The diesel engine shall be natural aspirated, super charged or turbo charged and either air or water-cooled. In case of charge air cooling by means of a belt driven fan or of a belt driven auxiliary water pump, there shall be multiple belts such that half the belts should be capable of driving the fan or pump.

- The diesel engine shall be capable of operating continuously (24 hours) on full load.

- The diesel engine shall be provided with an automatically adjustable governor to control the engine speed with 10% of its rated speed, under any condition of load up to the full load rating. The governor shall be set to maintain rated pump speed at maximum pump load.

- The diesel engine shall be provided within-in-built tachometer to indicate the speed of the engine in rpm.

- Any manual device fitted to the engine, which could prevent the engine starting, shall return automatically to the normal position.

- Engines after correction for altitude and ambient temperature shall have bare engine horsepower rating of 10% in excess of maximum horse power required to drive the pump at its duty point.

- The coupling between the engine and the pump shall allow each unit to be removed without disturbing the other.

01.09.05.02. **Cooling System**

- The engine shall be cooled by water from the discharge of the pump (takes off prior to the pump discharge valve) direct into the engine cylinder jackets via a pressure reducing device to limit the applied pressure to a safe value as specified by the engine manufacturer. The outlet connection from this system shall be terminated at least 150 mm above the engine water outlet pipe and be directed into an open tundish so that the discharge water is visible.

- The discharge from the engine shall be collected and drained into the nearest drainage channel.

01.09.05.03. **Air Filtration**

The air intake system ensure sufficient clean air to the engine. It shall incorporate the suction air filter, which shall be of oil bath type to supply clean air to the engine.

01.09.05.04 **Exhaust System**

The hot exhaust gases shall be let-off with suitable system. All the hot parts located at the working level shall be insulated. The exhaust system shall include:

- Exhaust manifold

- Silencer : The exhaust gas shall be let off through suitable silencer. The total back pressure shall not exceed the engine manufacturer's recommendation. Sufficient length of straight pipe shall be provided after the exhaust silencer to leave the gases at sufficient height above the engine and outside the engine room.

- Expansion joint in SS construction to reduce the forces and moment likely to be transmitted on the engine frame.

01.09.05.05. **Fuel System**

- Fuel for the engine shall be high-speed diesel oil as per IS : 1460 – 1974.

- Fuel tank and fuel feed pipe shall be provided for the engine.

- The fuel tank shall have the capacity sufficient enough to allow the running of the engine at full load for 3 hours.

- The fuel tank shall be of welded steel construction. The tank shall be mounted above the engine fuel pump to give gravity feed. The tank shall be fitted with a level gauge calibrated in liters, filling in and cleaning hand holes, drain cocks, self supporting from and connection to the engine fuel oil system.

- Valves in the fuel feed pipe between the fuel tank and the engine shall be placed adjacent to the tank and they shall be located in open position. Plastic tubing shall not be used.

- A duplex filter to suitable capacity shall be provided for the fuel feed pipe between the fuel tank and fuel pump.
- Suitable sludge and sediment trap shall be provided for the fuel feeding system.

- The fuel tanks shall be supplied with hand pump for tapping the fuel tank from oil barrel.

01.09.05.06. **Lubricating System**

The lubrication system shall be self-contained with the following equipment.

- Sump : To store sufficient lube oil for circulation, suitable sump shall be located in the engine.
- Pump : Suitable pump for forced lubrication.
- Filter
- Lubricating oil cooler
- Interconnecting piping & tubes in seamless construction.

01.09.05.07. **Starting System**

The engine shall be capable of manual starting by electric starter motor
Since the pump driven by the diesel engine is not required to run continuously for long period and the operation will not be frequent, special features shall be built –in the engine to allow it to start within a very short period, even if it has been remained idle for a considerable long period.

The engine shall be designed in such away that is shall be started by one operator, if necessary, without any preliminary heating of the combustion chamber. All controls/mechanism, which has to be operated in the starting process, will be within easy reach of the operator.

Automatic cranking shall be effected by a battery driven 24V DC motor having high starting torque to have adequate ampere-hour capacity to provide the starting power for the diesel engine. A control panel for starting of the engine through battery to be provided. Engine START/STOP/TEST buttons shall be provided on control panel. The

battery capacity shall be adequate for ten (10) Consecutive starts without recharging with a cold engine under full compression.

The battery shall be used exclusively for starting the diesel engine and kept fully charged all the time. Arrangement for both trickle and booster charge shall be provided. However, when the engine starts or is running, provision shall be kept to ensure that the charger is automatically disconnected and the battery is charged by the engine dynamo. At no times it should happen that the battery gets disconnected and is not available to start the engine.

The charger shall give constant D.C output voltage irrespective of incoming voltage variation specified. The charger shall be with fully controlled bridge circuit with diodes.

01.09.05.08. **Governing System**

The governor shall be fitted with a speed control device, which will control the speed under all conditions of load.

The governor shall offer the following features:

Engine should be provided with an adjustable governor capable of regulating engine speed within a range of 10% between shut-off and maximum load condition of the pump. The governor shall be set to maintain rated pump speed at maximum pump load. Engine shall be provided with an over-speed shutdown device. It shall be arranged to shut down the engine at a speed approximately 20% above rated engine speed and for manual reset, such that the automatic engine controller will continue to show an over-speed signal, until the device is manually reset to normal operating position.

The governor shall be capable of operating without external power supply.

01.09.05.09. **Foundation Frame**

Suitable foundation frame with foundation bolts & nuts shall be provided.

01.09.05.10. **Instruments**

The equipment shall be provided with necessary instruments to check the working of the engine continuously. The following instruments shall be minimum which will be provided and the same shall be fixed on a common instrumentation panel mounted directly on the engine base frame :

- Lubricating oil temperature indicator.
- Lubricating oil pressure indicator.
- Cooling water inlet temperature indicator.

- Cooling water outlet temperature indicator.
- Speed-cum-hour meter.

The pressure and temperature gauges shall be of reputed make. The following protections annunciation also shall be provided.

a. High cooling water outlet temperature
b. Low lubricating oil pressure

Any other instrument, control and protection equipment required for the safe operation of the engine shall also be provided.

All the pressure gauges, pressure transmitter, pressure switches etc. where viscous fluid enters inside the instruments shall be provided with diaphragm sealed flanged process connection with flanged isolation valves.

01.09.05.11. **Spares & Special Tools**

The bidder shall furnish the list of spares & special tools including the following mandatory spares, in their scope of supply.

- Two sets of fuel filters, elements & seals
- Two sets of lubricating oil filters, elements & seals
- Two sets of belts (where used)
- Two sets of engine joints, gaskets & hoses
- Two injector nozzles
- Two complete sets of piston rings for each cylinder
- Two inlet valve and two exhaust valves

In addition to the above, the bidder may include any other spare parts and special tools for maintenance/re-erection of the diesel engine/pump.

01.10. DESIGN CRITERIA FOR COOLING TOWERS

01.10.01 General

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 28 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 recirculating 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 when one of the cells is taken out for maintenance, the remaining cells shall be able to handle the entire hydraulic and thermal load.

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 FRP construction and shall be of velocity recovery venturi design.

The cooling tower shall be provided with a stairway located at each and 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. Reduction 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 apart form are illumination. Cooling tower fan controls shall be located in the pump house.

Blow down water from the cooling towers shall be connected to storm water drainage system. In case, the quality of blow down water is not within the statutory limits for disposal, the same shall be treated prior to discharging into storm sewer.

01.10.02 Materials of Construction

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	FRP
4	Fill	PVC / timber (temp>70°C)
5	Support grids	Stainless steel wire mesh
6	Drift eliminator	AC sheet
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

01.10.03 **<u>Drawings & Documents</u>**

i) Drawings & Documents to be furnished along with the offer:

- G.A drawing for cooling tower incorporating principal dimensions, battery limits, basin details indicating overflow and de-sludging arrangement, positions of sluice gates and screens in outlet channel and material handling facilities at fan deck level.

- List of motors and other field devices.

- List of local control boxes and push button stations indicating the devices mounted and their specifications.

- A brief write up giving description of control and annunciation schemes and safety interlocks.

- The list of list of spares for two years normal operation and the list of special tools and tackles required for erection, testing and commissioning and subsequent maintenance along with itemwise price..

ii) Drawings & Documents to be furnished after placement of order:

A) For Approval

i) QAP of various equipment
ii) G.A and schematic view of cooling tower
iii) G.A of fan deck slab
iv) C.S and longitudinal section drawing of cooling tower
v) G.A of fan cylinder
vi) Schedule of complete electrical equipment/ devices with specifications
vii) Fan motor data sheet and G.A of motor
viii) Layout drawing showing location of all electrical equipment / field devices.
ix) Illumination, cable and cable supporting structures layout plan and sections drawing.
x) Earthing layout drawing with bill of materials.
xi) Cable schedule indicating cable number, point of origin, point of termination, type, size and length of power and control cable.
xii) Terminal wiring and external cable connection diagrams.
xiii) Detailed design calculations for civil works of cooling tower and civil construction drawings.

B) For Information (Mechanical)

i) Distribution piping general arrangement
ii) Hot water distribution nozzle and details
iii) Lube oil equipment installation
iv) G.A and C.S drawing of sluice valve (with material of construction of various components)
v) G.A of drive shaft assembly (with material of construction of various components)
vi) G.A of gear reducer (with material of construction of various components)
vii) G.A of fan hub blade assembly (with material of construction of various components)

C) For Information (Electrical)

i) G.A of vibration limit switch
ii) G.A of local push button station
iii) Lighting protection and earthing scheme for cooling tower
iv) Cable schedule and installation details
v) Lighting arrangement
vi) Fan motor characteristic curves
vii) Instruction manual and drawings on erection, operation and maintenance.
viii) Test certificates and catalogues for each equipment

D) For Reference

i) Technical particulars, catalogues, literatures etc.
ii) Shop performance test report on motor, fan, gear box, drive shaft and other components as per QAP
iii) Final test report and inspection reports.
iv) Operation and maintenance manuals
v) Final test certificates
vi) As-built drawings
vii) Soft copy and reproducible of all final drawings

E) At the time of at the time of delivery of equipment

i) Internal wiring diagram.
ii) Termination and external connection diagrams..
iii) Detailed erection schedule and manuals, assembly drawings, erection sequence, special precautions to be followed during assembly / erection.
iv) Instruction manuals for testing and commissioning.
v) Maintenance and safety manuals.
vi) GA drg. of the equipment.

01.11. **VALVES:**

Flow control /isolating valves, drain valves, air release valves and Compensators, wherever necessary, shall be provided for the complete in-shop pipe network.

All valves shall be suitable for service conditions i.e. quality of fluid, flow temperature and pressure under which they are required to operate.

Valves shall be provided on pipe network for isolation of pipe section and equipment, control of pressure and flow, venting, draining etc. They shall be suitable located considering ease of operation and maintenance.

All valves shall be provided with hand wheel and position indictor. The face of each hand wheel shall be clearly marked with words “Open” and “Shut” with arrows adjacent to indicate the direction of rotation.

Valves shall be provided with suitable extension spindle and head stock assembly wherever required. In case gears or bevel system are used , these shall be of cast steel or suitable grade cast iron with machine cut teeth.

Non-return valves shall be Dual Plate zip check type and shall have a permanent “Arrow” inscription on its body to indicate direction of flow.

Larger size valves shall be provided with by pass and drain arrangement.

Float operated valve shall be preferably be right angled pattern complete with ball float, level and other accessories.

Butterfly valves shall be of quotable flanged, tight shut of design with angular travel of 90 deg. from open to shut off position.

01.11.02 **Specification for Valves**

01.11.02.01 **Specification for Globe Valve**

1	Type	Globe valve for water supply pipelines
2	Body & Bonnet	GM to IS : 318-1981,(RA'91)Gr LTB – 2, C.I.
3	Wedge	GM to IS : 318-1981(RA'91) Gr LTB – 2, C.I.
4	Stem	Stainless steel
5	Back seat	GM to IS : 318-1981(RA'91) Gr LTB-2
6	Seating surface & rings	GM to IS : 318-1981(RA'91) Gr LTB-2
7	Hand wheel	Cast Iron to IS:210-1993 Gr. FG-200
8	Gland, Gland plate disc spindle nut	Non ferrous alloy
9	Gland Packing	Asbestos IS:2712-1979
10	Pressure rating	PN = 1.6 N/mm2
11	Manufacturing standard	IS:778-1984 (RA 1990)/IS:781-1984
12	Max. operating temp	50 deg C
13	Operation	Manually operated hand wheel with open and close direction indication.
14	End connection	Screwed upto 40 mm except otherwise mentioned. Flanged ends for 50 mm & above, IS:6392-1971 (RA-1988), table 17
15	Hydro static testing	Shell test = 15 kg/cm2 Seat test = 10 kg/cm2 Back seat test = 10 kg/cm2
16	Special features required	1- Arrow indicating flow direction 2-Embossed name plate giving details of tag no.,type & size
17	Service	Water

01.11.02.02 **SPECIFICATION FOR BUTTERFLY VALVES (CAST STEEL)**

Manual Operation / Pneumatic Operation/Motor Operated

1	Type	Wafer type C.S. Butterfly valve for water supply pipe lines.
2	Body & Cover	ASTM A 216 Gr WCB
3	Disc	A 351 SS 304(CF8)
4	Seat, Body/Disc	EPDM
5	Pin	Stainless Steel, AISI-410
6	Spindle	AISI 410
7	Bolting, internal	-do- (HT)
8	Bolting, external	Carbon Steel, (HT)
9	End connections	Wafer type/(Flanged) Wafer Type- upto 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 ^{0}C
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		

01.11.02.03 **Specification for Pneumatic Actuator**:

a) Pneumatic Actuators shall be of double acting type for on/off operation and shall be directly mounted on the valve. Single acting type shall be considered for fail/safe operation

b) Each pneumatic actuator shall be supplied with
- Single solenoid common for both open &close operation.
- Valve position indicator- Mechanical type.
- Facility for emergency manual operation.
- SS tubing of 3.00 m length along with isolation valve and suitable end connections for connecting it to ½" MS pipe by welding complete with required pneumatic tube fittings for connection to dump valve and ½" MS Pipe.
- Open and close position, proximity switch, 2-wire, universal type (AC/DC),PLF,IFM make, wired up-to a junction box.

c) All the above accessories shall be mounted on / connected to the valve.

- Actuator shall be capable of operating the valve when the air pressure is 6 Kg/cm2 and shall be able to operate the valve even when the air pressure drops to 4.5 Kg/cm2.

- Each actuator shall be supplied complete with two or one way solenoid valves of ¼" pipe size. Material of construction for body shall be Brass.

- Solenoids for all solenoid operated valves shall be suitable for 20 to 240V AC/DC power (Universal type).

- The enclosure class of solenoids shall be IP65.

- For termination of cable to the solenoid, proximity switches junction box shall be provided by supplier. Terminals shall be suitable for terminating 2.5 sq. mm copper conductors. 20% spare terminals shall be provided in the junction box.

- Apart from other tests, performance test for pneumatically operated valves with respective actuators mounted in position to show valves opening and closing and observation of leakage shall be conducted.

01.11.02.04 **Specification for CI/Bronze Plug Valves.**

1	Type	DN 65 and above: C.I. Two way, lubricated type, tapered plug : Sizes up-to 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	Rubberized Asbestos
6	Gaskets	CAF
7	End connection	Screwed end up-to 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
10	Hydro static testing	Body:24 kg/cm2 Seat:16 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.		

01.11.02.05 **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
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	PN = 1.6 N/mm2
9	Manufacturing Standard	BS 5353/API 599
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		

01.11.02.06 **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, single large orifice type, with flanged ends. Air release valve shall conform to IS: 14845-2000.
2	Body	CIFG 200 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
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
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
14	Pressure rating	PN 1.6 N/mm2
15	Test pressure	Body : 24 kg/cm2 Seat : 16 kg/cm2 Test duration : 30 minutes

01.11.02.07 **Specification for Companion Flanges**

1	Type	Raised face plate flanges, Slip-on, welded, plate fabricated, machined finish.
2	Dimensional Standard	As per IS-6392-1971(RA'88), PN=1.6 /1.0 N/mm2 as per valve rating, Table-17/11, drilled off centre, RF.
3	Material	C.S as per IS-2062 -1992 GR.A.
	Note: Valve flanges and matching flanges shall be drilled as per IS:6392-1971 (RA'1988), table 17 for PN 1.6.	

01.11.02.08 **Specification of Actuator for Motorised Valve for Various Locations.**

1	MAKE	ROTORK/AUMA/LIMITORQUE
2	OUTPUTMOTION	ROTARY
3	OPERATION TIME	90 SEC (MAX)
4	SERVICE CONDITION	INLET PR.-8.5 Kg/cm2 (MAX) INLET TEMP.-40 deg.C max. FLUID – WATER
5	ACTUATOR SHALL BE SUPPLIED COMPLETE WITH THE FOLLOWING	
A	HANDWHEEL FOR MANUAL OPERATION	
B	POSITION INDICATOR	
C	OPEN/CLOSE LIMIT SWITCHES	
D	TORQUE LIMIT SWITCHES	
E	EACH LIMIT SWITCH SHALL HAVE 2 NO / 2 NC CONTACT SWITCH FOR 10 AMP. AT 240 V	
F	MOTOR TERMINALS AND LIMIT SWITCH CONTACTS SHALL BE WIRED UPTO A TERMINAL BOX TO BE MOUNTED ON THE VALVE ACTUATOR	

01.11.02.09 **Motor Specifications.**

1	Make & Type	ABB/NGEF/BHARAT BIJLEE/KEC & 3 PHASE,4 WIRE, SQUIRREL CAGE, INDUCTION MOTOR
2	Supply Conditions	415 V AC + 10%, 50 C/S + 3% -6%
3	Control Voltage	240 V
4	Protection	IP-65
5	Enclosure	TEFC
6	Duty Condition	S2, 30 MINUTES
7	Class of Insulation	`F' Temperature rise limited to class-B
8	No. of Starts/hr Allowed	60
9	Design Performance	As per IS:325-1996
10	Breakdown Torque	Minimum 2.5 TFL or higher

01.11.02.10 **SPECIFICATION FOR CAST STEEL DUAL PLATE ZIP CHECK VALVE**

1	Type	Dual Plate Zip Check Valve
2	Body	ASTM A 216 Grade WCB
3	Plate	ASTM A 351 Gr. CF8 M (SS 316)
4	Stop Pin	AISI SS 410
5	Hinge pin	AISI SS 410
6	Spring	INCONNEL
7	Retainer	CF8M (SS 316)
8	Body Bearing	AISI SS 316
9	Plate Bearing	AISI SS 316
10	Spring Bearing	AISI SS 316
11	Eye Bolt	Carbon Steel
12	Body Seal	EPDM
13	Plate Seal	Integral
14	Body Test Pressure	450 psi (g)
15	Seat Test Pressure	320 psi (g) (Max.) / 285 psi (g) (Mini)
16	Design Standard	API 594
17	Dimensions	As per API 594
18	Testing	As per API 598
19	Special features required	1. Arrow indicating the flow direction. 2.Embossed name plate giving details of tag No. size, etc.
20	End Connections	Wafer/ Flanged as per Valve list

01.12 **PLATE HEAT EXCHANGERS :**

01.12.01 **Equipment Specification**

A) The heat exchanger unit shall consist of gasketed plates supported in frame capable of being opened and closed. The frame provides structural support as well as pressure containment for the gasketed plates and consists of frame plate, pressure plate, guide bar & carrying bars, closing studs/nuts and carrying bar supporting columns.

B) The frame shall be designed to permit future installation of 30% additional plates.

C) Each plate heat exchanger shall be designed for full pressure in each stream having no pressure on other stream.

D) While designing heat exchange area and number of plates, cleanliness factor on account of fouling shall be considered as 20%.

E) Carbon steel components in contact with fluid system shall have a corrosion allowance of min 3mm. All the threaded hardware items like studs and nuts shall be zinc coated.

F) Minimum thickness of stainless steel plate shall be 0.5 mm.

G) Frame plate in the primary stationary end of the plate heat exchanger. All nozzles shall be located on frame plate.

I) Inspection openings shall be provided on the pressure plates. These openings shall be blanked by providing blind flanges. Ball valves shall be provided on the bottom blind flanges for drain purposes. Handles are to be provided on all the blind flanges.

J) All nozzles on the frame plate and inspection openings on pressure plate shall be provided with stainless steel sheet lining conforming to AISI 316.

K) Pressure plate shall be supported in a roller bearing hanger from the carrying bar. Pressure plate shall move along the carrying bar and shall be guided by the guide bar.

L) The carrying bar shall be welded to the frame plate and carrying bar support column. A stainless steel tee section shall be welded to the carrying bar to provide mounting member for the plates of the plate pack. A smooth surface shall be provided for roller bearing carrying grove for the whole length of the carrying bar. Carrying bar shall be designed to support 1.5 times the weight of the flooded exchanger along with pressure plate, tie rods, nuts and nozzles.

M) Guide bar shall be welded to the frame plate and carrying bar supporting column. It shall be sheathed in stainless steel on the 3 surfaces coming in contact with the plates and is a guide bar only for the plates.

N) Minimum diameter of tie rod shall be 19 mm.

O) Carbon steel boiler quality plates shall be as per SA 515/516 Grade 60.

P) Plates having thickness of 16 to 50 mm shall be examined ultrasonically as per ASTM A 435.

Q) The heat exchangers shall be designed, manufactured and tested as per ASME code Section VIII, Div. 1 and shall be suitable for the duty conditions and capacities as indicated in the Annexure-I .

R) The plate heat exchangers along with their auxiliary equipment shall be suitable for the required duty conditions and shall be designed and constructed for continuous duty.

S) The equipment and auxiliaries shall be designed for quick and economical maintenance. The equipment shall be easily dismantled without disturbing the inlet and outlet pipe connections.

T) Stainless steel name plate shall be furnished and securely attached by stainless steel pins at an easily accessible point on each plate heat exchanger. The plate shall be stamped with the following minimum information:-

- Purchaser's item no. or tag in 15 mm high letters.
- Serial number of plates heat exchanger
- Capacity in cubic metres per hour both for primary & secondary sides.
- Temperature ranges for primary & secondary liquids.
- Pressure drop in Primary & Secondary sides
- Design code.

01.12.02 **Inspection & Testing**

a) The tests to be conducted at shop for various sub-assemblies/assemblies of equipment shall include, but not limited to the following:

- Material test
- Testing during manufacture/fabrication like dye penetration tests on randomly selected plates, high intensity light check for plates
- Dimensional checking
- Hydrostatic tests
- Ultrasonic test for the plates used for frame and pressure plates.

b) All the plate heat exchangers shall be subject to stage inspection by the successful tenderer's own inspecting authority. However, Purchaser's Inspector may visit the works from time to time who shall have free access to all the places of the manufacturing premises where any part/parts are under manufacturer.

c) The successful tenderer's inspecting authority shall keep a close surveillance in respect of the quality of job for the design dimensions, tolerances, surface finish etc.

d) 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 tenderer shall be made available to the final Inspecting Authority. However, approval and final inspection at the manufacturing works shall not relieve the successful tenderer 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.

e) Hydrostatic test shall be carried out at 1.5 times the design pressure maintaining test pressure for a minimum of 60 minutes. Testing shall be done by pressurising each side separately.

f) The final tests shall be conducted in the presence of the Purchaser's representative. Test certificates for different tests shall be made available to the Purchaser. Material test certificates for bought out items shall be obtained from original manufacturer/reputed test house. For all bought out items, test certificates as relevant to the items shall be furnished by the successful tenderer before the equipment is offered for final inspection.

f) Wherever required, all tests shall be done as per relevant Indian Standards. In the absence of the Indian Standard, the equivalent internationally reputed standards shall be followed.

01.12.03 **Painting**

a) Surface of the heat exchanger frame work shall be cleaned to near white metal conforming to Sa 2 1/2 of Swedish Std. SIS 055900 or German Std DIN 55928 (Part-4)

b) After surface preparation, the plate heat exchanger shall be painted as per the manufacturer's standard.

01.12.04 **Acceptance Tests**

Acceptance tests shall be carried out by the successful tenderer after commissioning. These tests shall be performed according to code of practice of HEI of USA or other mutually agreed procedure in the presence of Purchaser's representative. All instruments required for the test shall be arranged by the successful tenderer. In Case during the tests the heat exchanger performance falls short of guarantee figures, the successful tenderer shall bear all expenses of improving the performance of the heat exchanger and shall carry out another acceptance test at no extra cost. In case the performance is again unsatisfactory, the successful tenderer shall be liable to replace the subject equipment by new and better equipment at no extra cost without affecting the overall schedule of the commissioning of the Main Plant.

01.12.05 **Guarantee**

a) All equipment shall be guaranteed for good workmanship, no material defect and the design parameters till a period of 12 months from the date of successful commissioning or 18 months from the date of despatch whichever is later.

b) The successful tenderer shall stand guarantee that the heat exchanger shall cool the required quantity of primary water with the specified quantity of secondary water to the temperatures stipulated in Annexure A of this technical schedule. The successful tenderer shall also guarantee the agreed pressure drops across the primary & secondary sides of heat exchanger. In addition, all items of the heat exchanger are to be guaranteed in respect of material and workmanship. Any defects found during warranty period shall be rectified to the complete satisfaction of the purchaser at the successful tenderer's cost.

01.12.06 **Penalty**

a) No negative tolerance on the "Overall heat transfer coefficient" of the plate heat exchangers shall be permitted.

b) For every 1% shortfall in the overall heat transfer coefficient, 1% contract value shall be levied as penalty. This shall be applicable for the overall heat transfer coefficient up to 95% of the guaranteed value.

c) For overall heat transfer projection less than 95% of the guaranteed value, the heat exchangers shall be rejected.

d) No positive tolerances on the pressure drop in the heat exchangers shall be permitted.

e) For every 1% increase in the pressure drop, penalty at the rate of 1% contract value shall be levied. This shall be applicable for the pressure drop upto 5% above the guaranteed value.

f) For pressure drop of more than 5% of the guaranteed value heat exchangers shall be rejected.

g) Guaranteed overall heat transfer coefficients offered by the successful tenderer shall hold good if the variation in the flow rates is within + 2O% of the flow rates.

01.12.07 **Information to be Furnished with Offer**

The Tenderer shall furnish the following documents along with the offer :

- Technical particulars of the plate heat exchanger.
- Preliminary GA drawings of the plate heat exchanger's alongwith auxiliaries indicating the overall dimensions.
- Predicted performance curves.
- Catalogues for the plate heat exchangers duly identifying the model.
- List of special tools, tackles and accessories required for assembly, erection, testing, start-up and commissioning.
- List of minimum commissioning spares that will necessarily be supplied along with the equipment.
- Testing & acceptance procedure as proposed by the tenderer.

01.13. ONLINE AUTOMATIC FILTER

01.13.01 Equipment Specification

01.13.01.01 Mechanism

The online filter shall be of cylindrical body with wedge wire slot tube element housed in it. For automatic filter, area will be in the ratio of 1:3 where-as for strainer it will be 1:6. The filter should start the self cleaning process when the pressure differential across the screen reaches a preset value or predetermined lapse of time. Cleaning of the filter elements is to be carried out by the suction scanner with its spiral rotational movement.

The filter control shall be carried out by purchaser's PLC and MCC system. However, tenderer shall furnish functional description / Control write-up, PLC Input/Output list to the purchaser.

Flush drain valve and vent shall be provided for each unit of the main filter. The design of the filter shall be suitable for easy maintenance and replacement of the parts and inspection.

Each strainer shall be provided with basket opening area (six times of pipe cross section area or bigger) to ensure high flow volumes at low pressure and a long service life.

Provision shall be made for collection of drainage water from the strainers and shall be suitably connected to the plant area drainage system.

Along with the offer the Tenderer shall furnish details of the basket filter such as make, general arrangement and cross sectional drawings, operating parameters, materials of construction of various components supported by manufacturer's literature and catalogues.

Valves to be supplied as part of the filters shall conform to the following standards. Pressure rating of all valves shall be 16kg/cm2.

01.13.01.02 Valve Actuator

All motors shall be suitable for 415V, 3-Phase power supply. Actuators shall be provided with travel Limit switches and Torque switches. These switches shall have IP-55 degree of protection. It shall have 2 NO + 2 NC contacts rated for 10 amps AC

a) Electrically operated built-in change over valves shall be complete with electric motors, necessary gear drive, position limit switches, torque switches and terminal box.

b) Motor shall be squirrel cage induction motor with DOL starter at 415+/- 10% 50Hz +/- 5% having the following:-

i) Class `F' insulation, temperature rise limited to Class `B'.

ii) TEFC enclosure with degree of protection IP55

c) Arrangement shall be provided on the valve for disconnecting power supply, which shall operate when valve is opened manually.
d) All end position limit switches and torque switches for open & close position shall be dust and water proof.
e) All the limit switch contacts shall be wired in a terminal box (part of actuator) suitable for termination of 14X1.5 mm2 control cable.

01.13.01.03 **Shop Testing**

Testing and inspection of equipment and materials shall be carried out at the works of the Contractor or his sub-Contractor during manufacturing and on final product to ensure conformity of the same with acceptable criteria of Technical Specifications, approved drawings, authenticated manufacturing drawings and reference Indian/International standards.

The Contractor shall furnish Quality Assurance Plan (QAP) for each equipment and material for Employer's/Consultant's approval at least two months prior to start of manufacturing.

Tests to be conducted at the shop for various assemblies/sub-assemblies of equipment shall include, but not be limited to the following:

- Material test.
- Tests during manufacture/fabrication.
- Dimensional checking.
- Hydraulic test at the shop.
- Performance test.
- Any other test as required

For each of the items being manufactured/supplied, the following test certificates and documents, as applicable, in requisite copies including original shall be submitted to the Inspection Agency. All test certificates shall be endorsed by the manufacturer and the Contractor with linkage to the project, purchase order and acceptance criteria.

- Raw materials identification and physical and chemical test certificates for all materials used in manufacture of the equipment/
- Welding procedures and welder's qualification test Certificates,

- Static/dynamic balancing certificate for rotating Components/ machines.
- Pressure test certificates.
- Performance tests certificates for all characteristics.

Inspection at manufacturers' works shall not relieve the Contractor of responsibility for replacing at his own cost any defective part/material and repairing equipment for defective workmanship that may be discovered at site at a later date.

01.13.01.04 **Shop Painting**

The complete paint system for any item shall include

- Surface preparation
- Application of primer coats, intermediate coats and finish coats of specified paints of Approved quality.

01.13.01.05 **Surface Preparation**

All surfaces shall be cleaned of loose substances and foreign materials, such as dirt, rust, scale, oil, grease, welding flux, etc. in order that the prime coat is rigidly anchored to the virgin metal surface. The surface preparation shall be as per Swedish Standard SIS 055900 or German Standard DIN 55928 (Part 4) or BS 4232 or IS 1477 Part I). Procedures for surface preparation shall cover solvent cleaning, hand tool cleaning, power tool cleaning and sand blast cleaning or combination thereof in order to attain desired surface quality as required by the specific primer paint.

Surface shall be prepared to achieve grade Sa 2 1/2 of SIS Standard by sand blasting. After surface preparation, equipment shall be painted with

- Two coats of two-pack air drying epoxy polyamide resin based red oxide zinc phosphate primer as per IS 2074 : 1992.
- One coat of two-pack air drying high-build epoxy resin based intermediate paint with micaceous iron oxide (MIO).
- Two coats of two-pack air drying epoxy polyamide enamel paint suitably pigmented.
- Dry film thickness (DFT) of each coat of primer, intermediate and finish Paints shall be 30, 100 and 40 microns respectively.

01.13.01.06 **Paint Application**

Paint shall be applied in accordance with manufacturer's recommendations as supplemented by this specification. The work shall generally be carried out as per IS 1477 (Part II).

Paint shall not be applied in rain, wind, fog or at relative humidity of 80% and above or when the surface temperature is below dew point resulting in condensation of moisture. Paint shall generally not be applied when the ambient temperature is 50 C and below.
Each coat of paint shall be continuous, free of pores and of even film thickness without thin spots.
Each coat of paint shall be allowed to dry sufficiently before application of the next coat to avoid damage such as lifting or loss of adhesion.

01.13.01.07 **Colour Code**

Shades of finish coat to be applied shall be as per IS 5 and of wide acceptability in water supply works. Prior approval shall be taken from the Purchaser after placement of order before adopting final colour shade for any particular item being painted.

01.13.01.0 8 **Warranty and Guarantee**

The Tenderer shall warrant for satisfactory performance of the equipment and material for a period of 18 months from the date of the last dispatch or 12 months from the date of commissioning of equipment whichever is earlier. The Tenderer shall replace/repair within seven days of receiving the notice at his own cost any defective parts in the equipment of his own manufacture or those of his sub-contractors.

The Tenderer shall guarantee various performance parameters as specified below

The pressure drop across the strainer under semi-clogged condition shall not exceed 5mWC.

The size of suspended solids in outlet of strainer shall not exceed 1000 microns.

In the event of a shortfall in the guaranteed performance figures the Purchaser shall have the right either

To agree to a financial settlement with the Contractor, or

To reject the plant as a whole and in such event the Contractor shall have to pay back the whole sum paid to him on this account.

01.14. **STAINLESS STEEL FLEXIBLE HOSES.**

01.14.01 **Equipment Specification**

1. Type of Hose : Single Stainless Steel wire braided corrugated flexible hose assembly SS AISI 304, fitted with SS female swivel fittings at both ends (Nut nipple) suitable for connecting pipes. As per BS: 6501 Part-I with type B flexibility. Alternatively cam lock connection can also be offered.

2. Size : By Bidder

3. Suitable for pipe Internal diameter : By Bidder

4. Test pressure : 18 kg/cm2

5. Operating pressure : 12 kg/cm2

6. Frequency of bend : Single

7. Design temperature : Normal : 40 to 50 deg C/
   Maximum : 110 deg C

8. End connection : Female swivel end on both sides (Nut nipple) suitable for connecting pipes having:

01.15. RUBBER EXPANSION JOINTS:

01.15.01 Equipment Specification

Material specification:
Rubber Expansion Joints shall be made of high grade abrasive resistant natural rubber compound reinforced with adequate numbers of piles of heavy cotton duck, rayon cord, impregnated within rubber compound and further reinforced with square metal ring embedded in it. The outer exposed surface of rubber expansion joints shall be given a coating of synthetic/neoprene rubber and further painted with chlorinated rubber based paint. Rubber expansion joints will be suitable for design temperature of 5O deg C and for handling clear water. Rubber expansion joints shall absorb vibration, shock and axial compression of 10 mm, axial elongation of 10 mm and lateral movement of 10 mm.

Control unit:
One set of control unit (stretcher bolt assembly) consisting of 2/3 nos. limit rod (material IS:3657 Gr. 6.6), Stretcher Bolt, Triangular Plate (material IS:226), Nuts (material IS:1363 Gr. 6.O) Steel Washer and Rubber Washer of durometer hardness of 100deg Centigrade +/- 5 deg Centigrade.

The control unit shall be made suitable to make RE joint and no. of limit rod matched against each.

01.15.02 Technical Parameters of Rubber Expansion Joints

1.

Sl. No	Size	Qty
1	DN	
2	DN	

2. Test pressure : 18 kg/cm2 or as per relevant standards

   Max. Pressure (operating) : 12 kg/cm2
   Design pressure : 16 kg/cm2

   Burst pressure : ……. kg/cm2

3. Leak test : 18 bar(g), joint shall be kept immersed in water bath to check leak tightness

4. Length : As per relevant Standard

5. Tie rod : 3 tie rods per Rubber Expansion Joint

6.	Material of construction		
	Body	:	Vendors to specify
	Cover	:	Vendors to specify
	Tie rod	:	Vendors to specify
7.	Design temperature	:	Normal 40 Deg Centigrade Max 80 Deg. Centigrade (Worst Case)
8.	End connection	:	Carbon steel forged loose flanges at both ends, with dimensions as per ANSI-B 16.5

01.16. SLUICE GATES

01.16.01 Equipment Specification

Sluice gates shall be supplied as per IS:3042-1965. Gear box arrangement shall be of open type for small size and closed type for sizes above 400mm size.

All assembly bolts/studs, nuts, anchor, bolts and washers are acceptable in stainless steel construction to AISI:304/ AISI:410.

Sealing of single face is acceptable. Accordingly leakage test shall be performed to ensure committed leakage for seating head only applied for unseating side.

Item Nos. of all the gates shall be punched on the gate (at an easily identifiable place) before dispatch.

01.16.02 Data for Design of Sluice Gates

i)	Type of Mounting	:	Wall mounted type with head stock. Headstock shall have geared handle for operation.
ii)	Spindle type	:	Rising Spindle.
iii)	Design code	:	Sluice gates shall be generally as per IS:3042; 1965. Wedges shall be provided on the sides to ensure maximum water tightness.

01.16.03 Material of Construction

i)	Head Stock, wedge, Shutter, Gate frame, Stop-nut.	:	CI, IS:210, Gr: FG 200 -1993
ii)	Hinge Pin & Stem	:	SS, AISI 410
iii)	Seat facing/sealing face.	:	Naval Brass IS:291, Gr:2 -1989
iv)	Fasteners	:	SS, AISI 304/410
v)	Anchor bolts	:	SS, AISI 304/410
vi)	Stem Coupling	:	SS AISI 410

vii) Gate Frame, Shutters, Ungeared head stock body, Wall Guide Brackets, Stop-Nut : CI , IS:210, Gr: FG200-1993

viii) Hand wheel : M.S.

01.16.04 **Shop Testing & Inspection**

Testing and inspection of the materials shall be carried out at the works of the Contractor or his sub-Contractor during manufacturing and on final product to ensure conformity of the same with acceptable criteria of Technical Specifications, approved drawings, authenticated manufacturing drawings and reference Indian/International standards.
The Contractor shall furnish Quality Assurance Plan (QAP) for each equipment and material for Employer's/Consultant's approval prior to start of manufacturing.

A leakage test shall be performed by the manufacturer to ensure committed leakage for both seating and unseating head.

Tests to be conducted at the shop for various assemblies/sub- assemblies of equipment shall include, but not be limited to the following:

- Material test.
- Tests during manufacture/fabrication.
- Dimensional checking.
- Hydraulic test at the shop.

For each of the items being manufactured/supplied, the following test certificates and documents, as applicable, in requisite copies including original shall be submitted to the Inspection Agency. All test certificates shall be endorsed by the manufacturer and the Contractor with linkage to the project, purchase order and acceptance criteria.

Raw materials identification and physical and chemical test Certificates for all materials used in manufacture of the equipment

01.16.05 **Pressure test Certificates**:

Inspection at manufacturers' works shall not relieve the Contractor of responsibility for replacing at his own cost any defective part/material and repairing equipment for defective workmanship that may be discovered at site at a later date.

01.16.06 **Shop Painting**

Immediately after casting and before machining, all cast iron parts shall be thoroughly cleaned and before rusting commences, these shall be coated with at least two coats of bituministic rust proof compound of approved quality. The final coats shall be applied to the exterior surfaces, excluding machined portions, after assembly & testing.

01.17. C.S FITTINGS - SPECIFICATION

01.17.01 **Black Fittings**

Black fittings upto 50NB shall be Socket welded type type as per ANSI B 16.11.

Black fitting above 50NB shall be Butt welded type as per ANSI B 16.9.

Black fittings of sizes above 40NB shall be forged fitting suitable for welding and conforming to ANSIB16.9. Black fittings shall be supplied with ends suitable for butt-welding.

01.17.02 **Material of Construction for Fittings:**

Sl. No.	Size	Material of construction
1	DN15 To DN50 FORGED BENDS	MATERIAL A105, Class 3000 (SW)
2	DN65 TO DN250 FORGED BENDS	MATERIAL A234 Gr WPB, Sch 40 BW
3	DN300 TO DN450 FORGED BENDS	MATERIAL A234 Gr WPB, Sch 30 BW
4	DN500 AND ABOVE FORGED BENDS	MATERIAL A234 Gr WPB, Sch 20 BW
5	FORGED SOCKOLETS	MATERIAL A234 Gr WPB, Class 3000 (SW).
6	FORGED REDUCERS UPTO DN250	MATERIAL A234, Gr WPB, Sch40
7	FORGED REDUCERS FROM DN250 TO DN400	MATERIAL A234, Gr WPB, Sch30
8	FORGED REDUCERS FROM DN500 & ABOVE	MATERIAL A234, Gr WPB, Sch20

01.17.03 **Flanges**

All flanges shall be slip on raised face type as per Table 11 of IS:6392:1971(RA 88). Material of construction for the flanges shall be Carbon Steel as per IS:2062:1992. All bolts and nuts shall be black hexagonal type as per IS:1364 Part 1&3-1992 Class 4.6/4.0.All gaskets shall be as per IS: 638 -1979 (RA 1993).

01.18. **FIRE HYDRANTS - SPECIFICATION**

01.18.01 **General**

a) Landing valve/yard hydrant shall be as per IS: 5290-1993, Type-A and should have TAC approval.
The hose cabinet shall be fabricated out of 18 SWG M.S. sheet. The size of the cabinet shall be suitable for holding one/two hoses as indicated under schedule of quantities and shall be hanging type for indoor installation & supporting type on pedestals for out door installations. The two sides and back of the hose cabinet shall be made from sheet by pressing. The top shall have pressed edges slightly projecting outside to prevent water (while cleaning etc) from entering the cabinet. The cabinet shall be fitted with two doors having glass panel. The thickness of glass shall not be less than 3mm. The door shall be provided with a knob and a lock with duplicated key on the body of the door with a glass cover. The glass of the key box shall be easily replaceable. Suitable hooks, etc. shall be provided in the cabinet to hold the hose reels etc. mentioned above. Suitable wall mounting bracket shall be provided with the cabinet. The word `key' shall be painted (on the body of door) with an arrow pointing the glass of key cover. The hose cabinet shall be painted red from outside and white from inside.
The tenderer shall provide a fully dimensioned general arrangement drawing indicating materials of construction, relevant specifications, etc.

01.18.02 **Internal Hydrants/ Yard Hydrants:**

Sl. No	Description	Material of construction
1.	Gun metal Fire Hydrant Landing valve, Oblique type, single outlet type of 75mm flanged inlet, 63mm female bronze coupling with instantaneous outlet with hand-wheel complete with blank cap and chain etc. as per IS:5290-1993, Type –A,	Material of construction shall be LTB2 as per IS:318-1981 Alternatively SS/ aluminum alloy.
2.	M.S. Matching flange DN 80 (slip-on type , PN16 rating) with nuts, bolts and gasket for the above hydrants as per IS:6392,1971,(R.A.1988), Table-18.	Carbon Steel Gr:2A of IS 2002.
3.	Wall Mounting type M.S. Hose cabinet size (600mmx450mmx250mm) fitted with double door glass front panel suitable for holding the following. (The hose box shall have handle with lock, bracket for holding hose and branch pipe, a hammer and a key box) :-	Material of construction shall be 18SWG MS sheet to IS:2062.

Sl. No.	Description	Material of construction
3.1	Rubberized fabric reinforced rubber lined (RRL) flexible hose of 15 meter length as per IS: 636 -1988, each fitted with instantaneous male coupling at one end and female coupling at the other end.	The couplings shall be of LTB2 construction as per IS:318-1981 Alternatively SS/ aluminum alloy
3.2	One 25 mm nozzle	Material of construction shall be LTB2 as per IS318:1981
3.3	One branch pipe as per IS:903 -1984 (R.A -1990)	- do -
3.4	One nozzle spanner as per IS:903-1984 (R.A-1990)	Material of construction shall be "Steel Gr34C4 or Steel Gr: 40C8 as per IS: 5720 (Part- 2/ Sec-1).

ANNEXURE - I

01. **DATA SHEETS**

01.01 **HORIZONTAL PUMP SETS**

HORIZONTAL PUMP SETS		
1	No. OF PUMPS	
2	TYPE OF PUMP	
3	PUMP MODEL	
4	PUMP OPERATING CHARECTERISTICS	
A	RATED CAPACITY OF EACH PUMP (m3/HR)	
B	TOTAL DYNAMIC HEAD(TDH) AT RATED CAPACITY (MWC)	
C	SHUT OFF HEAD, (mWC)	
D	SPEED (NOMINAL) RPM	
E	PUMP EFFICIENCY AT RATED CONDITIONS (%)	
F	PUMP SHAFT POWER AT RATED CAPACITY (KW)	
G	REQUIRED NPSH (mWC)	
H	TYPE OF GLAND SEALING	
I	MODE OF CONNECTING PUMP TO MOTOR	
J	DIRECTION OF ROTATION	
K	IMPELLER DIAMETER (MIN / RATED / MAX) mm	
L	TYPE OF END CONNECTION • SUCTION FLANGE BORE mm : • DISCHARGE FLANGE BORE mm : • DRILLING STANDARD FOR FLANGES	
5	MATERIALS OF CONSTRUCTION	
A	IMPELLER	
B	CASING	
C	CASING RING	
D	SHAFT	
E	SHAFT SLEEVE	
F	GLAND	
G	BASE FRAME	
H	COMPANION FLANGES	

01.02 **VERTICAL PUMP SETS**

VERTICAL PUMP SETS		
1	No. OF PUMPS	
2	PUMP MODEL	
3	PUMP OPERATING CHARECTERISTICS	
A	RATED CAPACITY OF EACH PUMP (m3/HR)	
B	TOTAL DYNAMIC HEAD(TDH) AT RATED CAPACITY (MWC)	
C	SHUT OFF HEAD, (mWC)	
D	SPEED (NOMINAL) RPM	
E	PUMP EFFICIENCY AT RATED CONDITIONS (%)	
F	PUMP SHAFT POWER AT RATED CAPACITY (KW)	
G	TYPE OF GLAND SEALING	
H	MODE OF CONNECTING PUMP TO MOTOR	
I	DIRECTION OF ROTATION	
J	IMPELLER DIAMETER (MIN / RATED / MAX) mm	
4	TYPE OF END CONNECTION • DISCHARGE FLANGE BORE mm : • DRILLING STANDARD FOR FLANGES	
5	COLUMN LENGTH (mm)	
6	TYPE OF SHAFT SEAL	
7	BEARINGS TYPE : MAKE :	
8	QUANTITY OF BEARING PROVIDED	
9	TYPE OF LUBRICATION REQUIRED	
10	COUPLINGS TYPE	
11	BASE FRAME WITH HOLDING DOWN BOLTS AND NUTS	
12	COMPANIAN FLANGES	

13	**MATERIALS OF CONSTRUCTION**	
A	IMPELLER	
B	CASING	
C	CASING RING	
D	SHAFT	
E	SHAFT SLEEVE	
F	GLAND	
G	BASE FRAME	
H	COMPANION FLANGES	
I	COLUMN PIPE	
J	SUCTION STRAINER	

01.03 MOTORS OF HORIZONTAL PUMP SETS

MOTORS OF HORIZONTAL PUMP SETS		
1	RATED KW AT 50 DEG.C	
2	RATED KW AT 40 DEG.C S1 DUTY (KW)	
3	RATED VOLTAGE & SYSTEM CONDITIONS	
4	FRAME SIZE	
5	CLASS OF INSULATION	
6	RATED SPEED & DIRECTION OF ROTATION	
7	FL CURRENT	
8	OPERATION AT 80% RATED VOLTAGE FOR 5 MINUTES	
9	NO.OF STARTS/HR (EQUALLY SPREAD) PERMISSIBLE	
10	OPERATION AT 80% RATED VOLTAGE FOR 5 MINUTES	
11	No OF STARTS/Hr (EQUALLY) SPREAD PERMISSIBLE	
12	LOCKED ROTOR WITHSTAND TIME AT 110% RATED VOL	
13	PULL UP TORQUE	
14	PULL OUT TORQUE	

01.04 MOTORS OF VERTICAL PUMP SETS

1	MAKE	
2	RATED KW AT 50 DEG.C	
3	RATED KW AT 40 DEG.C S1 DUTY (KW)	
4	RATED VOLTAGE & SYSTEM CONDITIONS	
5	FRAME SIZE	
6	CLASS OF INSULATION	
7	RATED SPEED & DIRECTION OF ROTATION	
8	FL CURRENT	
9	OPERATION AT 80% RATED VOLTAGE FOR 5 MINUTES	
10	NO.OF STARTS/HR (EQUALLY : SPREAD) PERMISSIBLE	
11	No OF STARTS/Hr (EQUALLY) SPREAD PERMISSIBLE	
12	LOCKED ROTOR TORQUE	
13	PULL UP TORQUE	
14	PULL OUT TORQUE	
15	MAX WINDING TEMPERATURE BY RESISTANCE METHOD	
16	DEGREE OF PROTECTION OF ENCLOSURE	

02. **ON-LINE AUTOMATIC FILTER**

02.01 **On line Simplex Filter in Gearbox cooling Water System(Primary Circuit)**.

Sl.No.	Description	Parameters
1.	Flow	m3/hr
2.	Inlet Pressure	Kg/cm2
3.	Line Size	
4.	Sieve Size	Micron
5.	Operation	Simplex type
6.	Qty.	

02.02 **On line automatic Filter in B.F.Shell Water supply System (Primary circuit).**

Sl.No.	Description	Parameters
1.	Flow	m3/hr
2.	Inlet Pressure	Kg/cm2
3.	Line Size	
4.	Sieve Size	Micron
5.	Operation	Automatic Self cleaning Filter
6.	Qty.	

02.03 **On line automatic Filter in Tuyere Water Supply System (Primary circuit).**

Sl.No.	Description	Parameters
1.	Flow	m3/hr
2.	Inlet Pressure	Kg/cm2
3.	Line Size	
4.	Sieve Size	Micron
5.	Operation	Automatic Self cleaning Filter
6.	Qty.	

02.04 **On line automatic Filter for Hearth Spray(open industrial water).**

Sl.No.	Description	Parameters
1.	Flow	m3/hr
2.	Inlet Pressure	Kg/cm2
3.	Line Size	
4.	Sieve Size	Micron
5.	Operation	Automatic Self cleaning Filter
6.	Qty.	

02.05 **Partial stream on-line Filter for Secondary Circuit water of PHE (open industrial circuit).**

Sl. No.	Description	Parameters
1.	Flow	m3/hr
2.	Inlet Pressure	Kg/cm2
3.	Line Size	DN
4.	Sieve Size	Micron
5.	Operation	Automatic Self cleaning Filter
6.	Qty.	

03. COOLING TOWER

03.01 GENERAL

Name of manufacturer	
Manufacturer's plant location	
Tower model no.	
Type of tower	
Number of cells	
Capacity per cell , m3/hr	

03.02 TOWER OVERALL DIMENSION, m

a) Length	
b) Width	
c) Height (to fan deck)	

03.03 DIMENSION OF EACH CELL, m

♦ Length ♦ Width ♦ Filled height ♦ Louvre height and angle from horizontal	

03.04 BASIC PARAMETERS PER CELL

Rated water flow, m3/hr	
Design wet bulb temp., deg.C	
Approach, deg.C	
Cooling range at rated flow , deg.C	
Evaporation loss at rated condition, m3/hr/cell	
Temp. of leaving air ♦ Dry bulb ♦ Wet bulb	
Total air area, m2/cell (full plan area)	
Total louvred area, m2/cell	
Dry air flow per m2 of air area, (G) kg/h/m2	
Water flow area, m2/cell	
Water flow rate per m2 of water area, (L), m3/h/m2	

03.05 **TOWER FILL**

Material	
Type of treatment	
Expected life, years	
Type of flow,	
No. of full and partial decks	
Equivalent fill decks	
Equivalent fill height, m	
Number, splash bars in direction of air flow (cross -flow)	
Size, splash bars, mm (nominal)	
Splash bar position	
Splash bar spacing ♦ Horizontal ♦ Vertical	
Fill stringer size, m	
Total fill volume, m3/cell	
Wetted surface area, m2/m3	
Splash surface area, m2/m3	
Fill performance characteristics	
Total vertical water fall height, m	
Solidity ratio of fill, cross flow	

03.06 **FILL SUPPORT AND GRIDS**

Type	
Material	
Size	

03.07 **GRID SUPPORT FRAME**

Type	
Material	
Type of treatment, if any	

03.08 **FAN**

Type and Make	
No. of fans / cell	
Diameter of fan, m	
No. of blades per fan	
Blade tip clearance, mm	
Hub diameter, m	
Net discharge area, m2	
Blade width at ¾ radius, m	
Capacity, m3/min per fan	
Speed , rpm	
Fan stack ♦ Height , m ♦ Type (std or velocity recovery) ♦ Stack exit air velocity, m/sec (based on NDA)	
Air density at fan, kg/m3 ♦ Dry air ♦ Mixture	
Fan pressure, mmWC ♦ Louvres ♦ Filling ♦ Eliminator ♦ Velocity head ♦ Total head ♦ Velocity recovery, if any ♦ Net head	
Fan efficiency, % ♦ Static ♦ Overall	
Brake power Kw at motor shaft	
Power at fan shaft, Kw per shaft	
Motor size, Kw	
Material of construction ♦ Blades ♦ Hub ♦ Fan shaft	
Type of connection with gearbox shaft	

03.09 **REDUCING GEAR UNIT**

Make	
Type	
Model No	
Reduction ratio	
Rated input, Kw	
Service factor at design point	
Material of construction ♦ Gear ♦ Shaft ♦ Enclosure	
"No load loss" at gear box	
Gear box oil ♦ Type ♦ Trade name ♦ Approximate quantity of oil required in each box, m^3	
Details of bearing	
Efficiency	

03.10 DRIVE SHAFT

Diameter, m	
Approximate length, m	
Material of construction	
Type of coupling	
Type of support	

03.11 DRIVE MOTORS

Make	
Voltage	
Phase	
Frequency	
Rated, Kw	
Shaft / pull out torque	
Full load current, Amp	
Starting current, Amp	
Efficiency	
Class of insulation	
Type of enclosure	
Degree of protection	
Recommended DOL	
Starting current	
Speed, rpm	

03.12 HOT WATER DISTRIBUTION SYSTEM

Type	
Nozzle spacing	
Elevation, inlet above curb, m	
Water pressure required at battery limit	
No. of nozzles per cell	

03.13 COLD WATER BASIN

Basin dimension, m (L X W)	
Basin curb elevation, m	
Normal water level, m	
Maxi. Water level, m	
Basin invert level, m	
Effective capacity, m3	

03.14 **VALVE DETAILS**

Make	Cell inlet water control valve	Header isolating valve	Desludging valve	Other
Type				
Number & size				
Material of construction ♦ Body ♦ Trim				

03.15 **MATERIAL OF CONSTRUCTION**

Structural member	
Casing and louvres	
Inner and outer casing	
Fan stack	
Distribution header	
Hardware	

03.16 **MATERIAL HANDLINGSERVICES**

Type	
Capacity	
Material of construction	
Protection against corrosion	

04. SLUICE GATES

Sl. No.	Unit	Size of Gate	Length of spindle from C-L of water-way upto the top of platform (In mm)	Qty Nos.	Remark Ungeared /Geared
1.	G.C.P Pump-House				
2.	Blast Furnace (Clear Water Circuit)				
3.	Blast Furnace (Contaminated Water Circuit)				
4.	Pig Casting Machine				
5.	Turbo Blower Station Pump house				

05. **SOFT WATER PLANT**

05.01 **PRESSURE FILTER/ACTIVATED CARBON FILTER**

Sl. No	Description	To be filled in by tenderer	
		Pressure Filter	Activated Carbon Filter
1.	Shell dimension: diameter and length, mm		
2.	Vessel design code adopted		
3.	Design pressure, kg/cm2		
4.	Hydro-test pressure, kg/cm2		
5.	Guaranteed output between two successive backwash		
6.	Guaranteed effluent quality		
7.	Flow rate, m3/h		
	Normal		
	Maximum		
	Backwash		
	Rinse		
8.	Head loss through bed, mWC		
	Normal		
	Maximum		
	Backwash		
	Rinse		
9.	Filter Materials		
	Type		
	Size of grading, mm		
	Quantity per filter, m3		
	Life of filtering material year		
10.	Bed depth and free board provided		
11.	Time required for backwash		
12.	Time required for rinse Minimum		
13.	Material of construction of vessel		
14.	Type and material of inlet distributor and under drain system		
15.	Material and detail of nozzle		
16.	Filter shell and dished End thickness, mm		
17.	Flooded weight, kg		
18.	Empty weight, kg		
19.	Compressed air requirement and pressure		
20.	Time of air scouring in min.		

05.02 **BASE EXCHANGERS**

Sl. No.	Description	To be Filled in by Tenderer
1	Nos. offered	
2	Sheel Dimension dia x ht	
3	Design pressure, kg/cm2	
4	Vessel design code adopted	
5	Thickness of a) Dished end b) Shell	
6	Regeneration Cycle	
7	Guaranteed output between two successive regenerations (12 hr cycle)	
8	Flow rate, m3/h	
	Normal	
	Maximum	
	Backwash	
	Regeneration	
	Slow Rinse	
	Fast Rinse	
9	Head loss through bed, mWC	
	Normal	
	Maximum	
	Backwash	
	Regeneration	
	Slow Rinse	
	Fast Rinse	
10	Time required for regeneration	
	Back wash	
	Salt Injection	
	Slow Rinse	
	Fast Rinse	
	Total time	
11	Type of resin	
12	Make of resin	
13	Volume of resin	
14	Depth of resin bed	
15	Free board provided	
16	Guaranteed life of resin	

Sl. No.	Description	To be Filled in by Tenderer
17	Expected rate of deterioration of resin per year	
18	Regeneration level by 100% NaCl per m3 of resin	
19	Exchange capacity of resin for above regeneration level	
20	Guaranteed quality of out-let water (a) total hardness as CaCo3 ppm (b) pH	
21	Quality of 100% NaCl required per regeneration Kg	
22	Type and material of inlet regeneration, distributor and under drain system	

05.03 **Blowers**

Sl. No	Description	For filter	For degasser tower
1.	Nos offered		
2.	Make		
3.	Capacity, m3/min		
4.	Total head, mWC		
5.	Rpm of blower		
6.	kW of motor		
7.	Rpm of motor		
8.	Type of coupling		
9.	Size of suction/ discharge, mm		
10.	Make of motor		
11.	Material of construction		
12.	Total weight, kg		

05.04 **Brine measuring tank / brine saturator**

Sl. No.	Description	To be Filled in by Tenderer
1	Capacity	
2	Size	
3	Material of construction	
4	Thickness of plate	
5	Thickness of lining	

06 PLATE HEAT EXCHANGERS

Sl No.	Description	T.S. Requirement Unit	Blast Furnace Shell		Tuyere Circuit		Stove Circuit		Gear Box Cooling Circuit	
			Primary (Soft)	Secondary (industrial)	Primary (Soft)	Secondary (industrial)	Primary (Soft)	Secondary (industrial)	Primary (Soft)	Secondary (industrial)
1	**General**									
1.1	No. of Plate Heat Exchangers	Nos.								
1.2	Manufacturer									
1.3	Model NO./Type	Plate Type	Plate Type		Plate Type		Plate Type		Plate Type	
1.4	Whether single or double pass	Single	Single		Single		Single		Single	
2	**Design**									
2.1	Design Pressure	Bar(g)								
2.2	Design Temperature	Deg.C								
2.3	Heat Load	Kcal/h								
2.4	LMTD(Corrected)	Deg.C								
3	**Guaranteed Performance for each heat exchnager**									
3.1	Flow Rate	Each PHE / m^3/h								
3.2	Inlet Temperature	Deg.C								
3.3	Outlet Temperature	Deg.C								
	a) In Fouled Conditions									
	b) In clean conditions									
3.4	Total Pressure drop across heat exchanger from inlet to oulet	Bar(g)								
	a) For Design flow									
	b) For 110% of design flow rate									
4	**Heat transfer and fluid flow data**									
4.1	Film heat transfer Coefficient	Kcal/hrm^2℃								
4.2	Fouling factor	m^2hr℃/Kcal								
4.3	Overall fouling	(Min 20%) / m^2hr℃/Kcal								
4.4	Overall Heat Transfer Coefficient	Kcal/hr m^2 ℃								

Sl No.	Description	T.S. Requirement Unit	Blast Furnace Shell		Tuyere Circuit		Stove Circuit		Gear Box Cooling Circuit	
			Primary (Soft)	Secondary (industrial)	Primary (Soft)	Secondary (industrial)	Primary (Soft)	Secondary (industrial)	Primary (Soft)	Secondary (industrial)
	a) In Fouled Conditions b) In clean conditions									
4.5	Total Effective heat transfer area per heat exchanger	m^2								
4.6	Average Velocity	m/s								
	a) Through Ports	4-5 m/s								
	b) Through plate channels	<2m/s								
4.7	Pressure drop in ports	Bar(g)								
	a) In Clean conditions b) In Fouled conditions									
4.8	Pressure drop in channels	Bar(g)								
	a) In Clean conditions b) In Fouled conditions									
4.9	Maximum diffrential pressure pressure between hot and Cold	Bar(g)								
5	**Heat transfer plates**									
5.1	Area of each plate	m2								
5.2	Dimension (width X height)	mm X mm								
5.3	Thickness	mm								
5.4	Material and chemical Composition		AISI316	AISI316	AISI316	AISI316	AISI316	AISI316	AISI316	AISI316
5.5	Number of plates per heat exchanger	Nos.								
5.6	Maximum number of plates that can be accommodated in the heat exchnager	Nos.								
5.7	Type of corrugation	Herring bone								
5.8	Maximum plate pack length	mm								
	a) as per 5.5 above b) as per 5.6 above									
5.9	Average spacing between two plates	<4mm								
5.1	Number of contact points for each plate	Nos.								

Sl No.	Description	T.S. Requirement Unit	Blast Furnace Shell		Tuyere Circuit		Stove Circuit		Gear Box Cooling Circuit	
			Primary (Soft)	Secondary (industrial)	Primary (Soft)	Secondary (industrial)	Primary (Soft)	Secondary (industrial)	Primary (Soft)	Secondary (industrial)
5.11	Hold up volume of each passage	m^3								
5.12	Port Size(Diameter)	mm								
6	**Plate Gaskets**									
6.1	Type	Moulded Single Piece								
6.2	Material and chemical Composition	NBR								
6.3	Thickness of Gasket	4.5 to 5mm								
6.4	Hardness of Gasket	> 75 Shore								
6.5	Expected life of gasket	min. 5 Years								
7	**Carrying bar**									
7.1	Type of construction	S.S.								
7.2	Number per heat exchanger	One No.								
7.3	Size									
7.4	Material	CS- IS2062, SS 304 Cladding								
8	**Guiding bar**									
8.1	Type of construction	SS cladded								
8.2	Number per heat exchanger	One No.								
8.3	Size									
8.4	Material	CS- IS:2062, SS 304 Cladding								
9	**Frame plate**									
9.1	Type of construction									
9.2	Material	IS:2062, Gr:B								
10	**Pressure plate**									
10.1	Type of construction									
10.2	Material	IS:2062, Gr:B								
11	**Supporting columns**									
11.1	Type of construction									
11.2	Material	IS:2062, Gr:B								
12	**Clamping/Gasket composition arrangement**									

Sl No.	Description	T.S. Requirement Unit	Blast Furnace Shell		Tuyere Circuit		Stove Circuit		Gear Box Cooling Circuit	
			Primary (Soft)	Secondary (industrial)	Primary (Soft)	Secondary (industrial)	Primary (Soft)	Secondary (industrial)	Primary (Soft)	Secondary (industrial)
12.1	Type of arrangement	Tie rod type	Tie rod type		Tie rod type		Tie rod type		Tie rod type	
12.2	Bolt size and material	ASTM 193 B7	ASTM 193 B7		ASTM 193 B7		ASTM 193 B7		ASTM 193 B7	
12.3	Nuts size and material	ASTM 194 2H	ASTM 194 2H		ASTM 194 2H		ASTM 194 2H		ASTM 194 2H	
13	**Inlet and Outlet Nozzels**									
13.1	Size	mm								
13.2	Rating	ANSI 150#								
13.3	Facing and drilling standard	ANSI B 16.5								
13.4	Flange material	CS, IS:2062, Gr:B								
13.5	Are all nozzles counter flnages, bolts, nuts and gaskets etc. included in the offer									
14	**Cleaning frequency of the heat exchanger for assumed factor**	Months								
15	**Is backwash necessary**									
16	**Are all auxiliaries and accessories included in the offer**									
17	**Local temperature indicators**		By Purchaser		By Purchaser		By Purchaser		By Purchaser	
17.1	Manufacturer & Type									
17.2	Number per heat exchanger	Nos.								
17.3	Dial size	mm								
17.4	Range									
17.5	accuracy									
17.6	Material of construction									
18	**Local Pressure gauges**		By Purchaser		By Purchaser		By Purchaser		By Purchaser	
18.1	Manufacturer & Type									
18.2	Number per heat exchanger	Nos.								
18.3	Dial size	mm								
18.4	Range									
18.5	accuracy									
18.6	Material of construction									

Sl No.	Description	T.S. Requirement Unit	Blast Furnace Shell		Tuyere Circuit		Stove Circuit		Gear Box Cooling Circuit	
			Primary (Soft)	Secondary (industrial)	Primary (Soft)	Secondary (industrial)	Primary (Soft)	Secondary (industrial)	Primary (Soft)	Secondary (industrial)
19	**Differential pressure gauges**		By Purchaser		By Purchaser		By Purchaser		By Purchaser	
19.1	Manufacturer & Type									
19.2	Number per heat exchanger	Nos.								
19.3	Dial size									
19.4	Range									
19.5	accuracy									
19.6	Material of construction									
20	**Relief and other valves(if applicable)**									
20.1	Location									
20.2	Type and size									
20.3	End details									
20.4	Materials									
	a) Body									
	b) Trim									
20.5	Pressure rating									
20.6	Number per heat exchanger	No.s								
20.7	Manufacturer									
21	**Are all counter flanges, bolts, nuts and gaskets etc. for all terminal points included in the offer**		Ref. 13.5		Ref. 13.5		Ref. 13.5		Ref. 13.5	
22	**Are all heat exchangers supplied with necessary foundation plates, anchor bolts sleeves, inserts, lifting lugs etc. as specified**									
23	**Shot tests & Inspection**									
23.1	Whether all tests and inspection as detailed in specification/quality plan will be carried will be carried out									
23.2	Hydrostatic test									

Sl No.	Description	T.S. Requirement Unit	Blast Furnace Shell		Tuyere Circuit		Stove Circuit		Gear Box Cooling Circuit	
			Primary (Soft)	Secondary (industrial)	Primary (Soft)	Secondary (industrial)	Primary (Soft)	Secondary (industrial)	Primary (Soft)	Secondary (industrial)
	a) Test Pressure	23 bar(g)								
	b) Test duration	30 min.								
23.3	Whether all tests checked for cracks and other defects bt penetration method?If not , what percentage is checked?									
23.4	whether hardness test will be conducted for plate gasket									
24	**Details of painting**									
24.1	Exterior surface									
	a) Surface preparation									
	b) Primer	As per SA 2-1/2 of								
	c) Finish Preparation	Swedish Standard								
24.2	Interior surface	SIS-055900								
	a) Surface preparation									
	b) Primer									
	c) Finish Preparation									
25	**Weight of each heat exchanger**									
	a) Empty	Kg								
	b) Flooded	Kg								
26	**Overall Dimensions**									
	Lenth X Breadth X height	mm x mm x mm								
27	**Withdrawl apace**									
28	**Other information (if any)**									

01.19 **STANDARDS TO BE FOLLOWED**

01.19.01 **Pumps**

IPSS-1-05-002-1989	Specification for Single stage horizontal split casting centrifugal pumps for raw water.
IPSS-1-05-003-1977	Specification for Single stage horizontal end suction centrifugal pumps for raw water.
IPSS-1-05-004-1977	Specification for multi stage centrifugal pumps for raw water.
IPSS-1-05-005-1977	Specification for vertical spindle centrifugal pumps for raw water.
IPSS-1-05-006-1979	Specification for single stage horizontal split casing centrifugal pumps for emulsion, slurry, & scale bearing water.
IPSS-1-05-007-1979	Specification for single stage end suction centrifugal pumps for emulsion, slurry, & scale bearing water.
IPSS-1-05-008-1979	Specification for vertical spindle centrifugal pumps for emulsion, slurry, & scale bearing water.
IPSS-1-05-009-1979	Specification for pumps handling corrosive liquids.
IPSS-1 – 05 – 010-1981	Sump pump unit.
IPSS-1 – 05 – 020-1985	Specification for self priming single stage end suction centrifugal pumps for coal tar.
IPSS-1 – 06 – 001-1996 (R-1)	Foot valves
IPSS-1 – 02 – 054	Specification for pneumatic sump pump- ejector type
IS: 11745,1986	Technical supply condition for positive displacement pumps-reciprocating.

IS : 1520	Horizontal centrifugal pumps for clear, cold & fresh water.
IS : 5120-1977	Technical requirement for roto-dynamic special purpose pumps.
IS : 5600-1970(R-2002)	Sewerage and drainage pumps.
IS : 5659-1970	Pumps for process water.
IS : 5639-1970	Pumps handling chemical & corrosive liquids.
IS : 1710-1989	Vertical turbine pumps for clear, cold and fresh water.
IS : 8034 -2002	Submersible pumpsets for clear, cold & fresh water.
IS : 8418-1999	Horizontal centrifugal self priming pumps.
IS : 9801	Slurry pumps
IS : 6536-1972	Pumps for handling volatile liquid.
API : 610	Centrifugal pumps for general refinery purpose.
BS : 599	British standard for method of testing pumps.

ASME Power test Centrifugal pump, power test code. Code PTC 8.2

BS : 5316 }	Code of acceptance tests for centrifugal, mixed flow and axial flow pumps.
IS : 9137 }	
IS : 9201-1987	Pumps for handling slurry

01.19.02 **Pipings**

ASTM A106	Code for boiler pipe lines
ASTM B 31.1	Code for pressure piping
ASTM B 16.5	Steel pipe flanges
IS 1239 Part I&II (Part-I-2004, Part-II-1992)	Mild steel tubes & fittings
IBR	Indian Boiler Regulation with latest amendments.
BS 806	Ferrous piping system for and in connection with land boilers.
BS 1414	Steel wedge gate valves, flanged & butt-welded ends.
BS 1873	Steel gate & globe, stop & check valves for petroleum industries.
BS 5351	Steel ball valves
API 600	Specification for steel valves.
API 5L	Specification for pipelines.
IS : 778 -1984	Copper alloy gate, globe & check valves for general purpose.
IS : 780- 1984 IS : 14846	Sluice valves for water works purpose
IS : 3589-2001	Electrically welded steel pipes for water, gas, and sewerage (Dn 200 to 2000 mm)
IS : 5312, Part-I-1984	Part I Swing check type reflux valves
IS : 5290-1993	Landing valves
IS : 909	Underground fire hydrant

IS : 6392-1971	Steel pipe flanges for water, oil, steam etc.
IS : 781-1984	Bib taps
IS : 3042-1965	Sluice gates
IS : 1703-2000	Ball valves including floats for water supply purpose
IS : 4038-1986	Foot valves
IS : 636 -1968	Rubber hose delivery coupling, branch pipe & fighting.
IS : 903-1993	Fire hose delivery coupling, branch pipe & nozzles
IS : 913-1968	Water hose of rubber with braided textile reinforcement
ANSI ; B 16.9	Butt welded fittings
ANSI: B 16.11	Forged steel fittings : Socket welded & threaded
BS : 1560	Steel pipe flanges and flange fittings
BS : 3601	Steel pipes & tubes for pressure purpose – ordinary duty carbon steel
BS : 3602	Steel pipes & tubes for pressure purpose- carbon steel high duty
BS : 3603	Steel pipes & tubes for pressure purpose- carbon 7 alloy steel
BS : 3604	Steel pipes & tubes for pressure purpose -ferritic alloy steel
BS : 3059	Steel boiler and superheated tubes
BS : 1952	Copper alloy gate valve for general purpose
BS : 5154	Copper alloy globe check & valve for general purpose

BS : 3808 API : 602	Cast & forged steel Flanged, screwed & socket welded wedge gate valve
BS : 5150	wedge and double disc gate valves for general purpose
BS : 1868	Flanged/butt welded type swing check valves
IS : 1978-1982	Line pipes
IS : 5504-1997	Spiral welded pipes
IS : 2712-1998	} Specification for compressed
BS : 2815	} asbestos fiber jointing
IS : 6157 -1981	General instruction for testing of valves & equipment's
IS : 1536 -2001	Centrifugal cast (spun) pressure pipes
IS : 1537-1976	Vertically cast (spun) pressure pipes
IS : 1538 -1993	CI fittings for pressure pipes for water, gas & sewage
IS : 2002-1992	Boiler quality plates
BS : 5157	Steel gate (parallel slide) valves for general purpose
BS : 5352	Steel wedge gate, globe & check valves for petroleum industry
BS : 2871	Copper & copper alloy tubes
BS : 4504	Flanges & bolting for pipes, valves & fittings
BS : 5146	Specification for inspection & test of steel valves
BS : 5155	CI & carbon steel plug valve for general purpose.

A : 106	Seamless carbon steel pipes for high temperature service
A : 335	Seamless ferritic alloy steel pipe for high temperature service.
A : 234	Steel fittings
IS : 10611-1983	Steel wedge gate valve butt welded/flanged end
IS : 9338-1984	CI globe valve
IS :10459-1983	Taper plug type valve for general purpose.
IPSS-1-06-014	Guidelines for moist fuel gas lines
IPSS-1-06-010-1994	Specification for C. S. non-return valve
IPSS-1-06-016	Colour coding for pipe lines in steel plant
IPSS-1-06-023	Guideline for painting of steel surface
IPSS-1-06-030	Heat resistant anti-corrosive paints
IPSS-1-06-022	Specification for hose nipples
IPSS-1-06-004	Specification for control valves and actuator
IPSS-1-06-021-1986	Specification for steam trap
IPSS-1-06-017-1986	Specification for selection of steam traps.
IPSS-1-06-026	Specification for taper plug type valve for general purpose.
IPSS-1-06-002	GM globe, gate & check valves
IPSS-1-06-005-1983	MS pipes
IPSS-1-06-007	CI gate valve (NB 50 to 300 mm)
IPSS-1-06-022	CI gate valve (NB 350 - 1200 mm)

IPSS-1-06-008-1994	Cast steel gate valve (rising spindle)
IPSS-1-06-009	CI non-return valve
IPSS-1-06-013-1984	Welded steel pipe for general use
IPSS-1-06-019-1987	Air release valve
IPSS-1-06-020-1995	Fabricated pipe fittings
IPSS-1-06-027	Safety valves and relief valve
IPSS-1-06-001-1996(R-1)	Foot valves
IPSS-1-06-003-1995(R-1)	centrifugally cast (spun) iron pipes for water and sewage.
IPSS-1-06-006-1985	MS tubular cast steel and malleable CI fitting.
IPSS-1-06-012	Butterfly valves for gas application.

02. GASES AND LIQUID FUELS

02.01 Regulations

The entire interplant and in shop pipelines shall conform to the provisions of relevant Indian statutory regulations, wherever applicable, such as :

- Indian Safety Rules
- Static & Mobile Pressure Vessels Rules
- Indian Petroleum Regulations
- Indian Explosives Manual
- The Carbide of Calcium Rules
- Indian Boiler Regulations

The Contractor shall have to obtain clearance/ approval of all the relevant drawings/ documents from such statutory bodies.

02.02 Pipe Laying

Routing and layout of piping system shall be as per good engineering practice. Following factors shall be taken into consideration while designing piping system.

- All functional requirements shall be fully satisfied.
- Adequate clearance is provided for equipment and operating personnel.
- Easy access for operation and maintenance of piping component.
- Convenient supporting points for piping, equipment, valves, etc.
- Adequate flexibility for thermal expansion / movements.
- Aesthetics and neat appearance.

Pipe Laying for Fuel Gases, Industrial Gases, Liquid Fuels, Compressed Air and Steam

01. The gas pipes installed along building wall should not cross window and door way.

02. While laying high pressure gas pipes along the walls, the later should be fire-proof. In doing so, the gas pipes should be laid along solid walls or above the windows of upper floors of plant buildings.

03. When gas pipes are installed along external walls of buildings below window ways, installation of flange, thread joints and also installation of accessories is not allowed.

04. Gas pipe may be laid along with pipes of water, steam, air, etc. and also with oxygen on a common support provided conditions stipulated under various clauses are followed.

05. The following conditions shall be observed when installing gas pipes with other pipes :

a) Additional pipes on existing gas pipes will be allowed to be laid only with the permission of concerned plant personnel.

b) In each case, the gas pipes and supporting structures shall be checked with due consideration for additional loads and practical state of the metal structure of gas pipes.

c) When installing with pipes carrying corrosive fluids they shall be kept at least 500 mm below or by the side of the gas pipe at a distance of 500mm.

If flange joints are provided on pipes carrying corrosive liquids, it is necessary to mount protective baffle plate against falling of corrosive liquids on gas pipes and their supports.

d) The associated gas pipes at the places on gas pipes where valves and other devices are mounted, should be kept at a minimum 800 mm distance from the main pipe.

e) Drainage of the associate pipes should be laid to one side at a distance so that condensate does not fall on gas pipes/ its accessories, supporting structures and their elements, etc.

06. The branch line should generally be installed outside building along roof wall. Branch line having diameter less than 500 mm may be laid inside shop building.

07. Branch line from gas main entering into building through building wall should pass through casings. Internal clearance between casing and pipe should be suitably filled up, wherever required.

08. Gas branch line from gas main passing through roof covering should have circular opening. For this purpose, a circular opening should be made on roof and a taper hood should be provided on the branch line above the roof for protection from rain.

09. Shop headers (except headers of By-product Plant) should be mounted at a height having minimum ground clearance of 4500 mm, when laying them outside the building wall.

10. Layout of gas consuming units in various shops should be such that it is possible to bring the gas pipes above ground.

11. Gas pipes of coke oven, natural gas and also their mixtures with blast furnace gas may be installed in channels and casings, in the region of gas supply to furnace and other consuming units.

The following conditions should be observed for this purpose :

a) Clearance between wall and bottom should be at least 400 mm, and for gas pipes of 200 mm and below clearances should not be less than the gas pipe diameter.

b) Installation of flanges, threaded joints and accessories (except accessories for removal of condensate on a pipeline) is not allowed when it is laid in a channel. The number of welds on such gas pipes should be restricted to a minimum.

c) Installation of gas pipes with air pipes to gas consumer units is allowed to be laid in channels.

d) Channels with gas pipes should not cross other channels, In case, it is unavoidable, air tight tie-plate should be made and gas pipe should be placed in casing. Ends of casing should be taken out beyond the limit of tie-plate by 300 mm at both ends.

e) Channels should have provisions for natural ventilation.

14. Gas pipes in buildings should be located at places convenient for servicing, inspection and repair. It is not allowed to lay gas pipes at places where there are chances of damage due to shop transport.

15. For gas lines installed in hot zone, it is recommended to provide protection against overheating of gas pipes.

16. It is allowed to fasten gas pipes to frames of furnaces, boilers and other units provided these frames are checked for strength by calculations.

17. Gas pipes are not allowed to pass through buildings producing or having materials liable to explode or burn and building of power distributing devices and substations and ventilation chambers and through buildings, in which gas pipe may be damaged by intensive corrosion.

18. Gas pipes should not cross ventilation doors, air exhauster, flue pipes and also gas pipes should not be installed in insufficiently ventilated space and in underground buildings.

19. Installation of high pressure gas pipes below main working platforms of shops is not permitted.

20. Gas pipes along bridges should be made of seamless pipe and laid in the open at a horizontal distance of one metre from ends of pavements for passing of people and it should be within reach for servicing. Supporting elements of the bridge should be accordingly checked for loads from gas pipes. Laying of gas pipes in channels of bridges is not allowed. All welding joints of gas pipes in the area of their attachment to bridge should be radio graphed.

21. Gas pipes passing through walls, ceilings, and other structures of buildings of construction shall be encased in a steel pipe having inside dia at least 50 mm more than that of the oxygen pipe. The Gas pipe shall have no joints in the section at such crossings. The gap between the gas pipe and the outer pipe shall be filled with non/inflammable material, but allowing vertical and horizontal movement.

22. The laying of moist fuel gas pipelines shall be as per IPPS: 1-06-014-95

23. Pressure pipe work for gases and liquid fuels generally shall be routed overhead. All overhead interplant pipe work to be routed such that they will have a minimum clearance of 6.0m between bottom of supporting structures / pipes and road / railway track. The pipelines laid over hot tracks shall have a minimum clearance of 10.0m, in case of using protective shields in these places, this clearance shall be reduced to 6.0m Buried pipes, wherever laid, shall be provided with a minimum earth covering of 1200mm in areas subject to temporary loads and minimum earth covering of 1000mm in areas not subject to temporary loads, unless otherwise specified.

24. For the pipelines laid on roof, the distance from the external edge of the pipe to the roof shall be at least 0.5m.

25. All shop headers, except for gravity fluids, shall be generally routed along columns in multiple rows at a height 4 to 6m above floor level. The connections to equipment shall be taken through suitable covered floor trenches for shops at ground floor and for basements, for elevated operating floors, the equipment pipe work connection may be taken below the floor level. All isolated single pipe connections to equipment shall be buried in the flooring / equipment foundations. Pipe work from basement and oil cellars to main equipment shall be routed in pipe tunnels / trenches with adequate spacing for easy maintenance. All pipe trenches shall be covered by chequered plate or by concrete slabs.

26. The bleeder pipes for purging lines and other exhaust pipe work shall be routed upward along columns / gable ends and / or walls to a minimum height of 4,000mm above the roof level / platforms.

27. For the gas pipelines laid along the building walls, the clearance between the gas pipelines and the wall shall be adopted so as to ensure the possibility for maintenance of the gas pipelines. The gas pipelines laid on the walls must not cross the window and door openings.

28. Branch pipes from the headers to the building through walls and the roof shall be encased.

29. Gas pipelines shall be earthed. When laid under the high voltage lines, a protective sheet guarding shall be provided above the gas pipelines. The guarding shall be earthed. The earthing resistance must be not over 10 ohm.

30. Platforms, access ladders, hand railing, etc. shall be provided for operation and maintenance of valves, instruments and controls. Manholes and hatches shall be provided for access inside the gas pipelines.

31. At all the places of regular maintenance (gate valves, throttle valves, orifice plates, hatches, manholes, bleeders, etc.) if located at a height of over 2.5m from the maintenance level, provision shall be made for stationary platforms with the railings and stairs / ladders.

32. To ensure the condensate drainage, the gas pipelines shall be laid with a gradient of about 0.005 towards the water drains.

Condensate drains shall be equipped with bleeders.

33. Flash back arrestors shall be provided in each section of the pipe work for acetylene and LP gas to prevent flame propagation or pressure surges. They may be of hydraulic / cartridge type flash back arrestors or back pressure valves.

34. All branch pipes from main header shall be connected through a hydraulic arrestor.

35. Shut-off globe valves shall be provided on both the inlet and outlet sides of the arrestor and unions shall be provided for repair or replacement, if required.

36. Oxygen pipelines may be laid on either side of the fuel gas line as per the following norms.

Oxygen Pressure in Kg/cm^2	Diameter of Oxygen pipe mm	Permissible gap in mm
Upto 0.1	Upto DN 500	300
Upto 0.1	Above 500	600
0.1 to 16	Upto 500	800
16 to 35	Upto 200	800

Continuous installation is not allowed if the oxygen pressure is more than 16 Kg/cm^2 and diameter of pipe is more than 200mm and also if the oxygen pressure is more than 35 Kg/cm^2 for any size.

Minimum clearances of overhead oxygen pipelines (surface to surface)

i)	Explosion Hazardous shops	:	3 meters clearance
ii)	Railway tracks	:	3 meters
iii)	Railway bridge and platform	:	3 meters
iv)	Roads	:	1.5 meters upto embankment

v)	High voltage Transmission lines		
A.	Parallel to pipelines	:	10 meters
B.	Crossing the pipelines upto 20kv	:	3meters
	35 to 150kv 220kv	:	4 meters
vi)	To place of hot metal tapping and Source of open fire	:	10 meters
vii)	Insulated L.T cables	:	0.5 meters
	Bare conductor L.T	:	1.0 meters.

02.03 **Design Parameters**

Design pressure for various categories of piping shall be as follows :

Low Pressure Fuel gas piping : 1.25 Times Maxi. Operating Pressure
(Up to 1500 mm WC MOP) But not less than 2000 mmWC minimum

All other gas piping : 1.25 Times Maxi. Operating Pressure

Steam piping : 1.5 times Maximum Operating Pressure.

Design temperature for all fluids shall be maximum working temperature of fluid. In case of ambient temperature, design temperature may be taken as 60 deg C for piping exposed to sun and 45 deg C for indoor piping.

Flow rate for design purpose shall be taken as peak flow rate for the respective section. In case of branches to individual consumers, peak flow rate for the consumers shall be considered. For common branches and main headers, peak flow rate based on consumption pattern/ diversity factor may be used for pipe sizing.

Future augmentation of flow rate for common piping shall also be taken into consideration for pipe sizing.

02.04 Selection of Pipe Size

- Pipelines shall be sized by limiting the gas velocity in the pipeline as per Table 08-01.
- Peak flow rate based on the distribution pattern shall be considered for sizing of pipes.

- Sizing shall be based on actual flow rate at worst combination of parameters i.e. lowest pressure and highest temperature.
- In case recommended velocity is dependant on diameter range, after initial sizing, velocity should be re-checked and if required size should be recalculated.
- Nearest higher standard pipe size shall be selected after calculation.

For critical applications, pipe sizes should be re-checked after pressure drop calculations and availability of required pressure at consumer point. If required pipe size may be increased to meet the pressure drop criteria.

TABLE 08-01
RECOMMENDED VELOCITIES IN CARBON STEEL PIPES

A: Low Pressure Fuel Gases

Sl. No	Nominal Pipe Dia – (mm)	Gas Velocity, m/sec (maximum)			Remarks
		BF & BOF Gas	CO Gas, Natural Gas	Mixed BF & Corex Gas	
1	20 – 80	2	2	2	
2	100 - 250	3 - 4	4 – 5	4 –5	
3	300 – 500	5 - 6	6 – 7	5 – 7	
4	600 – 800	6 – 7	7 – 8	7 - 8	
5	900 – 1200	8 - 10	9 – 12	8 – 11	
6	1300 – 2000	11 - 18	13 – 20	12 – 19	
7	> 2000	20 - 25	23 - 28	21 - 27	

B: Medium Pressure & High Pressure Gases

Medium	Pressure Range (kgf/cm^2 g)	Gas Velocity, m/sec (maximum)	Remarks
Nitrogen, Argon, Compressed Air, Instrument Air	Up to 6	8 –10	See Note 1
	6 - 16	12 – 16	
	16 - 40	Up to 20	
Oxygen	Up to 16	12	See Note 2
	16 - 40	8	
LPG	Up to 3	8	
Acetylene	Up to 1.2	8	Up to DN 25
Liquid Fuels	All Pressures	1.5	

C: FOR STEAM

Sl. No	Fluid Condition	Average Velocity, m/sec			Remarks
		Up to DN 50mm	DN 50 to DN 150mm	DN 200mm and above	
1	SATURATED AT SUB-ATMOSPHERIC PRESSURE	-	10 – 15	15 – 20	
2	SATURATED AT 1 TO 7 Kgf/cm^2 (g)	15 – 22	20 – 33	25 – 43	
3	SATURATED ABOVE 7 Kgf/cm^2 (g)	15 – 25	20 – 35	30 – 50	
4	SUPERHEATED UPTO 7 Kgf/cm^2 (g)	20 – 30	25 – 40	30 – 50	
5	SUPERHEATED ABOVE 7 TO 35 Kgf/cm^2 (g)	20 - 33	28 – 43	35 - 55	

02.05 **Expansion and Flexibility.**

All Pipe work shall be designed to provide sufficient flexibility against thermal expansion to prevent development of undesirable forces and moments at points of connection to equipment, at anchorage or at guide points.

As far as possible flexibility shall be provided by planning route with change of direction or by the use of bends, loops or off-sets..

Whenever self-compensation can not be achieved by pipe routing, provision for thermal expansion shall be made by providing expansion loops or expansion joints as per following criteria :

- U loops shall be provided for all low pressure fuel gas piping up to DN 300 size and high pressure piping for all sizes.

- For high pressure piping, where U-loop is not possible, bellow type expansion joint shall be provided. Bellow type compensators shall also be provided in low pressure gas lines.

While locating the expansion joints following guidelines should be followed:

- Bellow compensators should be located preferably in the center of two fixed points.

- U-Compensators should be located in between two fixed points with variation in pipe lengths in the ratio of 1:2 (max).

- Gland Compensators should be located near the fixed supports to facilitate smooth functioning.

- Bellow and gland compensators shall have flanged connection with pipes

U-loop Compensator

U-loops shall be provided in piping system using elbows/ bends as per piping material specification.

U-loops shall be in horizontal plane and loops for many pipes running in parallel may be provided at same location parallel to each other.

Loops shall be in the same plane as the pipe route. However, in some cases, where there may be obstruction due to other parallel pipes, U-loop plane may be raised to clear the pipes by providing bends.

Loops in vertical plane can be provided in exceptional cases if horizontal loop is not possible due to layout considerations. Provision shall be made in piping for draining of condensate, venting, etc.

Bellow Compensator

Bellow type expansion joints shall be made from SS sheet and can be single or multi layer with number of convolutions.

Loads due to Compensators

Loads on anchor points due to bellow compensators shall be considered based on the feed back from supplier / manufacturer.

02.06 **Load data for designing**

- The pipeline stockades shall be designed to take all vertical (dead) as well as horizontal loads.
- 20% extra load (vertical and horizontal) shall be considered for the design of structural and civil work to accommodate future pipeline on the stockades.
- Vertical load shall comprise of the following :

  Platforms

  Condensate collected in pipeline

  Dust deposition on pipeline

  Valves, compensators & fittings

  Supports, ladders, etc.
- Live load on platform shall be taken as 500 kg/m^2
- Platform shall be provided at the following locations :
  - Location of valves
  - Location of compensators
  - Location of condensate drain installation
  - Water seals and tanks for water seals
  - Purging and vent connections
  - Manholes
  - Instruments

Following norms shall be followed for calculating the condensate load of gas mains:

Sl. No.	Pipe Dia (mm)	Height of filling of pipe cross-section with condensate (mm)	Filling in cross – section (%)
1.	Upto 500	Full	100
2.	600 – 1400	500	88 – 35
3.	15oo and above	500 - 800	30 - 14

Condensate drain installation shall be located at approximately every 100 m length of the pipeline.

Load due to dust deposition shall be as follows :

- 50 Kg per m^2 area on pipelines at a distance within 100 m from blast furnaces.
- 25 Kg per sq metre area on pipelines at a distance between 100 to 500 from blast furnaces.

Horizontal load along the axis of the pipeline shall comprise the following:

- Load due to thermal expansion
- Load due to internal gas pressure
- Load due to friction (sliding of pipes on supports)

Horizontal load transverse to the axis of the pipelines shall comprise the following:

- Load due to wind pressure
- Load due to component of gas pressure at branch connections
- Load due to component of force arising from thermal expansion or at change of axis in plan.

For calculating load due to thermal expansion the co-efficient of linear expansion for mild steel shall be taken as 0.012 mm/deg.c/ m.

Internal gas pressure for coke oven and blast furnace gas shall be taken as 2000 mmWC (g) (Test pressure for the gas pipeline).

Co-efficient of friction for steel to steel shall be taken as follows :

Sliding support : 0.30

Roller support : 0.10

Ball support : 0.10

IS:875 shall be applicable for calculating the wind load on the stockades.

IS:1873 shall be applicable for calculating seismic load.

The unsupported span of pipeline between two supports shall be calculated on the following basis;

I) Maximum deflection in the span should not exceed 1/600 of length of the span.

II) Maximum stress in pipe should not exceed the limit as per design codes.

III) Maximum permissible spans are indicated below:

Table – 08.02

Maximum permissible spacing between pipe supports

Nominal Pipe size, mm	Maximum span for Liquid service, m	Maximum span for other services, m
25	2.0	2.5
40	2.5	3.0
50	3.0	4.0
65	3.5	4.0
80	5.0	4.5
100	5.0	4.5
150	5.0	6.5
200	6.0	7.0
300	7.0	9.0
500	-	13.5
600	-	15
1000	-	18
1500 and above	-	24

02.07 **Valves and measuring devices**

Valves shall be provided on pipe work for isolation of pipe sections and equipment, control of pressure, flow and level of fluids, venting, draining, pressure relief, etc. They shall be suitable for the service conditions in all respects and located suitably considering ease of operation and maintenance. Generally the following practice shall be followed;

- Stop valves:

  On all pipelines both at the sources and consumers also in the branch pipes to individual buildings and shops with a nominal diameter of 100 mm and above (if required, for smaller diameter as well).

- Isolating and by-pass valves for flow meters, filters, etc.

- Check valve on all pipelines requiring unidirectional flow.

- Quick action safety shut-off valve on fuel oil, gas/ air lines to furnaces and heaters as well as before each consumer or group of consumers.

- Pressure regulating valves with isolating, by-pass and relief valves for all pressure reducing installations.

- Manual drain valves at low points and manual vent valves at all high points of pipe work.

- Regulating valves with integral pressure gauge for all oxygen outlet points, fuel gas outlet, etc.

- All valves shall be provided with the operating handle/ lever/ wrench within easy reach. Where necessary, operating platforms shall be provided. Valves located in inaccessible locations such as basements, tunnels, etc. Shall have remote actuation by means of electric motors, solenoids, etc.

- For fluid lines with working pressures over 16 atg, valves of diameter 300 mm and above shall be provided with by-pass arrangement, unless otherwise specified in technical specifications.

- Shut-off valves of dia 500 mm and above as well as shut-off valves of all diameter with remote or automatic control shall be provided with electric drives .

- To facilitate operation of manually operated valves, adequate gearing and handling arrangement shall be provided, wherever necessary

- All gas branch pipes from the in shop collector to the consumers shall be provided with bleed valve arrangement comprising two gate valves in succession with a bleeder in between. After the second gate valve (upstream), a provision shall be made for installation of a blank flange.

- Shop pipe work for all production and ancillary units shall have metering of flow and pressure at the battery limits.

- Sectionalising of pipe work for fuel gases such as coke oven gas, blast furnace gas, mixed gas and converter gas will be provided to facilitate maintenance work. This may be achieved by water seals, goggle valves, spectacle blinds or patented gas tight isolators.

02.08 **Condensate Disposal**

Fuel gases as well as other gasses contain moisture and other condensable impurities which get separated during fluid transportation through piping system, effective condensate removal system should be incorporated to prevent accumulation of condensate in pipes which otherwise may cause obstruction to proper gas flow and excess live load to the pipe/ structure.

All piping for gasses containing moisture etc. like BF / Coke oven / BOF gas, Mixed gas, Compressed air, Steam & Natural gas are laid with gradient / slope. A slope of 5mm per meter run shall be provided for the above pipelines. In case of space constraint to accommodate slope, it may be reduced to 0.003 particularly for in shop piping. For straight length of pipeline, low / high points should be located generally at a distance 100 meters. However, in no case it should exceed 300 meters.

Condensate drain points shall be provided at all low points. In case of low pressure gas lines, automatic drainage system though seal pots shall be provided.

For compressed air lines and steam lines, automatic condensate / steam traps shall be provided.

Condensate Drain Arrangement for Low Pressure Gases

i) Drainage shall be provided at all the low points of gas pipes carrying moist gases for condensate removal. Disposal of condensate shall be through seal pots/ condensate drain installations.

ii) Distance between any two drain points of a gas pipe within a radius of 100 meters from gas cleaning plant should not exceed 60 meters.

iii) Drainage system for outdoor gas networks should be located in open air with necessary accessibility for operation.

iv) Pipes for condensate removal from inter shop gas pipes of blast furnace gas in a radius of 400 m from gas cleaning plant should be at least 80 mm diameter. For pipelines beyond 400 m and also for gas pipes for other moist gases, diameter of condensate removal pipes should not be less than 50 mm.

v) Separate seal pots shall be provided for different gasses.

vi) Removal of condensate from branch line from inter shop gas pipe and inshop gas pipe should be carried out in separate condensate seal pots.

vii) Minimum height of the water seal in the condensate seal pot shall exceed the maximum working pressure of gas by 500 mm, but this height in no case shall be lower than 2000 mm.

If necessary, the height of water seal can be increased by adding more than one seal pot in series. However, number of such seal pots shall not exceed three. Further base plate of seal pot shall have minimum thickness of 16 mm.

While installing common seal pot for a number of gas pipe, height of water seal should exceed by 500 mm the maximum working pressure in any of the connected gas pipe.

viii) Design of condensate seal pots should ensure protection against leakage of harmful gases into building by providing vent of adequate height on the seal pot.

ix) Condensate seal pot shall be provided with purging facilities.

x) Installation of condensate seal pot for inshop gas network is allowed inside the buildings.

Condensate Drain Arrangement for Medium pressure High pressures gas

i) Condensate disposal for gases having higher line pressure have to be done by using adequate pressure seal pots.

ii) In a high pressure seal pot the metallic float is utilized for disposal of condensate and prevent leakage of gas from the pot.

iii) The seal pot should be air tight and wall thickness should be decided on the line test pressure.

iv) Condensate coming out of seal pot should be discharged into phenolic sewerage line or in a reservoir provided locally.

Steam Traps / Moisture Traps-

At low points in steam & compressed air pipeline steam traps / moisture traps with strainer assembly will be provided to drain out the condensate. Selection of steam trap shall be as per IPSS: 1-06-039 – 02. Installation of steam traps shall be as per IPSS: 1-06-037

02.09 **Bleeders/ Vents**

Bleeders shall be provided on all the gas handling devices and pipelines for purging and venting any section of the gas pipeline. The purging bleeders of pipelines carrying different fluids, separated by gate valves, are not allowed to be combined into one bleeders. The bleeders shall be taken above the gas pipeline or above roof of the building by at least 4 m, but not lower than 12 m from the ground level. Bleeders on shop roofs shall be located away from roof monitors.

i) Bleeder/vents shall be provided for purging / venting any section of the pipeline. Bleeders shall be located generally at all high points in the piping system. Bleeder / vents shall also be provided at down stream / upstream of isolating devices & U-seals.

ii) All vents shall discharge at a safe height into atmosphere. The vents shall be above the operating floor / platform for vent valve or roof of the building 4m, but not lower than 8 meters from the ground level. In the presence of the aeration monitors on the roof of the building, the vents shall be located so as to eliminate the possibility of purged gas getting inside the premises.

iii) On straight lengths bleeder/vent shall generally be provided at an interval of 100 meters.

iv) All vents shall have T piece/cowl with bird screen preferably at the top. For isolation of bleeder/vent pipe flanged gate valve of rising stem type shall be provided. Sampling points (DN 25) below isolation valve with lubricated taper plug valve shall be provided in the line to monitor gas samples at the time of purging.

v) Vent pipes of different gases shall not be connected through a common vent.

vi) Recommended sizes of bleeder / vent pipes corresponding to gas pipe diameter are indicated in Table – 08.03.

Table –08.03

RECOMMENDED SIZES OF BLEEDER / VENT PIPES

Pipe dia.

DN (mm)	Bleeder pipe dia. DN (mm)	
	Low Pressure Fuel gas	Natural gas/Corex Gas
20	-	20
25	-	20
40	-	20
50	50	20
65	50	20
80	50	20
100	50	20
150	50	25
200	50	25
250	50	25
300	50	25
400	80	50
500	80	50
600	80	50
700	100	80
800	100	80
900	100	80
1000	150	100
1100	150	100
1200	150	100
1300	150	150
1400	150	150
1500	200	150
1600	200	-
1800	200	-
2000	250	-
2200	250	-
2400	250	-
2500	250	-
2800	250	-
3000	250	-
3200	300	-
3500	300	-

02.10 **Purging System**

Piping system particularly piping for fuel gases is required to be purged with inert gas prior to charging of gas as well as during shut down before any maintenance job.

System for feeding purge gas and venting of gas/ air from the piping system shall be provided for all fuel gas piping.

i) Gas pipelines of blast furnace gas, coke oven gas, converter gas and mixed gas shall be equipped with nitrogen or steam pipe connection with isolation valve . The connection of nitrogen or steam pipeline to the gas pipeline shall be done by means of flexible hose which shall be connected only during the period of purging.

ii) Location of purge gas inlet points and vents shall be such that entire section of piping can be purged with minimum dead space. Purging points shall be provided at low points.

iii) Purging points shall not in any case be provided at bottom half of the gas mains.

iv) Purge points for fuel gas pipes upto DN 950 mm shall be of minimum DN 25 mm same for pipes of DN 1000 mm & above shall be of minimum DN 50 mm.

02.11 VALVES AND ISOLATING DEVICES

Isolating devices shall be provided in piping system for isolation of pipe sections as well as for isolation of all other mounted accessories for the purpose of operation and maintenance. They shall be suitable for the service conditions in all respects and located suitably considering ease of operation and maintenance.

Isolation valves shall be provided at the following locations:

- On all pipe lines both at the source and at consumer ends
- On all branch pipes to individual buildings and shops
- On all bleeder / vent pipes, purge gas inlet points, drain points, sampling connections, etc.
- On all by-pass lines for large valve, regulators, filters, moisture traps etc.
- Instrumentation tapping points.

Relocation of isolation valves on request of CLIENT may be also be considered if technically acceptable.

Other types of valves required for piping system include the following :

- Check-valve on all pipelines requiring only unidirectional flow.
- Quick acting shut-off valves on gas/ air lines to furnaces and heaters as well as before each consumer or group of consumers.
- Pressure regulating valves for all pressure reducing installations, gas mixing stations and flow control system.

02.11.01 Selection of Isolating devices :

The gas cut-off arrangement shall ensure the possibility of complete cut-off gas along with fast and safe operation. Gate valves with rising stem shall be used normally for isolation in piping system.

Pipe work for fuel gases such as Blast Furnace Gas, Coke Oven Gas, Converter Gas, Mixed Gas with low operating pressure shall have some means of gas tight isolation of sections of the pipe work to facilitate maintenance work. These may be water seals, goggle valves, spectacle blinds, or gas tight isolators / slide plate valves, etc.

For sections where the gas tight isolating device can not be provided, provision to insert blind flange at outlet of gate valve shall be made.

Sectionalizing / isolation for purging of fuel gas lines may be done with Spectacle blinds.

Gas tight butterfly valves may be used for isolation near consumption points requiring frequent and quick operation. These can be valves with gas tight seating or eccentric valves for gas tight isolation.

Emergency quick shut off valves shall also be double eccentric butterfly valves.

For fluid lines with working pressure over 16 kg/cm2 (g), valves of DN 300 and above shall be provided with by-pass arrangement or depressurisation arrangement for pipe sections.

02.11.02 **Selection of Actuators for Isolating Devices:**

Manually operated shut-off gate valves of size DN 300 to DN 450 for low pressure lines shall have gear drive. For high pressure lines, gear operator shall be provided as per manufacturer’s recommendations for limiting the operating torque to acceptable limits.

Gate Valves of size DN 500 and above shall be provided with electric actuators. Electric actuators for fuel gas lines shall be of flame proof design if located in gas zone/inshop. In the interplant area these actuators need not be flame proof. Position and torque limit switches shall be provided on actuators. Manual over ride shall also be available in actuators.

Goggle valves shall have electrical actuators for disc/ plate movement and electro hydraulic drive for flange separation. Manual arrangement for valve operation shall also be provided with gear and chain operation from convenient location. The hydraulic power pack for the valve shall include one motorized pump and one manual pump. Encased design goggle valve with vent should be used at locations closed to buildings.

Electrically operated gate valves for gas pipelines of smaller diameter are recommended to be used only if they are incorporated in the automation scheme.

All valves located remotely, requiring frequent operation and / or with automatic control shall be provided with electric drives, electro- pneumatic drive, solenoids etc.

02.12 Other Flow Components

02.12.01 Check Valves

Check valves are used in piping system where unidirectional flow is required check valves can also used for stopping flow reversal incase of sudden stoppage of fluid flow like in the pump discharge. For small size pipes below DN 50, lift check valves are used. For DN 50 and above, swing check valves or dual plate check valve are used. Lift check valves can used only in horizontal pipeline it should not be used in vertical pipeline. For low pressure gas lines dual plate check valve are most suitable.

02.12.02 Pressure Regulating Valves

Irrespective of specified variations in upstream pressure, these shall maintain a reduced constant pressure on the downstream side of pipelines on which they are mounted. The valve shall be of globe / needle type, with material specifications, dimensional standards etc. as per the relevant piping Material Specification(PMS) for the service for which the valve is intended.

Self actuated pressure regulators shall be used for pressure reduction in service piping. Spring loaded pilot operated regulators shall be used. In case precision control of pressure is required. Dome loaded regulators with additional pilot spring loaded regulator for pressurizing the dome may be used. For pressure regulators, maximum and minimum available pressure upstream of regulator and desired range of outlet pressure with maximum flow rate shall be specified.

For process lines where continuous regulation/ control of pressure or flow is required, control valves shall be used.

1 **For Compressed Air**

Pressure regulators of sizes up to DN 50 shall be complete with a prefilter having 40 micron porous bronze filtering element in shatterproof plastic or glass container, pressure regulator and pressure relief arrangement to prevent overpressure at downstream of the regulator.

For higher sizes to meet larger flow rates, the pressure regulator shall be self actuating type as per manufactures standards, but capable of meeting the service conditions and duty specified.

2 **For Steam**

For sizes up to DN 50, pressure reducing valves of single seated diaphragm type having in-built strainer, with screwed ends up to DN 20 for PN 10 and below and flanged ends for higher sizes and for higher PN. Body of main and pilot valves shall be of carbon steel / alloy steel castings / forging, diaphragms shall be of stainless steel, internal springs of stainless steel and pressure adjustment springs of spring steel.

For higher sizes to meet larger flow rates, the pressure reducing valves shall be as per manufactures standards, but capable of meeting the service conditions and duty specified.

3 **For Other Gases**

For dry air, nitrogen and argon the pressure reducing valves shall be of stainless steel. For oxygen service, the valve shall be of bronze construction and shall be degreased and cleaned to meet the service requirements.

For acetylene and LP gas services, the pressure regulators shall have material for the service. For acetylene, the materials of construction shall not have copper in excess of 70% by composition. (Refer IGC code).

Pressure regulators for large diameter gas lines shall comprise butterfly type valves actuated by means of an oil hydraulic control system, which is actuated in turn by changes in the preset downstream pressure through impulse pipe work.

02.12.03 **Pressure Relief Valves**

These shall be spring loaded type and shall automatically open when the pressure on the pipelines, on which they are mounted, exceed preset values. The valves shall have end connections and materials specified for throttling valves in relevant PMS.

Relief / Safety valves for steam service shall have IBR certification. Relief valves shall have hand wheel / wrench for adjustment of preset value of relief pressure.

Pressure relief valves shall always be used on outlet lines from the pressure reducing valves. Pressure relief valves shall be designed for full flow rate from pressure regulators. Set pressure shall be 10 % higher than the maximum working pressure at outlet of regulator.

02.12.04 **Filters**

Filters are installed in piping system before the pressure regulators/ control valves and at consumer points depending on nature of fluid and technological requirements. For small size pipes below DN 50, Y-type strainers with sintered/ wire mesh cartridge may be used. For higher sizes, straight line mounted filters with removable cartridge shall be used.

Filter element can be of wire mesh, sintered material, woven fibers or other suitable type as per process requirement. Filtration area shall be at least 500% of the inlet cross section area.

Full flow rate, maximum working pressure, micron rating, allowable pressure drop, material of body and mesh shall be specified.

02.12.05 **Safety Shut-Off Valves**

These shall shut-off in case the pressure on the upstream side of the valve becomes less than preset values. The valves shall be of globe type for DN 50 and below and butterfly type for sizes above DN 50; the material shall be suitable for service conditions. The valves shall be actuated by electromagnetic or pneumatic device working in conjunction with pressure switches located on the pipelines being safeguarded and shall include all components required for its functioning.

02.12.06 **Electrical continuity**

Metallic electro static jumpers shall be provided at all locations on all flanged in case of flammable gases and oxygen. This is to prevent accumulation of static electricity in pipe sections. Piping system shall be suitably earth at a regular length of pipeline.

02.13 **Measuring and Control Devices**

Instrumentation and control devices are required for monitoring the fluid distribution system, regulation of pressure and flow.

Flow measurement shall be provided at battery limit of all production and consuming units, inlet/ outlet piping of storage installations, on surplus gas bleeder piping to flare system etc. When orifice plates are used, proper care shall be taken in piping layout for preventing accumulation of condensate by providing suitable slope or drain system. Requirement of straight length upstream and downstream of flow sensors shall be maintained as per instrumentation requirements. Normally the straight length recommended is 10 times pipe dia before inlet and 5 times pipe dia after outlet of device.

Pressure measurement shall be provides at battery limits of production and consumer units, at outlet of storage systems, inlet and outlet of pressure regulators/ controllers, etc.

Temperature measurement is provided at piping from gas cleaning plants and near consumer installations.

Pressure and Flow Control valves are provided at gas mixing stations, main pressure regulating stations, flare stack piping, inlet/ outlet piping of storage installations (gas holders). For low pressure gas lines, butterfly type control valves are used. For high pressure gases, globe valves may be used. Sizing of control valves is based on flow rate and pressure parameters. In most cases, the control valve size is lower than the main pipe size. Suitable reducers/ expanders shall be provided at inlet/ outlet of the control valves. In case of piping with possibility of condensate accumulation, eccentric reducers shall be used.

02.14 **Special Considerations for Oxygen Piping**

Filters should be installed in the oxygen pipeline system at the following points:

a) At the outlet of the oxygen plant.

b) Upstream of components having soft seating in contact with the oxygen stream e.g. pressure regulator and control valves.

c) Upstream of components that have moving parts in contract with the oxygen stream e.g. flow measuring and limiting devices.

Provision shall be made for safe and easy access for frequent cleaning and / or replacement of the filter element. The larger capacity filters like (a) above should be provided with differential pressure gauge for monitoring the condition and providing indication for cleaning / replacement of the filter element. The filter bodies shall preferably be of copper alloy or stainless steel and filter element of copper alloy or glass cloth suitably earthed to the filter body with copper wires.

Two (2) or more pressure relief valves should be provided downstream of each set of pressure reducing valves. One or more main relief valve(s) should be capable of discharging 100% of the full oxygen flow and limiting the pressure within the defined limits. The secondary relief valve should be sized to discharge the nominal leakage from the pressure reducing valves. The relief valves should be positioned as close as possible to the pressure reducing valves. The vent lines from the relief valves should be preferably of stainless steel or copper.

Consideration should be given to providing of small size pressure equalisation bypass isolation valves across large diameter isolation valves in large pipeline systems so as to ensure safe pressurization of the downstream pipeline. Sonic velocities may occur during the initial stages of valve opening with possibility of high velocity transport of material / dirt particles in the system. If the valve opening action is rapid, there is also a possibility adiabatic compression and heating of the oxygen specially if additional closed valves exist downstream. The bypass pipe work and valve should be of copper or copper alloy.

Fire break sections may be installed in the oxygen pipeline to limit the propagation of combustion in a steel pipeline. Fire break sections may be introduced immediately downstream of the main isolation and throttling valves where the velocities can be high. The fire break section will be either a length of copper pipe having the same inside diameter as the main pipe with flanges fitted at the two ends which is installed between the steel pipes or a copper insert tube made from copper sheet / tube and inserted inside the steel pipe downstream of the valves. The copper insert tube is generally used in large diameter steel pipelines.

In steel pipelines care should be taken to install isolation valves on straight sections of the pipeline. Any pipeline component which is likely to cause a change in the flow pattern like reducer, bend, tee or “Y” connection, orifice plate etc. should be at a distance of at least four diameters away from the valve.

For cleaning of the gaseous oxygen pipelines after erection, provision for "pigging" will be provided for pipelines having diameters upto DN 200. However, if the pipeline is pickled and phosphated as per approved procedure, pigging of pipelines is not essential. The bends on these pipelines will have a radius of 5 DN. DN 250 and above, extra care will have to be taken regarding cleanliness of these pipeline during installation. For line sizes DN 250 and above the bends will have a radius of 3 DN.

Gaseous oxygen pipe work shall preferably have butt welded pipe joints. To reduce safety hazards the number of components should be kept to a minimum compatible with the system requirements. Flange joints are to be used only for connection of the pipe to the system components on the pipe work. Threaded joints and couplings should be sparingly used.

02.15 Piping system shall be designed with high degree of reliability so that the systems perform the duty of fluid handling without structural or functional failure under most adverse condition of plant operation anticipated. All piping systems shall be designed with sufficient corrosion and stress margins to ensure a life time without failure, not less than the life of the plant. 7000 complete cycle of operation shall be considered for stress analysis purpose. Piping system shall not impose reactions on equipment terminals exceeding permissible limits even under adverse operating conditions. Personnel injury from discharge of hot fluids from drains, steam traps, hot pipes or exposures to pipe vibrations shall be guarded against.

01. Pipes shall be sized for minimum pressure drops and considering the velocity limitation for various types of fluids.

02. Adequate flexibility shall be provided in the pipelines to keep stresses and reactions in the system arising due to thermal expansion or other effects within limits. Where the piping terminates at an equipment or at the terminal point of a system, the reactions and thermal movement imposed by piping on the equipment or the system concerned shall be well within the limits specified.

03. If cold springing of pipleline is used, care shall be taken in determining the location and amount of cold spring gap. Cold spring gap shall be located at points where the bending and torsional moments are minimum. Use of cold spring gaps less than 10mm shall not be acceptable and cold spring gaps above 100mm shall be avoided. All outdoor piping exposed to sunlight carrying fluid at a temperature less than 80^0C shall be designed considering thermal expansion corresponding to 80^0C and empty pipe as one of the operating conditions although not necessarily the worst.

04. All piping shall have butt welded connections with minimum of flanged joints for connection to vessels and equipment to facilitate erection and maintenance. All high pressure steam valves and accessories shall have welded connections. Standard fittings shall be used wherever practicable. Unless otherwise specified, for all welded lines with pressure above 4 kg/cm2 g and / or temperature above 200^0C, branch connections with branch sizes upto 25% of welded mains shall be made with special forged steel welded fittings.

05. Bends for pipes for oxygen service shall have a radius of not less than three times the nominal pipe dia unless otherwise specified.

06. In general pipes having size 50mm and above, are to be joined by butt welding and 40mm below by socket welding / screwed connection. Threaded joints shall have to be seal welded except for galvanized pipes where Teflon sealing tapes shall be used. For galvanized pipeline, pipe joints which are to be made before galvanising shall be of welding type. Those joints which are to be made after galvanising shall be either flanged or screwed type. As far as practicable, whole fabricated piping assemblies shall be galvanized at a time in order to minimize the number of joints to be made after galvanising.

07. All pipelines shall be provided with drain connections, generally at the lowest point for removing accumulated condensate or water and line draining. The drains piping shall have drain pockets and isolation valves. Trap stations shall be provided where necessary. Lines shall be given proper slope towards the drain points. Drip legs on mainson line dia 150mm or over shall be at least 75% of the main dia with a depth twice the dia of the main or 600mm minimum from the centre line of the main to the trap off take unless otherwise specified. Drip legs on mains smaller than dia 150mm shall be full dia of the line. All drip legs for fluids which may deposit undesirable liquid or solid matter shall have full dia flanges for the bottom cover.

08. Pipe supports, anchors, restraints

- In general pipe supports, restraints, braces or anchors shall be located at those points in the building or outdoor where provision has been made for the loads imposed. Loads at the supporting points or restraints shall be determined sufficiently early and provisions shall be made in the building or outdoor structures for pipe supports. The Tenderer shall locate, design, supply and erect all the supplementary steel structures to properly secure and support all pipe hangers, supports, restraints, etc.

- Provision shall be made for support of piping which may be disconnected during maintenance work. All large pipes and all long pipes shall have at least two supports each arranged in such a way that any length of piping or valve may be removed without any additional supports being required.

- Supports, guides and anchors shall be so designed that excessive heat is not transmitted to the building steel. Supporting steel shall be of structural quality. Perforated, strap, wire or chain shall not be used. Support components shall be connected to support steel by welding, bolting or clamps. Bolt holes shall be drilled and not gas cut. Structural steel work for supporting shall be designed on the basis of a maximum design stress of 1265 kg/cm2. Pipe attachments coming in direct contact with pipes having surface temperature above 400^0C shall be made of alloy steel. Use of insulating materials like asbestos between pipe clamp and pipe surface to meet the above temperature limitation shall not be permitted. The maximum spacing between two consecutive supports shall be not more than as specified. Pipe hangers and supports shall be capable of supporting the pipelines under all conditions of operation. They shall be capable of supporting the pipelines under all conditions of operation. They shall allow expansion and contraction without over stressing the piping system or overloading the terminal equipment due to variation in supporting effort. Rigid supports or hangers shall be permitted only for pipes with small movements. For hot lines, spring hangers shall be used. The maximum permissible load variation on the terminals of sensitive equipment between hot and cold conditions shall be limited to 6%. Variability in load between hot and cold conditions expressed as a percentage of the design load shall be taken as the criteria for spring selection for spring hangers. Variable spring hanger shall be set at cold conditions so that they take design load under operating condition after the designed thermal expansion has taken place.

Spring shall be encased in suitable cages and the hangers shall be provided with spring locking arrangement, external load and movement indicator and turn buckles for load adjustment. All the rigid hangers shall be provided with turn buckles for vertical length adjustments. Hangers rods shall be subjected and designed for tensile loads. At locations of high axial or lateral movement, suitable arrangement shall be provided to permit the swing. The swing from vertical position shall be within 4^0. Double nuts and locknuts shall be used for hanger rods and bolts in all cases. Hangers shall be designed so that they can not become disengaged by movements of supported pipe.

- The supporting structures at each support points shall be designed for the highest of the following loads to take into account the extra load during hydraulic testing.

- 1.25 times the maximum load under operating condition

- Weight of pipelines full of water (combined weight of pipe, insulation, valve attachment etc. plus weight of water)
- Weight pipeline full of water as above plus any cold reaction as anticipated.

- Where the piping system is subjected to shock loads such as thrust imposed by the actuation of safety valves, hanger design shall include provision of shock absorbing devices of approved design. Vibration control devices shall be part of piping system design.

- Outdoor piping shall be designed with due consideration to expansion resulting from exposure to sunlight and care shall be taken to prevent progressive movement of long pipelines. Outdoor piping may be supported on shoes, saddles or steel sections. Effect of support friction especially for large dia pipelines shall be considered and friction forces minimized by suitable arrangement. Piping inside the trenches shall be supported at intervals on steel sections and the arrangement shall permit easy maintenance.

09 Valves and specialties

- All valves shall be of approved make and type. All valves shall be suitable for service condition i.e. flow, pressure and temperature under which they are required to operate. The valves for high and medium steam service shall have butt welded ends unless otherwise approved and the internal dia shall be same as that of the pipes to be joined.

- All gate/ sluice, globe and needle valve shall be fitted with outside screwed spindles and bolted type glands and covers. Spindle glands shall be of the bridge type construction and screwed glands will not be accepted. All high pressure valves having nominal dia more than 150mm, shall have integral steam bypasses concede to the valve body by means of welded joints.

- All gate/sluice, globe and needle valve shall be provided with hand wheel and position indicator. The face of each hand wheel shall be clearly marked with words “open” and “shut” with arrows to indicate the direction of rotation to which each refers. Arrangement limiting the travel of any valve in the “open” or “shut” position shall be provided exterior to the valve body. All globe valves shall be designed to prevent erosion of valve seats when the valves are operated partially opened. Valves which cannot be operated from the floor or walkways, shall be provided with suitable extension rods and linkages to facilitate operation from the floor or walkways. Chain operation will not be accepted for steam valves. Stems shall preferably be arranged vertically with gland at the top. In no circumstances must the gland be at the bottom. Valves shall not be installed in an inverted position. The design of valves shall be

such that it will permit packing of glands under pressure. Where required, valve spindles shall be extended so that the hand wheel is at a height of about 1.0m above the level of the floor or platform from where the valves are to be operated. Where required, they shall be provided with head stocks and pedestals of rigid construction and where gears or bevel wheels are used, these shall be of cast steel or suitable grade cast iron with machine cut teeth.

- Non return valves on all pumps discharges and steam line shall be of an approved non slamming type. Draining arrangement shall be made on both sides of the horizontal non-return valve where such a valve adjoins an isolating valve. Valve bodies shall be provided with removable access cover to enable the internal parts to be examined without removing the valves. Valves shall have a permanent "arrow" inscription on its body to indicate direction of flow.

- Gate sluice valves for low pressure service shall be outside screw rising spindle type. For these valves wherever necessary, chain operator shall be provided to operate the valve from the floor or walkways. Larger size gate valves for low pressure applications shall be provided with bypass and draining arrangement and valves with dia more than 350mm shall be provided with gear operator. For low pressure water applications, the non-return valves shall be lift check type for size upto DN 50mm and swing check type for higher sizes.

- Valves in corrosive service shall be diaphragm or rubber lined type. Diaphragm shall be of reinforced rubber and rubber lining of body shall have minimum thickness of 3mm. Generally plug valves shall be used in compressed air line. Plug valves shall be supplied with wrench operator. Valves shall be of taper plug type. Sampling valves for demineralised water shall be of cock type and stainless steel AISI 316.

- For motor operated valve, a 415V, 3 phase, 50Hz reversible speed motor shall be furnished. Motor shall be capable of producing not less than 1.5 times the required operator torque. Each operator shall be equipped with two adjustable limit and torque switch for both open and closed position. The motor shall be of high torque low starting current. Each operator shall be provided with auxiliary hand wheel for manual operation. The hand wheel shall automatically disengage when the operator is energized.

- Manual operator shall be of worm and gear type, having permanently lubricated, totally enclosed gearing with hand wheel diameter and gear ratio designed to meet the required operating torque. The operator shall be designed to hold the disc in any intermediate position between full opened & full closed without creeping and fluttering. Adjustable stop shall be built into the operator to prevent over travel in

either direction. Operator shall be equipped with direct coupled position indicator and suitable locking device.

- Pressure reducing valves shall be perfectly stable, quiet and vibration less in operation when reducing the pressure for any throughput upto maximum and shall be suitable for continuous use at operating temperature. Valves shall be designed to prevent erosion of the valve seats. Safety valves shall be the direct spring loaded type and shall have a tight, positive and precision closing. All the safety valves shall be provided with manual lifting lever. Valves used for compressible fluids shall be of pop type. Safety valve shall be so constructed and adjusted to permit the fluid to escape without increasing the pressure beyond 10% above the set blow off pressure. Valve shall reset at a pressure not less than 2.5% and more than 5% the set pressure.

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

09. Fabrication and installation of pipe work

- Pipe joints shall be assembled with the inside of all pipes and fittings smooth, clean and free from burrs, scale, welding slag, sand and dirt. The inside edges of pipe and tubing shall be reamed after cutting to remove burrs. Screw threads shall conform to ANSI B 2.1 for taper pipe threads. All the threaded joints shall be made up with a lubricant or compound suitable for the service under which the piping is to be used.

- Welded joints shall conform to “Code for pressure piping ANSI B31 1.0 (power piping) or approved equivalent, except where the welding of such joints is covered by other code requirements such as IBR, ASME pressure vessel and boiler code or approved equivalent.

- Branches shall in generally be formed by welding standard fittings. Pipe bends and tees shall be truly cylindrical and of uniform sections. Where permitted for certain services, elbows or branch connections may be formed from steel pipe. Unless otherwise agreed, slip-on welding flanges shall be used on pipe and for connection to low pressure equipment. Welded neck flanges shall be used for butt welding fitting as elbows, tees and reducers and for connection to high pressure equipment. Where class 125 ANSI flanges are bolted to 150 ANSI steel fittings, the 1.5mm raised face on the steel flange shall be removed. When bolting such flanges, a full face gasket shall be used. Equipment terminal flanges if consist of a different standard, a suitable companion flange shall have to be provided at the connecting points.

- Flange drilling shall straddle the natural centre line of pipe. Faces of all flanges shall be 90^0 to the longitudinal axis of the pipe to which they are attached. Slip-on flange when used, shall be welded in accordance with ANSI B31.1 or any other equivalent code. If distorted after welding, the flange shall be refaced. In all cases, flange faces, must be free from particles of weld metal. The flange face and the pipe projecting end shall then be machined to permit both pipe and flange to bear against.

11. All welding by the electric arc and gas welding process for pipe joints and fabrication shall be done by qualified welders and done according to appropriate IBR, ANSI code / regulations as applicable for welding, subject to accompanying code regulations and standards for filler metal, pressure, temperature and fluid carried. The ends of pipe and welding fittings shall be beveled according to the details shown in ANSI B31.1 or equivalent. All welds shall be made in such a manner that complete fusion and penetration are obtained without an excessive amount of filler metal beyond the root area. The reinforcement shall be applied in such a manner that it will have a smooth contour merging gradually with the surface of adjacent pipe and welded fittings.

02.15 Thermal Insulation of Pipelines

Thermal insulation is applied to pipelines for two purpose.

i) To prevent heat loss to atmosphere in case of fluid being hot or to gain heat in case of the fluid it contains is cold or below ambient temperature.

ii) To ensure that the skin temperature of the equipment or pipe is not more than 60^0C which is a permissible limit prescribed by the Inspector of factories.

Insulation Materials

Following insulating materials are normally used.

i) Unbonded mineral wool made from slag or rock confirming to IS : 3677 or glass wool conforming to IS : 3690

ii) Bonded mineral wool conforming to IS:8183 made from slag or rock or glass process from molten state into fibrous form and bonded with a suitable binder.

iii) Preformed fibrous pipe insulation conforming to IS:9842. The material shall be mineral wool processed from rock or glass fibres.

iv) Insitu Polyurethane / polyisocynurate insulation conforming to IS:13205 (applicable for max operating temperature of 110^0C).

Thickness of Insulation

Thickness of heat insulation to be provided is a function of the value of thermal conductivity of the material selected, the temperature of the fluid and the bulk density of the heat insulation material.

Following table gives the bulk density for unbonded and bonded mineral wool with temperature limitations of hot face temperature.

Unbonded Mineral wool	Bonded Mineral Wool (kg/m^3)			Max hot face Temp ^{0}C
	Slabs / mattresses	Pipe sections		
		Glass Wool	Rock Wool	
120 kg/m^3	50	85	120	250
150 kg/m^3	80	85	120	400
200 kg/m^3	120	85	120	550

Table for Insulation thickness

Pipe size (outside dia)	Insulation thickness in mm for various temperature ranges					
Pipe size (outside dia)	100^0C and below	Between 101 and 200^0C	Between 201 and 300^0C	Between 301 and 400^0C	Between 401 and 500^0C	Above 500^0C
Upto DN 50mm	25	50	50	75	100	100
DN 65 to DN 100mm	25	50	75	100	125	125
DN 125 & DN 150mm	50	75	75	100	125	150
DN 200 mm	50	75	75	125	125	150
DN 250 mm	50	75	100	125	150	150
DN 300 mm	50	75	100	125	150	150

Note:

The metallic jacket over the insulation shall be galvanized steel sheet conforming to IS: 277 with following thicknesses:

- Pipe sizes up to 300 mm OD : 0.63 mm
- Pipe sizes up to 300 mm OD equipment, flanges, valves : 0.80 mm

02.16 Load Calculations and Flexibility Analysis

02.16.01 Load Calculations

Loads from the piping system are transferred to the pipe supports and connected equipment. Depending on the direction of application, loads are calculated under two major heads :

- Vertical Loads
- Horizontal Loads

02.16.01.01 Vertical Loads

Vertical loads transferred to pipe supports comprise of the following :

- Dead weight of the pipes
- Weight of fluid in pipes
- Weight of insulation if any
- Condensate weight in gas pipeline
- Dust load due to deposition on pipeline
- Load due to mounted valves, compensator and fittings.
- Load due to saddles, supports and other service pipes
- Dead load and live load from Platforms and walkways

Empty weight of pipes shall be taken from standard weight tables.

In case of pipes carrying liquid, fluid weight with full pipe section shall be considered.

Following norms shall be followed for calculating the condensate load in low pressure fuel gas mains.

Pipe dia. (mm)	Height of filling of pipe cross-section with condensate (mm)	Filling in cross-section (%)
1. Upto DN 500	Full	100
2. DN 600 – DN 1400	500	88 – 35
3. DN 1500 – DN 3500	500 – 800	30 – 14

Load due to dust deposition shall be as follows:

- 50 Kg/m^2 on pipelines at a distance within 100 m from dust generating plant (viz. Blast Furnace, Coke ovens, SMS, Lime and Dolomite plant etc.)
- 25 Kg/m^2 on pipelines at a distance between 100 m to 500 m from dust generating plants.

Weight of valves, compensators and other mounted accessories shall be taken from drawings/ catalogues.

Live load on platform shall be taken as 500 Kg/m^2. This is indicated to Structural Section for designing platforms.

It is recommended to add 10% to 20 % of vertical load as a provision for pipes to be laid in future on the same route.

02.16.01.02 **Horizontal loads**

Horizontal loads transferred to pipe supports comprise of the following:

- Load due to thermal expansion
- Load due to internal gas pressure i.e. blanking load, load due to annular space of compensator, unbalanced pressure load at branch locations, etc
- Load due to friction
- Wind load

Depending on the pipe configuration, horizontal loads can be in axial direction as well as in transverse direction.

Horizontal loads due to thermal expansion, internal pressure and friction are calculated by carrying out flexibility analysis on individual pipe. Procedure is given in para 05.03. However, wherever possible, standard software package like CEASER-II may be used for carrying out flexibility analysis and calculations of loads transmitted to supports and nozzles of equipment to which piping is connected.

02.16.02 **Location of Pipe Supports**

Supports for pipes shall be provided based on pipe layout. Span between two consecutive supports for a pipe shall be limited to the values given in Table 05.01 and 05.02

In specific cases where span between two supports can not be provided as per the table, alternative arrangement for intermediate support using bridge between trestles or guy rope supports may be considered. In exceptional cases where distance exceeds the limiting span, suitable stiffening of pipe section to prevent sagging may be considered.

At sliding supports pipe saddle shall be allowed to rest on bearing plate for free movement. In case U-clamps are provided, clearance shall be maintained for pipe movement by providing two nuts on opposite sides.

All intermediate supports shall be of sliding type. Anchor supports shall be located based on piping configuration and layout to provide adequate flexibility.

Distance between two consecutive fixed supports in straight runs of pipe route should be approx 70 m. However, in special cases it may go up-to 100 m (max.). In no case it should exceed 100 m.

However, for steam pipeline it should be limited to 60 m. For pipe dia. above 100 mm cold pull if any during erection may be given as per instructions of the respective drawings.

To reduce friction force transmitted to supports, roller supports or anti friction pad supports can also be used.

05.03 **Flexibility Analysis**

Piping arrangement shall provide for flexibility of lines to take care of the thermal expansion, contraction and equipment settlement. Large reactions or moments at equipment connections shall be avoided . Expansion computation shall be made on the basis of a base temperature of 21.1deg C (70 deg F) and shall cover (+ve, or –ve) design temperature(s) as given.

i) Flexibility analysis shall meet the requirement of Code ASME B-31.3 (Latest Edition). Analysis shall consider stress intensification factors as per ASME B31.3.

ii) Lines which shall be subjected to steam out conditions , shall be designed and analyzed at low –pressure steam design temperature of line whichever is more. Lines having negative design temperature shall be analyzed for both conditions separately.

iii) Flexibility Analysis of lines shall be carried out using simplified methods or a comprenhensive computer program. Comprehensive computer analysis shall be carried out for the piping as per Cl. No. 05.03 (vii) For lines connected to equipment like vessels, pumps, filters, furnace, compressors or other strain sensitive equipment. The result of the analysis must satisfy the allowable loading on the nozzles of such equipment.

iv) Piping shall be adequately supported for the weight of piping, water, attached unsupported components, wind, seismic, insulation and any other applicable forces. Care should be taken that these supports are adequate to prevent excessive stress, load or moments in either the piping or terminal nozzles of the equipment to which it is connected. Adequacy of supporting of lines having heavy valves shall be checked. The support shall be indicated in the piping General Arrangement Drawings and Isometrics as applicable.

v) Safety valve manifolds and downstream of control valves shall be adequately supported to avoid vibrations.

vi) The following factors shall be considered in the stress analysis

- Friction for lines >= 8" NB ; @ steel to steel = 0.3: (Sliding friction), @ steel to Steel =0.1 (Rolling friction),
- Corrosion Allowance.
- Initial displacement of nozzles at design temperature(s).
- Transverse deflections =25 mm(maximum)
- Longitudinal expansion/contraction = 200 mm (maximum) Special care to be taken to check for expansion loops and shoe support lengths shall be finalized accordingly.

viii) The following shall always be analyzed using comprehensive computer analysis:

a) All lines 4" and above and Design Temp.> 300 deg. C.
b) All lines 8" and above and Design Temp. > 150 deg. C.
c) Al l lines 16" and above and Design Temp. > 80 deg. C.
d) All lines 6" and above and Design Temp. > deg. 65 C that are connected to rotating Equipment, Air Coolers or any other sensitive equipment.
e) Any other system/line that stress engineer feels necessary for stress check.

The report shall comprise of the following:

- Basic input data and calculated conditions.

- Layout isometric and supports configuration.
- Load cases and calculated member stresses.
- Forces, moments and displacements reports.
- Spring hangers design parameters.
- Allowable Stress Range.

Additional requirements (reinforcement pad etc.)

02.16.04 **Wind Load Calculation**

Wind load acts on transverse direction across pipe due to pressure of wind.

Wind pressure shall be taken as per IS : 875. In cyclone prone areas maximum wind pressure due to cyclonic wind pressure shall be taken.

Wind load for a section of pipe = Wind pressure X projected area x shape factor

For circular pipes shape factor is 0.7.

In case of multiple pipes, for each tier of pipes, largest pipe may be considered for calculating wind load.

02.17 **Piping Material Specification**

02.17.01 **Scope**

This PMS covers the various piping specification for process and utility piping in Metallurgical plants and its related industrial Installation.

Deviation from this specification may be necessary to conform to specific job requirements. In such cases a separate and specific PMS shall be issued with the approval of piping competent authority.

02.17.02 **Referred Codes & Standards**

All piping shall be designed in accordance with relevant latest codes and standards like B 31.1, B 31.3 and different IPSS (Inter plant standard for steel industry)

Individual piping material specification has been designed to cover a set of services operating within fixed pressure and temperature.

02.17.03 **Pipes**

Pipe dimension shall be in accordance with ANSI B36.10 : IS:1239, IS:3589 for carbon steel pipe and to B36.10/B36.19 for stainless steel pipe.

Pipe made by acid Bessemer process shall not be acceptable.Pipes shall be made by open hearth, electric furnace or basic oxygen process.

All pipe threads shall conform to ANSI B1.20.1 except where otherwise noted.

02.17.04 **Flanges**

Flanges shall be in accordance with following codes except where otherwise noted.

DN 15 to DN 600 (150 # - 600#)	ANSI/ANSI B16.5 / IS : 6392
Above DN	600API 605/ANSI B16.47/MSS-SP-44/ IS:6392 DIN etc.

Flanges to MSS-SP-44 or any other std. like DIN, BS etc. may be specified to be made with equipment or valve flanges with corresponding bolting.

Finish of steel flange faces shall conform to MSS-SP-6/ ASME B46.1/ASME B16.5. The interpretation shall be as follows :

Serrated	:	250 – 500 Mu in AARH
Smooth (125 AARH)	:	125 – 250 Mu in AARH
For RTJ groves (32 AARH)	:	32 – 250 Mu in AARH

Bore of WN flanges shall match the ID of the attached pipe Bore of slip on flanges shall suit the pipe OD and its thickness.

Dimensions of welded steel flanges for low pressure gas (Pressure upto 1 kg/cm^2) is indicated in Table 06.01

02.17.05 Fittings

Forged steel socket welded and threaded fittings shall be in accordance with ANSI B 16.11 unless otherwise noted.

Butt welded fittings shall be in accordance with ANSI B16.9 unless otherwise noted.

Fabricated (site/factory) fittings shall conform to IPSS-06-020-95 unless otherwise specified.

Fittings thickness and tolerance shall match pipe thickness and tolerance.

Mitres and reducers fabricated form pipe may be use if specified in PMS, shall conform to IPSS:1-06-020-95. In no case mitres thickness and material shall be inferior to parent pipe.

02.17.06 **Gaskets**

Non metallic gasket shall conform to IS:2712.

Spiral wound gaskets (SPR, WND) shall conform to API 601/B16.20.

Ring type and spiral wound gasket shall be self aligning type.

02.17.07 **Bolting**

Dimensional std of Bolt/studs and nuts shall conform to B 18.2 / IS:1364-1992. Unless otherwise noted.

02.17.08 **Threads**

Threads for threaded pipes, fitting flanges and valves shall be in accordance with B1.20.1 taper threads unless otherwise noted.

Upto 200^0C threaded joints shall be made with 1" width PTEE joining tape.

Above 200^0C threaded joints shall be seal welded with full strength fillet weld.

All threaded joints irrespective of pressure and temperature on lines carrying toxic fluid shall be seal welded with a full strength fillet weld.

02.18 **Valves**

02.18.01 Face to Face/End to End dimension of valves shall conform to B16.10 to the extent covered. For valves not covered in B16.10. reference shall be made to BS2080 and / or the manufacturer's drawings.

02.18.02 Flange / weld ends of the valve shall be as per the corresponding Flange/Fitting ends of the piping class, unless otherwise specified.

02.18.03 Pressure temperature rating for flanges and butt welding end valves shall be as per ANSI B16.34 except for ball, plug & butterfly valves. For these valves refer TABLE FOR PRESSURE TEMP. RATING FOR BALL, PLUG AND BUTTERFLY VALVES

02.18.04 Unless called-out specifically, valves shall be as per the following Standards.

Valve	Size DN mm	Rating	Des. Std.	Testing Std.
Gate	15 - 40	800/1500	API-602	API-598
Globe/Check	15 - 40	800/1500	BS – 5352	BS-6755 Pt-I
Gate	50 - 600	150/300/600	API-600	API-598
Gate	650 - 1050	150/300	BS-1414	BS-6755 Pt-I
Globe	50 – 200	150/300/600	BS-1873	BS-6755 Pt-I
Check	50 – 600	150/300/600	BS-1868	BS-6755 Pt-I
Gate/Globe/Check		900/1500/2500#	B-16.34	API-598/ BS6755 Pt-I
Ball	15 – 400		BS-5351	BS-6755
Plug	15 – 300		API-599	API-598 /BS-5353 BS-6755
Butterfly	80 & above	-	API-609/ BS5155 AWWA C504	API-1898/ BS-6755 Pt-I /AWWA
Diaphram	ALL	-	BS-5156	BS-6755 Pt-I

02.18.05 If not covered in 06.09.04 the valve shall be as per B16.34 and relevant MSS SP Standard

02.18.06 DN 50mm and larger steel Gate, Globe & Check valves in Hydrocarbon and utility service shall have bolted bonnets. Pressure seal bonnets or covers shall be used for Classes 900# and above to minimize bonnet leakage. However, valves with pressure seal bonnet shall have wall thickness & seal stem diameter as per API600. Welded bonnets or screwed & seal welded bonnets are acceptable for sizes lower than DN 50 for Classes 900# & above.

02.19. **PIPING MATERIAL SPECIFICATION**

02.19.01 **Service : BF Gas, CO Gas, BOF, Corex Gas & Mixed Gas**

Service Conditions : Maximum Working Pressure 1500mmWC Temp 60 ^{o}C
Minimum Working Pressure 50 mmWC Temp 5 ^{o}C
Corrosion Allowance: 2 mm.

Item	Size Range	Description	Dimension Standard	Material Specification
Pipe	DN 15 to 40	ERW, PE; Sch Heavy	IS : 1239	IS:1239 - Black
	DN 50 to 150	ERW, BE; Sch Heavy	IS : 1239	IS:1239 - Black
	DN 200 to 350	ERW, BE; 6 mm Thk	IS : 3589	IS: 3589 Gr.330
	DN 400 to 750	ERW/SWP,BE; 8 mm Thk	IS : 3589	IS: 3589 Gr.330
	DN 800 to 3500	Fabricated – Electric Fusion Welded, BE;10mm Thk.	IS : 3589	IS : 2062, Gr.B
Fittings	DN 15 to 40	SW /Screwed Fittings (Elbow R=1.5D)	IS : 1239 (P-2)	IS : 1239 (P-2) Black
	DN 50 to 150	BW (Elbow R=1.5D)	IS : 1239 (P-2)	IS : 1239 (P-2) Black
	DN 200 & above	Fabricated Miters bends & fittings from pipe / plate	IPSS-06-20	IS : 2062, Gr.B
Flanges #150	Upto DN 150	SORF; Serrated Finish	IS : 6392 Table - 5	IS: 2062, Gr.B
	DN 200 to 300	SORF; Serrated Finish	IPSS:1-06-20 Table 3	IS: 2062, Gr.B
	DN 400 & above	SORF; Serrated Finish	IPSS:1-06-20 Table 3	IS: 2062, Gr.B
Gaskets	Upto DN 500	Gasket: Thk. 2 mm Ring Type CAF	As per Flange	IS : 2712 Gr W/3
	Above DN 500	Asbestos rope graphite impingnated. Ø8mm		
Valves	DN 15 to 40	Gate valve; Screwed	API 602	Body ASTM A105; Cr 13% Trim

Item	Size Range	Description	Dimension Standard	Material Specification
	DN 50 to 550	Gate valve; Flanged	IS : 14846	Body CI GR. FG 200
	DN 600 to 1600	Gate valve; Flanged	IPSS: 1-06-023	Body CI, Gr.FG-210
	DN 1800 & above	Gate valve; Flanged	MSS	Body IS: 2062 GR. B
	DN 15 to 40	Check valve SW – Lift Type #800	BS 5352	Body A105, 13% CR Trim
	DN 50 and above	Check Valve Flanged swing check valve/ dual plate #150	BS 1868 / API 594	Body A216;WCB, 13% CR Trim
	DN 15 to 40	Globe valve SW / Screwed ; #800	BS 5352	Body A105, 13% CR Trim
	DN 50 to 300	Globe valve; Flanged ; Serrated Finish; #150	BS 1873	Body A216 Gr WCB, 13% CR Trim
	DN 350 & above	Butterfly valve WAF Type; #150	BS 5155/ API 594	Body A216 Gr WCB;13% Cr Trim
	DN 15 / DN 25 LUB.TAPERED PLUG VALVE	Screwed	BS: 5158	Body & PLUG : CI IS 210 FG 200
Bolting	All	M/C Bolts	IS: 1364-1992	ASTM A193 Gr B7
		Nuts	IS: 1364- 992	ASTM A194 Gr 2H
Piping Fabrication	Flanged Joints	At valve/ equipment location and for sectionalising & Maintenance. To be kept minimum		
	Pipes Joints	DN 50 & below SW coupling		
		DN 50 & above Butt welded		
	Fabricated pipes	Fillet welding using semi bandage on each segment.		
	Temp Connections	DN 40 – Flanged set-on nozzle		
	Pressure Tapping	DN 20 – SW Half Coupling Nipple Sch 80 with Gate valve to Spec.		
	Vents	On lines >= DN 50 ; MEC std.		
	Drains	On lines >= DN 80, MEC Std.		

02.19.02 **PIPING MATERIAL SPECIFICATION**

Service: LPG

Service Conditions : Maximum Operating Pressure 6 kgf /cm2 Temp 60 ^{o}C
Minimum Operating Pressure Atm Temp 5 ^{o}C
CORROSION ALLOWANCE : 1.5 mm.

Item	Size Range	Description	Dimensional/ Design Standard	Material - Carbon Steel
Pipe	DN 15 to 40	Seamless PE Sch. 80	B 36.10	API 5L GR.B
	DN 50 to 150	Seamless BE Sch.40	B36.10	API 5L GR.B
	DN 200 to 300	Seamless BE Sch.20	B36.10	API 5L GR.B
	DN 350	Seamless BE Sch.10	B36.10	API 5L GR.B
	DN 16 & above	EFSW BE Thk. 6.0mm	B36.10	API 5L GR.B
Fittings	DN 15 to 40	SW / Screwed Fittings # 3000 (Elbow R=1.5D)	ANSI B 16.11	ASTM A 105
	DN 50 to 150	BW Fittings #150 (Elbow R=1.5D)	ANSI B16.9	ASTM A234 Gr WPB
	DN 200 & above	Miter bends & fittings fabricated from pipe	IPSS-1-06-020	Same as parent pipe
Flanges	DN 15 to 40	SW:RF : Serrated Finish; #150	B 16.5	ASTM A 105
	DN 50 & above	SORF : Serrated Finish; #150	B 16.5	ASTM A 105
Gaskets	All sizes	Gasket : Thk. 2.0 mm Ring type CAF	B 16.21	IS : 2712 Gr W/3
Valves	DN 15 to 40	Gate valve SW # 800	API 602	Body A105 ; 13% CR Trim
	DN 50 to 600	Gate valve Flanged RF Serrated Finish # 150	API 600	Body A216 Gr. WCB 13% Cr Trim
	DN 15 to 40	Globe valve, SW # 800	BS 5352	Body A105; 13% Cr Trim
	DN 50 to 200	Globe valve : Flanged RF Serrated # 150 finish	BS 1873	Body A216 Gr.WCB 13% Cr Trim

Item	Size Range	Description	Dimensional/ Design Standard	Material - Carbon Steel
	DN 15 to 40	Check valve SW # 800 Lift type	BS 5352	Body A105; 13% Cr Trim
	DN 50 to 600	Check valve flanged RF Serrated finish # 150	BS 1868	Body A216 Gr.WCB 13% Cr Trim
	DN 15 to 150	Ball valve flanged RF Serrated finish #150	BS 5351	Body A216 Gr.WCB 13% Cr. Trim
Bolting	All	Studs / Bolts	B 18.2	ASTM A193 Gr B7
		Nuts	B 18.2	ASTM A194 Gr 2H
Miscellaneous	DN 15 to 40	TRAP #150, THRMDNMC	MANF' STD.	BODY A105, TRIM 13% CR , S: SS304
	DN 15 to 40	PERM. STR, SW, Y Type	MANF' STD.	BODY A05: INT SS 304
	DN 50 to 350	PERM. STR, BW, T Type	MANF' STD.	BODY A234WPB : INT SS 304
	DN 400 to 600	PERM. STR, BW, T Type	MANF' STD.	BODY A234WPBW: INT SS 304
	Above DN 600	TEMP. STR, FF, CONE Type	MEC' STD.	BODY A516GR. 70: INT SS 304
Piping Fabrication	Flanged Joints	At valve/ equipment location and for sectionalizing & maintenance To be kept minimum		
	Pipes Joints	DN 40 & below SW coupling		
		DN 50 & above Butt welded		
	Pressure Tapping	DN 20 – SW half coupling Nipple Sch 80 with Gate valve to spec. Gate		
	Temp Connections	DN 40 – Flanged set-on nozzle		
	Vents	On lines <= DN 40 ; MEC std.		
	Drains	On lines <= DN 40 ; MEC std.		

02.19.03 **Service: Medium Pressure Nitrogen , Argon, & Compressed Air.**

Service Conditions: Maximum Operating Pressure 10.5 kgf /cm2 Temp 60 ^{o}C
Minimum Operating Pressure Atm Temp 5 ^{o}C

Corrosion Allowance: 1.5 m.m.

Item	Size Range	Description	Dimensional/ Design Standard	Material - Carbon Steel
Pipe	DN 15 to 40	ERW, PE Sch. HEAVY	IS:1239	IS:1239 BLACK
	DN 50 to 150	ERW, BE Sch. HEAVY	IS:1239	IS:1239 BLACK
	DN 200 to 350	ERW, BE , THK 6.0mm	IS:3589	IS:3589 GR.330
	DN 400 to 500	ERW, BE , THK 8.0mm	IS:3589	IS:3589 GR.330
	DN 550 to 600	ERW BE Thk. 10.0mm	IS:3589	IS:3589 GR.330
	DN 650 & above	ERW/ SAW, BE Thk. 10.0mm (min)	IS:3589	IS:3589 GR.330
Fittings	DN 15 to 40	SW / Screwed Fittings # 3000 (Elbow R=1.5D)	ANSI B 16.11	ASTM A 105
	DN 50 to 150	BW Fittings #150 (Elbow R=1.5D))	ANSI B16.9	ASTM A234 Gr WPB
	DN 200 & above	Miter bends & fittings fabricated from pipe	IPSS-1-06-020	Same as parent pipe
Flanges	DN 15 to 40	SW:RF : Serrated Finish #150	B 16.5	ASTM A 105
	DN 50 to 600	SORF : Serrated Finish #150	B 16.5	ASTM A 105
	DN 650 & Above	SORF : Serrated Finish #150	B 16.47 / IS:6392 / API 605	ASTM A 105
Gaskets	All sizes	Gasket : Thk. 2.0 mm Ring type CAF	B 16.21	IS : 2712 Gr W/3
Valves	DN 15 to 40	Gate valve SW # 800	API 602	Body A105 ; 13% CR Trim

Item	Size Range	Description	Dimensional/ Design Standard	Material - Carbon Steel
	DN 50 to 600	Gate valve Flanged RF Serrated Finish # 150	API 600	Body A216 Gr. WCB 13% Cr Trim
	DN 15 to 40	Globe valve, SW # 800	BS 5352	Body A105; 13% Cr Trim
	DN 50 to 200	Globe valve : Flanged RF Serrated # 150 finish	BS 1873	Body A216 Gr.WCB 13% Cr Trim
	DN 15 to 40	Check valve SW # 800 Lift type	BS 5352	Body A105; 13% Cr Trim
	DN 50 to 600	Check valve flanged RF Serrated finish # 150	BS 1868	Body A216 Gr.WCB 13% Cr Trim
Bolting	All	Studs / Bolts	B 18.2	ASTM A307 Gr B
		Nuts	B 18.2	ASTM A563Gr B
Miscellaneous	DN 15 to 40	TRAP #150, THRMDNMC	MANF' STD.	BODY A105, TRIM 13% CR , S: SS304
	DN 15 to 40	PERM. STR, SW, Y Type	MANF' STD.	BODY A05: INT SS 304
	DN 50 to 350	PERM. STR, BW, T Type	MANF' STD.	BODY A234WPB : INT SS 304
	DN 400 to 600	PERM. STR, BW, T Type	MANF' STD.	BODY A234WPBW: INT SS 304
	Above DN 600	TEMP. STR, FF, CONE Type	MEC' STD.	BODY A516GR. 70: INT SS 304
Piping Fabrication	Flanged Joints	At valve/ equipment location and for sectionalizing & maintenance To be kept minimum		
	Pipes Joints	DN 40 & below SW coupling		
		DN 50 & above Butt welded		
	Pressure Tapping	DN 20 – SW half coupling Sch 80 Nipple with Gate valve to spec.		
	Temp Connections	DN 40 – Flanged set-on nozzle		
	Vents	On lines <= DN 40 ; MEC std.		
	Drains	On lines <= DN 40 ; MEC std.		

02.19.04 **Service: High Pressure Nitrogen, Argon & Compressed Air**

Service Conditions: Maximum Operating Pressure 40 kgf /cm2 Temp 60 ^{o}C
Minimum Operating Pressure 10.5 kgf /cm2 Temp 5 ^{o}C

Corrosion Allowance: 1.5 mm.

Item	Size Range	Description	Dimensional/ Design Standard	Material - Carbon Steel
Pipe	DN 15 to 40	Seamless PE Sch. 80	B 36.10	ASTM A106 Gr.B
	DN 50 to 150	Seamless BE Sch.40	B36.10	ASTM A106 Gr.B
	DN 200 to 250	Seamless BE Sch.30	B36.10	ASTM A106 Gr.B
	DN 300 to 350	Seamless BE Sch. Std.	B36.10	ASTM A106 Gr.B
	DN 400 to 600	EFSW BE Thk. Calculate	B36.10	ASTM A672 B60 CL 12
Fittings	DN 15 to 40	SW Fittings # 3000 (Elbow R = 1.5D)	ANSI B 16.11	ASTM A 105
	DN 50 to 350	BW Fittings (Elbow R = 1.5D)	ANSI B16.9	ASTM A234 Gr WPB
	DN 400 to 600	BW Fittings (Elbow R = 1.5D)	ANSI B16.9	ASTM A234 Gr WPBW
Flanges	DN 15 to 40	SW:RF : Serrated Finish #300	B 16.5	ASTM A 105
	DN 15 to 600	WNRF : Serrated Finish #300	B 16.5	ASTM A 105
Gaskets	All sizes	SPIRAL; THK. 4.4 mm	API 601	SS 304 SPR. WND + CA FIL
Valves	DN 15 to 40	Gate valve SW # 800	API 602	Body A105 ; 13% CR Trim
	DN 50 to 600	Gate valve Flanged RF Serrated Finish # 300	API 600	Body A216 Gr. WCB 13% Cr Trim

Item	Size Range	Description	Dimensional/ Design Standard	Material - Carbon Steel
	DN 15 to 40	Globe valve, SW # 800	BS 5352	Body A105; 13% Cr Trim
	DN 50 to 200	Globe valve : Flanged RF Serrated # 300 finish	BS 1873	Body A216 Gr.WCB 13% Cr Trim
	DN 15 to 40	Check valve SW # 800 lift type	BS 5352	Body A105; 13% Cr Trim
	DN 50 to 600	Check valve flanged RF Serrated finish # 300	BS 1868	Body A216 Gr.WCB 13% Cr Trim
	DN 15 to 150	Ball valve flanges RF Serrated finish # 300	BS 5351	Body A216 Gr.WCB 13% Cr. Trim
	DN 15 to 300	Plug valve flanges RF Serrated finish # 300	BS 5353	Body A216 Gr.WCB HARDEN PLUG
Bolting	All	Studs /Bolts Nuts	B 18.2 B 18.2	ASTM A193 Gr B7 ASTM A194 Gr 2H
Miscellaneous	DN 15 to 40	TRAP #150, THRMDNMC	MANF' STD.	BODY A105, TRIM 13% CR , S: SS304
	DN 15 to 40	PERM. STR, SW, Y Type	MANF' STD.	BODY A05: INT SS 304
	DN 50 to 350	PERM. STR, BW, T Type	MANF' STD.	BODY A234WPB : INT SS 304
	DN 400 to 600	PERM. STR, BW, T Type	MANF' STD.	BODY A234WPBW: INT SS 304
	DN to 600	TEMP. STR, FF, CONE Type	MEC' STD.	BODY A516GR. 70: INT SS 304
Piping Fabrication	Flanged Joints	At valve/ equipment location and for sectionalizing & maintenance To be kept minimum		
	Pipes Joints	DN 40 & below SW coupling		
		DN 50 & above Butt welded		
	Pressure Tapping	DN 20 – SW half coupling Nipple Sch 80 with Gate valve to spec.		
	Temp Connections	DN 40 – Flanged set-on nozzle		
	Vents	On lines <= DN 40 ; MEC std.		
	Drains	On lines <= DN 40 ; MEC std.		

02.19.05 **Service: Instrument Air (UP TO 1.5")**

Service Conditions: Maximum Operating Pressure Up to 10.55 kgf /cm2 Temp 65 ^{o}C

RATING: # 150

Matching Companion Flanges of Valves & flow components as per corresponding rating.

Corrosion Allowance: NIL

Item	Size Range	Description	Dimensional/ Design Standard	Material - Carbon Steel
Pipe	DN 15 to 40	ERW ; Screwed end HEAVY	IS:1239	IS:1239 (PART-I) GALV.
Fittings	DN 15 to 40	Screwed Fittings # 3000	ANSI B 16.11	ASTM A 105 (GALV.)
Flanges	DN 15 to 40	Screwed :RF : Serrated Finish #150	B 16.5	ASTM A 105 (GALV.)
	DN 15 to 40	Blind Flanged RF : Serrated Finish #150	API 590	ASTM A 105 (GALV.)
	DN 15 to 40	FIG. 8 Flange ; FF Serrated Finish #150	B 16.5	ASTM A 105 (GALV.)
Gaskets	All sizes	Gasket : Thk. 2.0 mm Ring type	B 16.21	IS : 2712 Gr W/3
Valves	DN 15 to 40	Gate valve SCRF; # 800	API 602	Body A105 ; 13% CR Trim
	DN 15 to 40	Globe valve, SCRF; # 800	BS 5352	Body A105; 13% Cr Trim
	DN 15 to 40	Check valve SCRF; # 800 Lift type	BS 5352	Body A105; 13% Cr Trim
Bolting	All	M/C BOLT	B 18.2	ASTM A307 Gr B
		Nuts	B 18.2	ASTM A563 Gr B
	Flanged Joints			

Item	Size Range	Description	Dimensional/ Design Standard	Material - Carbon Steel
Piping Fabrication	Flanged Joints			
	Pipes Joints	Screwed Coupling		
	Temp. Conn.	Flanged Installation as MEC std.		
	Pressure Tapping	DN 20 – SW half coupling Nipple HEAVY with Gate valve to spec.		
	Vents	MEC std.		
	Drains	MEC std.		

02.19.06 **Service: Low Pressure Steam, Condensate & Boiler Feed Water**

Service Conditions: Maximum Operating Pressure 18 kgf /cm2 Temp 360^{o}C

Corrosion Allowance: 1.5 m.m.

Item	Size Range	Description	Dimensional/ Design Standard	Material - Carbon Steel
Pipe	DN 15 to 40	Seamless PE Sch. 80	B 36.10	ASTM 106 GR.B
	DN 50 to 150	Seamless BE Sch.40	B36.10	ASTM106 GR.B
	DN 200 to 300	Seamless BE Sch.40	B36.10	ASTM106 GR.B
	DN 350 to 400	Seamless BE Sch.40	B36.10	ASTM106 GR.B
Fittings	DN 15 to 40	SW Fittings # 3000; (Elbow R=1.5D)	ANSI B 16.11	ASTM A 105
	DN 50 to 600	BW Fittings (Elbow R=1.5D)	ANSI B16.9	ASTM A234 Gr WPB
	DN 200 to 600	BW Fittings (Elbow R=1.5D)	ANSI B16.9	ASTM A234 Gr WPBW
Flanges	DN 15 to 40	SW:RF : Serrated Finish	B 16.5	ASTM A 105
	DN 50 to 600	WNRF : Serrated Finish	B 16.5	ASTM A 105
Gaskets	All sizes	Gasket : Thk. 2.0 mm Ring type CAF	B 16.21	IS : 2712 Gr W/1
Valves	DN 15 to 40	Gate valve SW # 800	API 602	Body A105 ; 13% CR Trim
	DN 50 to 400	Gate valve Flanged RF Serrated Finish # 300	API 600	Body A216 Gr. WCB 13% Cr Trim
	DN 15 to 40	Globe valve, SW # 800	BS 5352	Body A105; 13% Cr Trim
	DN 50 to 200	Globe valve : Flanged RF Serrated # 300 finish	BS 1873	Body A216 Gr.WCB 13% Cr Trim
	DN 15 to 40	Check valve SW # 800 Lift type	BS 5352	Body A105; 13% Cr Trim
	DN 50 to 600	Check valve flanged RF Serrated finish # 150	BS 1868	Body A216 Gr.WCB 13% Cr Trim

Item	Size Range	Description	Dimensional/ Design Standard	Material - Carbon Steel
	DN 15 to 150	Ball valve flanges RF Serrated finish # 300	BS 5351	Body A216 Gr.WCB 13% Cr. Trim
Bolting	All	Studs /Bolts	B 18.2	ASTM A193 Gr B7
		Nuts	B 18.2	ASTM A194 Gr 2H
Miscellaneous	DN 15 to 40	TRAP #300, THRMDNMC	MANF' STD.	BODY A105, TRIM 13% CR , S: SS304
	DN 15 to 40	PERM. STR, SW, Y Type	MANF' STD.	BODY A05: INT SS 304
	DN 50 to 400	PERM. STR, BW, T Type	MANF' STD.	BODY A234WPB : INT SS 304
Piping Fabrication	Flanged Joints	At valve/ equipment location and for sectionalizing & maintenance to be kept minimum		
	Pipes Joints	DN 40 & below SW coupling		
		DN 50 & above Butt welded		
	Pressure Tapping	DN 20 – SW half coupling Nipple Sch 80 with Gate valve to spec.		
	Temp Connections	DN 40 – Flanged set-on nozzle		
	Vents	On lines <= DN 40 ; MEC std.		
	Vents	On lines >= DN 50 ; MEC std.		
	Drains	On lines <= DN 40 ; MEC std.		

Note:

1. Class of various items shall be selected based on the pressure of steam in the line (For low pressure inferior class may be considered)

2. For higher pressure i.e, more than 18 bar the technologist (PP & EE) to be contacted for specification.

02.19.07 **Service: Medium Pressure Oxygen**

Service Conditions: Maximum Operating Pressure 15 kgf /cm2 Temp 60 ^{o}C

Corrosion Allowance: 2 m.m.

Cleaning, Pickling, Passivation & Degreasing As Per IGC: 33/86/E

Item	Size Range	Description	Dimensional/ Design Standard	Material - Carbon Steel
Pipe	DN 15 to 40	Seamless PE Sch. 80	B 36.10	ASTM A106 GR.B
	DN 50 to 150	Seamless BE Sch.40	B36.10	ASTM A06 GR.B
	DN 200 to 300	Seamless BE Sch.40	B36.10	ASTM A06 GR.B
	DN 350 to 600	Seamless BE Sch.40	B36.10	ASTM A06 GR.B
Fire Breaker	DN 50 to 150	Copper Pipe	B36.10	Deoxidised non Arsenic Copper
	DN 200 to 600	Copper Pipe	B36.10	Deoxidised non Arsenic Copper
Fittings	DN 15 to 40	SW Fittings # 3000; (Elbow R=4D)	ANSI B 16.11	ASTM A 105
	DN 50 to 600	BW Fittings (Elbow R=4D)	ANSI B16.9	ASTM A234 Gr WPB
Flanges	DN 15 to 40	SW:RF : Serrated Finish	B 16.5	ASTM A 105
	DN 50 to 600	WNRF : Serrated Finish	B 16.5	ASTM A 105
Gaskets	All sizes	PTFE LOX GRADE	B16.21	ASTM D3293; TYPE 3; Gr. 1+A
Valves	DN 15 to 40	Gate valve; SW; # 800	API 602	Body A182 GR. 304; /BRONZE ;13% CR Trim / BRONZE
	DN 50 to 600	Gate valve; Flanged; RF; Serrated Finish # 150	API 600	Body A351 GR.CF8 13% Cr Trim
	DN 15 to 40	Globe valve, SW; # 800	BS 5352	Body A182 GR. 304;/ BRONZE; 13% CR Trim/ BRASS

Item	Size Range	Description	Dimensional/ Design Standard	Material - Carbon Steel
	DN 50 to 200	Globe valve : Flanged RF Serrated # 150 finish	BS 1873	Body Al BRONZE CASTING; TRIM BRASS; PTFE Seat
	DN 15 to 40	Check valve SW # 800 lift type	BS 5352	Body A105; 13% Cr Trim
	DN 50 to 600	Check valve flanged RF Serrated finish # 150	BS 1868	Body & Trim A182 GR. 304
	DN 15 & Above	Ball valve flanged RF Serrated finish	BS 5351	Body A351 GR.CF8 ; A182 GR. 304 Trim;PTFE Seat
Bolting	All	Studs/Bolts	B 18.2	ASTM A193 Gr B7
		Nuts	B 18.2	ASTM A194 Gr 2H
Piping Fabrication	Flanged Joints	At valve/ equipment location and for sectionalizing & maintenance To be kept minimum		
	Pipes Joints	DN 40 & below SW coupling		
		DN 50 & above Butt welded		
	Pressure Tapping	DN 20 – SW half coupling Nipple Sch 80 with . Gate valve to spec.		
	Temp Connections	DN 40 – Flanged set-on nozzle		
	Vents	On lines <= DN 40 ; MEC std.		
	Vents	On lines >= DN 50 ; MEC std.		
	Drains	On lines <= DN 40 ; MEC std.		

02.19.07 **Service: High Pressure Oxygen**

Service Conditions: Maximum Operating Pressure 40 kgf /cm2 Temp 60 ^{o}C
Minimum Operating Pressure 16 kgf /cm2 Temp 5 ^{o}C

RATING: # 300
Matching Companion Flanges of Valves & flow components as per corresponding rating.

Corrosion Allowance: 2 mm.
Cleaning, Pickling, Passivation & Degreasing As Per IGC : 33/86/E

Item	Size Range	Description	Dimensional/ Design Standard	Material - Carbon Steel
Pipe	DN 15 to 40	Seamless PE Sch. 80	B 36.10	ASTM A106 GR.B
	DN 50 to 150	Seamless BE Sch.40	B36.10	ASTM A06 GR.B
	DN 200 to 300	Seamless BE Sch.20	B36.10	ASTM A06 GR.B
	DN 350 to 600	Seamless BE Sch.10	B36.10	ASTM A06 GR.B
Fire Breaker	DN 50 to 150	Copper Pipe	B36.10	Deoxidised non Arsenic Copper
	DN 200 to 600	Copper Pipe	B36.10	Deoxidised non Arsenic Copper
Fittings	DN 15 to 40	SW Fittings # 3000; (Elbow R=4 D)	ANSI B 16.11	ASTM A 105
	DN 50 to 600	BW Fittings (Elbow R=4 D)	ANSI B16.9	ASTM A234 Gr WPB
Flanges	DN 15 to 40	SW:RF : Serrated Finish; #300	B 16.5	ASTM A 105
	DN 50 to 600	WNRF : Serrated Finish # 300	B 16.5	ASTM A 105
Gaskets	All sizes	CAF/ PTFE LOX GRADE	B16.21	ASTM D3293; TYPE 3; Gr. 1+A
Valves	DN 15 to 40	Gate valve; SW; # 800	API 602	Body A182 GR. 304; /BRONZE ;13% CR Trim / BRONZE
	DN 50 to 600	Gate valve; Flanged; RF;Serrated Finish # 300	API 600	Body A351 GR.CF8 13% Cr Trim

Item	Size Range	Description	Dimensional/ Design Standard	Material - Carbon Steel
	DN 15 to 40	Globe valve, SW # 800	BS 5352	Body A182 GR. 304;/ BRONZE; 13% CR Trim/ BRASS
	DN 50 to 200	Globe valve : Flanged RF Serrated finish; # 300	BS 1873	Body Al BRONZE CASTING; TRIM BRASS; PTFE Seat
	DN 15 to 40	Check valve SW # 800 Lift type	BS 5352	Body A182 GR. 304; /BRONZE ;13% CR Trim / BRONZE
	DN 50 to 600	Check valve flanged RF Serrated finish # 300	BS 1868	Body A351 GR.CF8 13% Cr Trim
	DN 15 & Above	Ball valve flanges RF Serrated finish #300	BS 5351	Body A351 GR.CF8 ; A182 GR. 304 Trim;PTFE Seat
Bolting	All	Studs	B 18.2	ASTM A193 Gr B7
		Nuts	B 18.2	ASTM A194 Gr 2H
Piping Fabrication	Flanged Joints	At valve/ equipment location and for sectionalizing & maintenance To be kept minimum		
	Pipes Joints	DN 50 & below SW coupling		
		DN 50 & above Butt welded		
	Pressure Tapping	DN 20 – SW half coupling Nipple Sch 80 with Gate valve to spec.		
	Temp Connections	DN 40 – Flanged set-on nozzle		
	Vents	On lines <= DN 40 ; MEC std.		
	Vents	On lines >= DN 50 ; MEC std.		
	Drains	On lines <= DN 40 ; MEC std.		
	Drains	On lines <= DN 45 ; MEC std.		

02.20 Erection

02.20.01 Fuel gas and oil pipelines

01 General

- All elements of the pipelines system shall be erected at site strictly as per the drawings approved by the Purchaser/ Consultant.
- Any modification to be carried out at site, shall have the prior approval of Purchaser/ Consultants representatives.
- While erecting, pipelines shall rest uniformly on each support. Yokes, if provided, shall not allow lateral movement of pipes.
- Matching faces of flanges shall be perpendicular to the axis of pipelines. Use of gaskets of unusual thickness to fill gap between flanges shall not be allowed.
- For horizontal pipes, the flanges shall bee erected such that top two bolt holes are displaced by half pitch from the vertical axis of the flange.
- Flangers of adjoining pipes shall be located in staggered manner.
- Flanged joints shall be laid as close to the support as possible.
- In case the location of spindle wheel of valves is not clearly shown in the erection drawings, the same shall be located in a manner as to facilitate easy operation from ground level of nearest operating platform.
- For making pipe bends/ elbows at site using hot/ clod bending process, the decrease in the pipe thickness shall not be more than 15% of the pipe thickness.
- After erection of pipelines, the holes made in the walls shall be covered with bricks & mortar. A gap of 10 to 20 mm shall be kept between wall and the pipe for the movement due to thermal expansion. The gap shall be filled with felt/ asbestos.
- Holes made in the roof shall be covered with removable CGI sheets.
- The trenches for pipes shall be covered with removable chequered plate covers/ concrete slabs as per the drawings.
- All pipeline branches not connected to equipment shall be closed using blank flanges and gaskets.

02 Welding of pipelines

- All pipelines shall be joined by welding. Flanged joints shall be used for connecting the pipe with equipment, valve or fitting.
- Electric arc welding shall be used for joining pipes, support, structures, etc.
- All manufactured pipes shall be joins by butt welding. Large dia pipes, fabricated from sheets, shall be joined by fillet welding using semi- bandages attached each section being joined.
- Welding shall be done by qualified welders. Code of practice as per relevant Indian Standards shall be followed for the welding procedure, use of electrodes, etc.
- Proper edge preparation and preheating of edges to be welded, whenever required, shall be ensured before welding.
- After every 50 butt welded joints of gas pipeline, one test sample shall be welded by the same welder. Tensile teat and bend test shall be performed as per IS :814 to check the strength of welding. Four test samples shall be made from the test piece, two each for tensile and bend test.
- Tensile strength shall not be less than 34 kg / mm2 and elongation less than 12 %.
- Angle of bend at the appearance of first crack shall not be less than 70 deg.
- Visual inspection shall be done for all welded joints to checks for following possible defects.
    - Surface cracks on weld metal or parents metal.
    - Fusion or cuts at the joining of weld metal and parent metal.
    - Sponginess or porosity on the surface of weld.
    - Non-uniform thickness or distortion in case of fillet welds.
    - Deviation in the pipe axes or dimension of the joint.
    - All defective spots found shall be chipped off and re-welded.
    - For high pressure pipes, radiographic examination of welds shall be carried out as per IS : 2825.

03 Link lengths and tolerances

- Straight sections of gas pipelines shall be manufactured as separate links and joined at site by butt welding.
- Link lengths for pipes shall be as follows :
    a) Up to 13 m : for pipes with dia 1400 mm or less.

b) Up to 26 m : for pipes above 1400 mm dia.

- Following tolerances are allowed :

i) For length of links :

a) +/- 3 mm for length up 1 m

b) +/- 0.5 % for length more than 1 m, total deviation shall not exceed 10 mm for every 10 m or part thereof .

ii) Deviation in the pipe axis from the straight line :

Upto 0.12% of the link length but not more than 15mm for links with length more than 10 m. Deviation shall be checked by stretched cord.

iii) For distance between the contracting surfaces from the geometrical axis for bends, tees, crosses and other pipe fittings.

+/- 3 mm for distance upto 500 mm .

+/- 0.5% or 10 mm maximum for distance more than 1 m.

However, for BF gas and CO gas pipelines, the tolerance shall be limited to +/- 1.5 mm only.

iv) Deviation of pipe axes at the joining point from the diametral plane of pipes :

2 mm, irrespective of link length.

v) For distance between two adjacent connections on a pipe :

+/- 2 mm for each length but not more than +/- 5 mm overall.

vi) Distortion of the contacting surface of flange relative to the geometrical plane perpendicular to the pipe axis :

0.004 times the outer diameter of the flange at the periphery.

vii) Tolerance for clearance between flanges and flange rings :

Not more than 2 mm.

04 Erection of valves and fittings

- Before erection, the valves, cocks and other fittings, to be mounted on pipelines, shall be dismantled, cleaned, oiled and reassembled. Glands shall be packed with suitable materials as per approved drawings.
- All moving parts of the pipe fittings should move freely without jamming.
- Valves shall be tested hydraulically for leakage by applying pressure on up stream side with valve in closed position.
- Bolts & nuts shall be cleaned and lightly oiled.

- Proper grades of gaskets shall be used for erection as per approved drawings.

05 Testings of pipelines

- Preliminary acceptance test for erected pipelines shall be carried out as follows :

  a) Checking of metal marked as per manufacturer's certificate/ approved drawings.

  b) Checking of test result of mechanical tests for welding/ radiographic tests.

  c) Visual examination of welds.

  d) Dimensional checks as per the approved erection drawings.

  e) Checking of welded joints by chalk kerosene test.

- In case defects are found by visual examination, these shall be rectified prior to leakage test.

- Checking of proper installation of supports, expansion joints, valves and fittings.

- The pipeline shall be cleaned from inside, all debris removed and pipeline blown with air to remove all dirt, rust particles, etc.

1) Strength and leakage test for low pressure gas pipelines :

  a) Pipe sections shall be disconnected from equipment, etc. Using blank flanges.

  b) Test pressure equivalent to 1. 25 times the maximum operating pressure but not less than 0.2 kg/ cm2 shall be applied using air.

  c) Test pressure shall be maintained for 1 hour and then reduced to the working pressure.

  d) Soap solution shall be applied to the weld surfaces/ flanges to chaeck any leakage.

  e) Any defects found shall be rectified after releasing the pressure.

  f) Tightness test shall be carried out by maintaining the test pressure indicated in (b) above for a minimum period of 2 hours.

  g) Pressure and temperature readings shall be taken at the beginning and end of the test. The percentage pressure drop (P) shall be calculated as follows :

  $$P = 100 (1 – P2/ P1= * T1/ T2)$$

  Where P1 and P2 are pressure in the pipe at the beginning and end of test and T1 and T2 are absolute temperatures at the beginning and end of the tests.

h) For out door pipelines, the allowable pressure drops for different diameter shall be as follows :

Upto 300 mm	:	2.0%
300 to 1000 mm	:	1.5%
Above 1000 mm	:	1.0%

i) For indoor pipelines, the allowable pressure drop shall not exceed 1 %

2) High pressure pipelines (above 1 kg/ cm2 g) shall be tested as follows :

a) Pipe sections shall be disconnected from the equipment using blank flanges.

b) Vents shall be provided at high points for air release during pipe filling. The vents shall be plugged with threaded nipples after the tests.

c) Tests shall be carried out before painting of the pipelines and before application of insulation.

d) Pipe upto 300 mm diameter shall be tested hydraulically for strength by applying test pressure equivalent to 1.25 times the operating pressure. Test pressure shall be maintained for 30 minutes and then gradually reduced to the operating pressure. For steam pipelines test pressure shall be 1.5 times the working pressure and duration 2 hrs.

e) Leakage from welded joints shall be checked by tapping with light hammer. No sweating should occur on the weld surface. Test shall be considered satisfactory if no visible leakage is found and pressure in pipeline remains steady.

f) In case hydraulic testing is not feasible, test shall be carried out by compressed air. Leakage from joints shall be checked by soap solution.

g) Test for tightness shall be carried out using compressed air at the operating pressure, the test pressure shall be held for 12 hours. The percentage pressure drop calculated as per formula given in para (g) of previous clause shall not exceed.

06 Commissioning

- Pipelines shall be commissioned only after successful completion of acceptance tests, strength tests and leakage tests.
- All valves and regulating devices shall be checked for proper operation.
- All safety relief valves shall be checked and set at required pressure setting.
- All instruments, interlocks, etc. shall be checked.

- Before charging the pipelines with fuel gas, the entire air from the pipeline shall be purged with steam/ nitrogen.
- Before purging, all valves shall be set at required position, drain pots filled with water, all hatches & manholes, closed. All bleeders except the ones used for venting the purge gas shall be tightly shut.
- Discharged from the pipelines be through bleeder/ vents only. The air/ gas should not discharge in to the shop/ furnace.
- After purging is complete, the fuel gas shall be gradually charged in to the pipelines. The charging shall be done sectionwise gradually approaching the consumer end.
- The gas shall be discharged through bleeders only. Exhaust gas from bleeders can be set on fire.
- Completion of filling shall be determined by taking samples from the bleeders. In case oxygen content of two successive samples is less than 1 % the gas blowing shall be deemed to be complete.
- All activities of gas pipe purging and charging shall be co-ordinated with the Energy Management Department of the plant. All safety regulations in force as per practice followed by BSL shall be followed including presence of safety personnel, fire engines, etc.
- After charging the gas into the system, all isolating devices, instrument, control, safety devices, condensate seal pots, etc. Shall be again checked for proper operation.

02.20.02 Oxygen pipelines

01 General

- All work concerning oxygen pipelines system shall be done by persons of contractor well conversant with the oxygen service and having proven ability in the field.
- All safety aspects with regards to selection of materials, erection procedure, degreasing, testing and commissioning procedures, cleanliness, etc. shall be kept in view by all personnel connected with the job.
- Erection of pipes, fittings, instruments, etc. shall be done strictly as per the approved drawings. Any change proposed to be done at site shall have the approval of the Purchaser's/ Consultant's representatives.

02 Routing of oxygen pipes

- Oxygen pipes can be laid along with other pipes on same stockades. Oxygen pipeline shall have independent support from the same stockade.
- Clear distance of 300 mm shall be kept between oxygen pipe and any other pipe.
- In shop pipes can be laid along the wall and can be supported from building structures, crane girders etc. by independent brackets, hangers, etc.
- Pipelines laid in trenches shall be covered with sand/ earth.
- Oxygen pipeline shall not be laid in tunnel/ basements. In case it is necessary to pass the pipeline through a tunnel, an encasing pipe +shall be provided on oxygen line extending 1.0 m on both ends of the tunnel.
- A clearance of 500 mm shall be kept between oxygen pipe and electrical cables and in case of bare conductors, the clearance shall be 1000 mm.
- Oxygen pipelines crossing the walls/ floors shall also have encasing pipe. The gap between the pipe and casing shall be filled with non-0inflamable material allowing movement of the pipe.
- Oxygen pipelines shall be effectively earthed, Jumpers of minimum 5 mm diameter shall be proved at all flanged joints.

03 **Materials**

- All materials supplied for erection shall have manufacturer's test certificates including materials test and hydraulic test reports.

04 **Cleanliness**

- All steel pipes & fittings shall be picked at the manufacture's works or at site prior to degreasing.
- In case the pickling is done at manufacturer's work, the ends of pipes shall be sealed/ plugged, and then pipes packed and tagged 'picked for oxygen service' before despatch.
- Pickling shall be done using HCL of 20% concentration (w/ w). After pickling, pipes shall be washed with water, neutralised with 0.25% NaOH solution and again washed with water.
- Before erection, the pipes & fittings shall be visually inspected for presence of scales/ foreign matter like fillings, flux, corrosion products, dirt wood and metal chips, threading compounds, sealants, tar asphalt, moisture, paint, chalk, etc.
- The pipe work shall be thoroughly cleaned to ensure removal of all foreign matter.

- Presence of grease or oil shall also be checked visually. Inside surface of pipes shall be checked by passing clean white cotton piece.

  Hands, clothes and aprons of the workers doing erection job shall be clean and free oil and grease.

05 **Degreasing**

- Before erection, all pipelines, fittings, valves, gaskets, packing material, instruments etc. Shall be degreased using proper solvent like carbon tetrachloride or trichloroethylene. For initial degreasing detergent made by mixture of sodium hydroxide trisodium phosphate and calcium sodium silicate can be used.
- The quality of the solvent used for degreasing shall for degreasing shall be checked before its application.
- The parts to be degreased should be cleaned and dried by blowing air.
- Outer surface of pipes is degreased by wiping with cloth dipped in solvent and then dried till smell of solvent disappears.
- For degreasing inner surface of pipes, pipe shall be plugged at one end, filled with solvent and closed at other end. Pipe shall be kept in horizontal position, rotated about axis atleast once in a minutes. After continuing the process for about 15 minutes, the solvent shall be drained and pipe blown with dry oil free air or nitrogen for at least 5 minutes.
- Drying after degreasing can also be done in open air for at least 24 hours.
- Vapour degreasing method can also be applied for pipes.
- For degreasing of valves, fittings and other components, the same shall be dismantled and parts dipped in solvent for 5 to 10 minutes. After degreasing, the parts shall be dried in open air till smell of solvent is eliminated.
- Gaskets and packing material shall be degreased by dipping in solvent for 1.5 to 2 hours after which these shall be dried in open air for 24 hours.
- Degreasing operation shall be done in open air.
- The workers should use safety masks to prevent hazards due to inhaling of the solvent vapours. Solvent contact with skin shall also be avoided.
- Safety aspects regarding handling of solvents shall be kept in mind during degreasing process.

006 **Erection**

- Erection of oxygen pipelines shall be done as per approved drawings and general guidelines for erection of pipelines.

- Gas welding or electric arc welding shall be used for erection of pipelines. Welding shall be done by qualified welders.
- Qualifying tests for welding, welding procedures and quality control etc. shall be generally as per IS: 2825, ' code of Practice for Unifired pressure Vessels'.
- Radiographic examination of 100% welds for oxygen pipelines with working pressure over 6 km/ cm2 and OD above 76 mm shall carried out. Interpretation of radiographs shall be done by a competent agency like Lloyds Register of Shipping. Proper identification marking for welds and their corresponding radiographs shall be carried out by the contractor.
- For pipelines having working pressure below 6 kg/ cm2, 40% welds shall be tested by radiography.
- Cleanliness of personnel as well as tools and tackles shall be ensured.

007 **Testing**

- All erected pipelines shall be tested for strength and leakage using dry and oil free air or Nitrogen.
- Before testing, the pipeline shall be degreased by vapour degreasing method.
- After degreasing, the pipelines shall be blown with dry and oil free nitrogen. During blowing, velocity in the pipelines shall not be less than 20 m/ sec.
- Blowing shall be done for a period of at least 1 hour to remove all particles of dust, scale etc. from the system. Cleanliness shall be checked by holding a piece of white paper at the air outlet.
- After blowing, the line shall be pressurized up to 1.25 times the maximum working pressure of the pipeline using air/ nitrogen. The test pressure shall be held for 30 minutes during which the joints shall be lightly tapped with a wooden hammer of 1.5 kg weight.
- Pressure shall be gradually reduced to the operating pressure and all joints checked by soap solution for leakage. If any leakage is detected, line shall be depressurized and defect rectified.
- Leakage test for the pipeline system shall be done at operating pressure for a period of 24 hours. During this period, pressure and temperature readings shall be taken at an interval of 1 hour. Duplicate gauge with least count of 0.1 kg/ cm2 for pressure and 0.5 deg. C for temperature shall be used.
- Leakage of air determined by formula indicated under clause 08.03.04.A. 005 (i) 9 shall not exceed 0.2% hour.
- After satisfactory completion of leakage test, the pipeline shall be isolated and kept under pressure of 1.0 kg/ cm2 till the line is commissioned.

008 **Commissioning**

- Before charging the pipeline with oxygen, the line shall be blown with dry, oil free air/ nitrogen at a velocity of minimum 20 m/ s for a period of at least 8 hours. Cleanliness of outlet air shall be checked by holding a piece of white paper for 3 to 5 minute at air outlet. If dust particles are found on the paper, blowing shall be continued till paler test shown negative results.
- After completion of blowing, oxygen shall be introduced gradually increasing the oxygen percentage in the pipe. The velocity of oxygen flow shall be limited to 10 m/ s till all air/ nitrogen is exhausted from the pipe.
- Oxygen shall be vented through bleeders on open atmosphere at a safe place away from open flames/ fire. Minimum height of bleeders outlet shall be 2.5 m from ground/ platform level or shop roof.
- After charging the line completely with oxygen, bleeder valves shall be closed and line may be put into service.

009 **Safety**

- Testing, cleaning and commissioning of oxygen pipelines shall be carried out only in the presence of and with the permission of senior engineers of the Purchaser and the Contractor.
- The safety department of the Purchaser shall be informed and their concurrence taken on all matters related to cleaning, testing and commissioning of oxygen pipe lines.
- All first aid and fire fighting facilities should be readily available.
- During testing of pipelines by air, the area shall be cordoned off and clear working placards shall be displayed.
- All safety precautions shall be observed in storage and handling of solvents.

02.21 Piping for Compressed Air, Steam, Condensate, Water, Feed Water & Slurry

02.21.01 Layout

⇒ Piping layout must follow good engineering practices. Proper attention shall be given to obtain full functional requirement of piping system with a layout which provides sufficient clearance for other equipment and operating personnel, easy access for operation and maintenance, convenient supporting points, adequate flexibility for thermal expansion movements and neat appearance. As far as practicable, interplant pipelines shall be laid along X or Y axis of the plant grid system.

02.21.02 **Design Consideration**

⇒ Piping system shall be designed with high degree of reliability so that the system perform the duty of fluid handling without structural or functional failure under most adverse conditions of plant operation anticipated. All piping system shall be designed with sufficient corrosion and stress margin to ensure a life time, without failure, not less than life of the plant. 7000 complete cycles of operation shall be considered for stress analysis purpose. Piping system shall not impose reactions on equipment terminals exceeding permissible limits even under adverse operating conditions. Personnel injury from discharge of hot fluids from drain, steam traps, vents, relief valves, hot pipes or exposure to pipe vibration shall be guarded against.

⇒ Piping coming under the purview of Indian Boiler Regulations (IBR) shall be designed in accordance with such regulations. The design criteria of piping coming under the purview of IBR shall have to be approved by "Chief Inspector of Boilers" Bihar, India prior to manufacture. All welding procedures, stress relieving procedures, inspection / testing / certificates and all other records shall have to be approved by Chief Inspector of Boilers in approved form.

⇒ Pipes shall be sized for minimum pressure drops and considering the velocity limitation for various types of fluids as given in Table -08.4. Pipe thickness shall be as per the pipe thickness schedules.

⇒ Pipes having nominal bore less than 15 mm, shall not be used. Design pressure of steam and all other service pipelines shall be considered as 1.2 times the maximum expected pressure. However it shall not be less than 4.0 kg/cm^2 gauge for steam services and 3.5 kg/cm^2 gauge for other services. Design temperature for steam services shall be as pr IBR and for other pipelines shall be 5 deg. above the maximum sustained service temperature expected.

⇒ All the piping coming under the purview of IBR, shall be designed with the allowable design stresses as per IBR. For all other piping, the allowable design stress shall not be more than that specified in ANSI B 31.1 or BS:806 latest revision. Pipe thickness of all pipeline shall be taken as per the pipe thickness schedules. The design and stress analysis shall take into account the effect of internal/external pressures, thermal expansion, self weight of piping, support reactions, shock due to relieving devices, surge and water hammer, earth quake and wind effect, noise and vibrations, corrosion and erosion etc. and any other effects dictated by recommended engineering practices.

⇒ Adequate flexibility shall be provided in the pipelines to keep stress and reactions in the system arising due to thermal expansion or other effects within limits. Where the piping terminates at an equipment or at the terminal point of a system, the reactions and thermal movement imposed by piping on the equipment or the system concerned shall be well within the limits specified.

⇒ The flexibility analysis of steam, condensate and hot service media pipelines shall be furnished.

⇒ If cold springing of pipeline is used, care shall be taken in determining the location and amount of cold spring gap. Cold spring gap shall be located at points where the bending and torsional moments are minimum. Use of cold spring gaps less than 10 mm shall not be acceptable and cold spring gaps above 100 mm shall be avoided. All outdoor piping exposed to sunlight carrying fluid at a temperature less than 80 deg.C shall be designed considering thermal expansion corresponding to 80 deg.C and empty pipe as one of the operating conditions although not necessarily the worst.

02.21.03 **General Requirement**

⇒ Unless otherwise specified, all piping shall have butt welded connections with minimum of flanged joints for connection to vessels and equipment to facilitate erection and maintenance, All high pressure steam valves and accessories shall have welded connections. Standard fittings shall be used wherever practicable. Unless otherwise specified, for all welded lines with pressure above 7 kg/cm2 and/or temperature above 200 deg.C, branch connections with branch sizes upto 25 % of welded mains shall be made with special forged steel welded fittings.

⇒ Bends for pipes other than general water pipelines shall have a radius of not less than three times the nominal pipe dia unless otherwise specified.

⇒ In general pipes having size 50 mm and above, are to be jointed by butt welding and 40 mm & lower sizes by socket welding/screwed connection. Threaded joints shall have to be seal welded except for galvanised pipes where teflon sealing tapes shall be used. For galvanised pipeline, pipe joints which are to be made before galvanising shall be of weldable type. Those joints which are to be made after galvanising shall be either flanged or screwed type. As far as practicable, whole fabricated piping assemblies shall be galvanised at a time in order to minimise the number of joints to be made after galvanising. However, for instrument grade air line, GI pipes with welded joints shall be used for sizes NB 25 mm and above; screwed joints for lower sizes pipes upto NB 20.

⇒ All pipelines shall be provided with drain connections, generally at the lowest point for removing accumulated condensate or water and line draining. The drain pipings shall have drain pockets and isolation valves. Trap stations shall be provided, wherever necessary.

Lines shall be given proper slope towards the drain points. Drip legs on mains on line dia 150 mm or over shall be at least 75 % of the main dia with a depth twice the dia of the main or 600 mm minimum from the centre line of the main to the trap off-take unless otherwise specified. Drip legs on mains smaller than dia 150 mm shall be full dia of the line. All drip legs for fluids which may deposit undesirable liquid or solid matter shall have full dia flanges for the bottom cover.

⇒ Steam traps shall be provided with integral or separate strainers, by-pass and isolation valves. All high pressure drain piping shall have two isolation valves on either side of it. All drains released into a sewer shall not exceed 60 deg.C. All the highest points in a piping shall generally be provided with adequate venting arrangement with isolation valves. High temperature vents shall be routed outside the building or at a safe height of personnel protections. Silencers shall be provided at safety valves exhaust. Drain line shall not be less than 25 mm. For main header size 100 mm & above, traps minimum size shall be 25 mm.

⇒ Expansion joints shall not be used on steam lines. Sight flow indicators shall preferably be of flapper type provided with illuminating arrangement. A safety valve shall be provided at the down stream of every pressure reducing station.

⇒ All piping 50 mm in size and larger shall be fabricated in the manufacturer's shop. Small piping materials shall be shipped separately in straight lengths and fabricated at site. If any flow nozzle is required, it shall be fixed in a pipe piece in the shop.

02.21.04 Pipe supports, anchors, restraints

⇒ In general pipe, supports, restraints, braces or anchors shall be located at those points in the building or outdoor where provision has been made for the loads imposed. Loads at the supporting points or restraints shall be determined sufficiently early and provision shall be made in the building or outdoor structures for pipe supports. The tenderer shall locate, design, supply and erect all the supplementary steel structures to properly secure and support all pipe hangers, supports, restraints, etc.

⇒ Provision shall be made for support of piping which may be disconnected during maintenance work. All large pipes and all long pipes shall have at least two supports each arranged in such a way that any length of piping or valve may be removed without any additional supports being required.

⇒ Supports, guides and anchors shall be so designed that excessive heat is not transmitted to the building structures. Supporting steel shall be of structural quality. Perforated, strap, wire or chain shall not be used. Supporting components shall be connected to supporting structure by welding, bolting or clamps. Bolt holes shall be drilled and not gas cut. Structural steel work for supporting shall be designed on the basis of maximum design stress of 1265 kg/cm2. Pipe attachment coming in direct contact with pipes having surface temperature above 400 deg.C shall be made of alloy

steel. Use of insulating materials like asbestos between pipe clamp and pipe surface to meet the above temperature limitation shall not be permitted. The maximum spacing between two consecutive supports shall be not more than as specified in Table - 08.5. Pipe hangers and supports shall be capable of supporting the pipelines under all conditions of operation. They shall allow expansion and contraction without over stressing the piping system or overloading the terminal equipment due to variation in supporting effort. Rigid supports or hangers shall be permitted only for pipes with small movements. For hot lines, spring hangers shall be used. The maximum permissible load variation on the terminals of sensitive equipment between hot and cold conditions shall be limited to 6 %. Variability in load between hot and cold conditions expressed as a percentage of the design load shall be taken as the criterion for spring selection for spring hangers. Variable spring hangers shall be set at cold conditions so that they take design load under operating condition after the designed thermal expansion has taken place.

⇒ Spring shall be enclosed in suitable cages and the hangers shall be provided with spring locking arrangement, external load and movement indicator and turn buckles for load adjustment. All the rigid hangers shall be provided with turn buckles for vertical length adjustments.

⇒ Hanger rods shall be subjected and designed for tensile loads. At locations of high axial or lateral movement, suitable arrangement shall be provided to permit the swing. The swing from vertical position shall be within 4 deg. Double nuts and locknuts shall be used for hanger rods and bolts in all cases. Hangers shall be designed so that they do not become disengaged by movement of supported pipe.

⇒ The supporting structures at each support point shall be designed for the highest of the following loads to take into account the extra load during hydraulic testing.

- 1.25 times the maximum load under operating condition.
- 1.25 times the weight of pipeline full of water
- Weight of pipeline full of water (combined weight of pipe, insulation, valve attachment etc. plus weight of water).
- 1.25 times the weight of pipeline ((combined weight of pipe, insulation, operating medium and valve attachment)
- Weight of pipeline full of water as above plus any cold reaction as anticipated.

⇒ Where the piping system is subjected to shock loads such as thrust imposed by the actuation of safety valves, hanger design shall include provision of shock absorbing devices of approved design. Vibration control devices shall be part of piping system design.

⇒ Outdoor piping shall be designed, with due consideration, for expansion resulting from exposure to sunlight and care shall be taken to prevent progressive movement of long pipeline. Out door piping may be supported on shoes, saddles or steel sections. Effect of support friction especially for large dia pipelines shall be considered and friction forces minimised by suitable arrangement. Piping inside the trenches shall be supported at intervals on steel sections and the arrangement shall permit easy maintenance. Spacing of pipes in tunnels and trenches shall be as shown in table 08.10.

⇒ Walkway platform for outdoor over ground pipelines on stockades, if any, will be provided for pipeline maintenance, including maintenance platform for gland compensator, if any.

02.21.05 **Valves and Specialties**

⇒ All valves shall be of approved make and type. All valves shall be suitable for service condition i.e. flow, pressure and temperature under which they are required to operate, chemical characteristics & nature of operation. The valves for high and medium steam services shall have butt welded/flanged ends unless otherwise approved and the internal dia shall be same as that of the pipes to be joined.

⇒ All gate/sluice, globe and needle valves shall be fitted with outside screwed spindles and bolted type glands and covers. Spindle glands shall be of the bridge type construction and screwed glands will not be accepted. All high pressure valves having nominal dia more than 150 mm, shall have integral steam bypass connected to the valve body by means of welded joints.

⇒ All gate/sluice, globe and needle valves shall be provided with hand wheel and position indicator. The face of each hand wheel shall be clearly marked with words "open" and "shut" with arrows to indicate the direction of rotation to which each refers. Arrangement limiting the travel of any valve in the "open" and "shut" position shall be provided exterior to the valve body. All globe valves shall be designed to prevent erosion of valve seats when the valves are operated partially opened. Valves which cannot be operated from the floor or walkways, shall be provided with suitable extension rods and linkages to facilitate operation from the floor or walkways. Chain operation will not be accepted for steam valves. Stem shall preferably be arranged vertically with gland at the top. In no circumstances, the gland be at the bottom. Valves shall not be installed in the inverted position. The design of valves shall be such that with back seat arrangement it will permit repacking of glands under pressure. Where required, valve spindles shall be extended so that the hand wheel is at a height of about 1.0 m above the level of the floor or platform from where the valves are to be operated. Where required, they shall be provided with head stocks and pedestals of rigid construction and where gears or bevel wheels are used, these shall be of cast steel.

⇒ Globe type valves shall have a permanent "arrow" inscription on its body to indicate direction of flow.

⇒ Gate/globe valves on steam, air, condensate services shall be outside screw & yoke type with rising spindle. Smaller size valve shall have rising hand wheel but larger ones (NB 50 & above) only non rising hand wheel.

⇒ Non return valves on all pumps discharge and steam line shall be of an approved non-slamming type. Draining arrangement shall be made on both sides of the horizontal non-return valve where such a valve adjoins an isolating valve. Valve bodies shall be provided with removable access cover to enable the internal parts to be examined without removing the valves. Valves shall have a permanent "arrow" inscription on its body to indicate direction of flow.

⇒ Non-return valves of sizes NB 250 and above shall have anti-slamming devices. Non-return valves shall be lift check type for size upto Dn 50 mm and swing check type for higher sizes.

⇒ Valves coming under the purview of IBR, shall meet its requirement.

⇒ Gate/sluice valves for low pressure service shall be outside screw rising spindle type. For these valves, wherever necessary, chain operator shall be provided to operate the valve from the floor or walkways. Larger size gate valves for low pressure applications shall be provided with bypass and draining arrangement and valves with dia more than 250 mm shall be provided with gear operator.

⇒ Valves in corrosive service shall be diaphragm or rubber lined type. Diaphragm shall be of reinforced rubber and rubber lining of body shall have minimum thickness of 3 mm. Generally plug valves shall be used in compressed air line. Plug valves shall be supplied with wrench operator. Valves shall be of taper plug type. Sampling valves for dematerialized water shall be of cock type and stainless steel AISI 316. Indicator for 'OPEN/ & 'CLOSE' position shall be provided on all plug valve.

⇒ For motor operated valve, a 415V, 3 phase, 50 Hz reversible speed motor shall be furnished. Motor shall be capable of producing not less than 1.5 times the required operator torque. Each operator shall be equipped with two adjustable limit and torque switch for both open and closed posit-ion. The motor shall be of high torque low starting current. Each operator shall be provided with auxiliary hand wheel for manual operation. The hand wheel shall automatically disengage when the operator is energized.

⇒ Manual operator shall be of worm and gear type, having permanently lubricated, totally enclosed gearing with hand wheel diameter and gear ratio designed to meet the required operating torque. The operator shall be designed to hold the disc in any intermediate position between full open and full closed without creeping and fluttering. Adjustable stop shall be built into the operator to prevent over travel in

either direction. Operator shall be equipped with direct coupled position indicator and suitable locking device.

⇒ Pressure reducing valves shall be perfectly stable, quiet and vibration less in operation when reducing the pressure for any throughput up to maximum and shall be suitable for continuous use at operating temperature. Valves shall be designed to prevent erosion of the valve seats. Safety valves shall be the direct spring loaded type and shall have a tight, positive and precision closing. All the safety valves shall be provided with manual lifting lever. Safety valves used for compressible fluids shall be of pop type. Safety valves shall be so constructed and adjusted to permit the fluid to escape without increasing the pressure beyond 10 % above the set-blow off pressure. Valve shall reset at a pressure not less than 2.5 % and more than 5 % of the set pressure.

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

⇒ Steam traps shall be impulse type, inverted bucket type, thermodynamic type or any other proven design and shall be complete with integral or separate strainer. The integral components of the traps including the strainer screen shall be of stainless steel (AISI : 316) .

⇒ Valves on dry air line shall be non-lubricated / non-greased type. Graphited gland packing shall not be used for it.

⇒ The compressed air hoses shall be as per IS:911, IS:446 or any other internationally accepted standard. Strainer shall be of stainless steel AISI:316. Body material shall be suitable for the service condition. Blowing arrangement shall be provided with removable plug at the outlet.

⇒ All pipes, fittings, valves, gaskets, steam traps, flanges etc. shall be as per the Annexure-1 to 7 for various services for design, manufacture, material, types, end connections, testing etc.

02.21.06 Thermal Insulation

⇒ The tenderer shall furnish heat insulation for all necessary equipment and piping to efficiently prevent abnormal heat loss from all exposed parts to limit surface temperature within 60 deg.C. Resin bonded mineral wool/slag wool, fiber glass, asbestos ropes and preformed pipe sections, mats/mattresses form of insulation conforming to IS:8183/IS:9842/IS:7413 will be acceptable, however, the grades shall be selected considering respective temperature. In case of using loose insulation, proper care shall be taken at site to get recommended density. Packing density of the insulation wool shall be 150 kg/m3. The various insulation thickness shall be taken as recommended in Table 08.7.

⇒ Insulated surface of ail equipment, piping, valves and fittings shall be covered with aluminium sheet of 22 SWG (0.8 mm thick) held in place by self tapping screws of nickel plated type. apart from the screw, joints shall be further sealed with a suitable sealing compound. All fastening materials such as clips, wires for field weld to the equipment, galvanised wire mesh, metal corner bead shall be provided. Where valves, pipes fittings, flanges, etc. occur, a clear space between end of covering and flange shall be left of sufficient length, to permit withdrawal of flange bolts without interference. Ends of the covering at those joints shall be levelled from the outside covering to the pipe and sealed.

Flanges, valves bonnet, end flanges and fittings shall be effectively insulated. Valve & flange insulation covers shall be made in two halves so that these may be removed/refitted readily without interfering with the adjacent covering. Protrusions through the insulation which themselves do not require insulation such as pipe clamps, supports, small piping, instrument take-offs, etc. shall be covered to the same thickness as the adjacent insulation and be tightly sealed except at hanger rods. Ample provision shall be made to prevent damage of insulation due to thermal movement of the pipe or equipment. All the services to be insulated shall be cleaned of all foreign materials such as scale, rust and paint by use of steel wire brushes and steel scrapers. Anti corrosion painting (primer coat) shall be applied on hot surfaces before application of insulation