



TITLE:
1X800 MW WANAKBORI STPP
TECHNICAL SPECIFICATION FOR
CONDENSATE POLISHING UNIT

SPECIFICATION NO.: PE-TS-408-155-A001

VOLUME II-B

SECTION -C2-A

REV. NO. 00

SECTION-C2-A
CUSTOMER SPECIFICATION
(TECHNICAL REQUIREMENT)
LARGE DIAMETER LOW PRESSURE PIPING,
VALVES AND MISC. TANKS

VOLUME : II-I

SECTION-V

LARGE DIAMETER LOW PRESSURE PIPING,
VALVES AND FABRICATED TANKS

1.00.00 GENERAL SPECIFICATION

This specification is intended to cover the design, supply of steel plates, structural steel and all accessories as required, associated civil works, paints and protective paintings as specified and as required, fabrication, erection, painting, testing of the following items with accessories as specified.

1.01.00 The Large Diameter Piping to be fabricated and installed shall include the following pipe lines having sizes 450 mm NB and above:

- a) Circulating Water Piping
- b) Auxiliary Cooling Water Piping
- c) Raw Water Intake Piping
- d) DM Closed Cooling Water Piping
- e) Cooling Tower Make-up Water Piping

1.02.00 The different steel storage tanks are :

- a) Demineralised Water make up tanks.
- b) Drinking Water Storage Tank.
- c) Service Water Tank.
- d) Condensate Storage Tank.

1.03.00 Rubber Expansion Joints

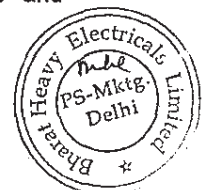
1.04.00 Spring supports for CW pipes

2.00.00 CODES AND STANDARDS

In addition to the requirements spelt out in Vol.-IIA, the equipments to be supplied under this section shall conform to the following Codes and Standards as required.

2.01.00 Large Diameter Piping

2.01.01 Material of pipe : IS-2062 - Code for Structural Steel



- 2.01.02 IS-817 : Code of practice for Training and testing of metal arc welders
- 2.01.03 IS-1367 : Technical supply conditions for threaded steel fasteners

2.02.00 Steel Storage Tanks

The design, manufacture and testing of tanks shall comply with the requirements of one or more of the following standards as applicable.

- 2.02.01 IS - 803 : Code of practice for design, fabrication, and erection of vertical mild steel cylindrical welded oil storage tank.
- 2.02.02 IS - 804 : Rectangular pressed steel tank
- 2.02.03 IS - 805 : Code of practice for use of steel in gravity water tank.
- 2.02.04 IS - 816 : Code of practice for use of metal arc welding for general construction in mild steel.
- 2.02.05 IS - 823 : Code of procedure for manual metal arc welding of mild steel.
- 2.02.06 IS-2825 : Code for unfired pressure vessels.
- 2.02.07 API-12D : Large welded production tanks
- 2.02.08 API-12F : Small welded production tanks
- 2.02.09 API-620 : Recommended rules for design and construction of large welded, low pressure storage tanks.
- 2.02.10 API-650 : Welded steel tank for oil storage.
- 2.02.11 BS-1564 : Pressed steel tank
- 2.02.12 BS-2594 : Carbon steel welded horizontal cylindrical tank
- 2.02.13 AWWA-C-504 : Butterfly valve

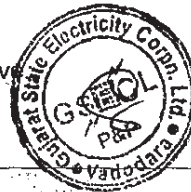
2.03.00 Rubber Expansion Joints

The design, material requirement, manufacture, testing and performance requirements of the Expansion Joints shall generally conform to one or more of the following codes and standards/ documents :

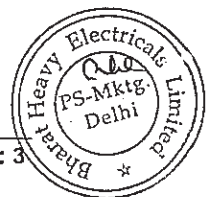
- 2.03.01 Expansion Joints Manufacturers Association (EJMA), USA, Standards.
- 2.03.02 Fluid Sealing Association, U.S.A.: Technical Handbook-Rubber Expansion Joints and Flexible pipe connectors.
- 2.03.03 Other International Standards, equivalent to above



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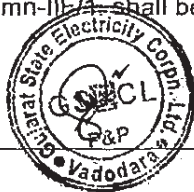
- 2.04.00 Spring supports for C.W. pipe - Spring supports shall conform to the following codes and standards as applicable :
- 2.04.01 IS-1570 : Schedule for wrought steel
- 2.04.02 IS-2062 : Weldable Structural Steel
- 2.05.00 The technical requirements of the various equipments shall be guided by the design criteria and the Data specification sheets. In case of any contradiction between the aforesaid standards and stipulations of the design criteria and data specification sheets, the stipulations of design criteria and the data specification sheets shall prevail.
- 3.00.00 **SYSTEM DESCRIPTION & SPECIFIC REQUIREMENTS**
- 3.01.00 The different large diameter piping systems are as follows :
- 3.01.01 The Circulating Water Piping will be used for supplying water for condenser cooling from the CW pump house sump by C.W. Pumps to the condenser and also for taking out the hot water from the outlet of condenser to the inlet of hot water distribution system of cooling towers. The scheme of C.W. piping has been shown in drawing no K9213R-DWG-M-001G.
- 3.01.02 Auxiliary cooling water piping will be used for supplying cooling water from the sump of C.W. pump house by Auxiliary C.W. pumps for cooling the closed cycle cooling DM water through Plate Heat Exchangers. ACW piping shall also be used for taking out the hot water from these coolers to the cooling towers. The scheme of Auxiliary C.W. piping has been shown in drawing no K9213R-DWG-M-001G.
- 3.01.03 Raw water intake piping will be used for supplying water to clarifier from the Jackwell. Raw water piping shall also include interconnection with existing Jackwell system and Canal Water System.
- 3.01.04 DM closed cooling water piping will be used for supplying cooling water to boiler and turbine auxiliary equipments as well as for other auxiliary equipments like compressors etc.
- 3.01.05 Cooling tower make-up water piping used for supplying make-up water to cooling tower.
- 3.02.00 The details of Miscellaneous steel tanks for storage of water at atmospheric pressure to be fabricated and erected under this section of specification are given as follows :
- 3.02.01 One (1) Drinking water tank will be installed on the power house roof.
- 3.02.02 One (1) Demineralised water (DMCW) make-up tanks will store demineralised water for supplying make-up quantity to the demineralised closed cooling circuit of the Plant. These tanks will be located at an elevated level, in the Power House.
- 3.02.03 One Service water tank shall be located on the ground.



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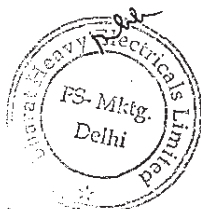
- 3.02.04 One Condensate Storage Tank (CST) will store demineralised water for supplying DM water for power cycle make up.
- 3.03.00 **Rubber Expansion Joints**
- 3.03.01 The expansion joints will be used on C.W Pipes at inlet and outlet of condenser to absorb relative movement between C.W Pipes and condenser.
- 3.03.02 The expansion joints shall be designed for the maximum pressure that may appear in the C.W and ACW system considering shut-off, water hammer, back wash and other operating conditions. The condenser shall be designed to withstand the maximum axial thrust from the inlet and outlet nozzles and pressure compensation type expansion bellow shall be provided for CW inlet and outlet of condenser.
- 3.04.00 Spring supports if required shall be provided for supporting C.W pipes at inlet to and outlet from the condenser.
- 4.00.00 **SCOPE OF WORK**
- 4.01.00 **Large Diameter Piping**
- 4.01.01 Supply and Installation of all piping system as mentioned against Clause 3.01.00 above, and shown in relevant drawings complete with all interconnections including connections with pump flanges and condenser/ equipment flanges wherever required, bends, reducers, tees, distant pieces etc. of all sizes and shapes as required for complete installation of the piping system. The nominal size of various pipes in different sections to be fabricated from steel plates are 450 mm N.B and above.
- 4.01.02 Erection of all vents, drains, instrument tapping points with stubs up to root valves and thermometer well etc.
- Drains, vents, thermometer wells and instrument stubs up to root valves etc. Connected with the above pipelines may be erected from straight length of piping. All bends, reducers, distant pieces, tees, etc. of all shapes and sizes shall, however, have to be fabricated as necessary. All materials required for the same shall be supplied by the Contractor at his own cost.
- 4.01.03 Mitered fittings, Valves, Flanged butterfly valves, strainers, flanges, root-valves other accessories shall be provided. Butterfly valves at condenser inlet and outlet shall be provided with Power actuators. Over and above, those specified above, the Bidder shall provide additional valves/strainers etc. if required for safe and trouble-free operation of the systems. All the slip-on type counter flanges, blank flanges, caps, etc. necessary for the piping, shall be fabricated and installed by the Contractor to make the installation complete in all respect. All materials for the same shall be supplied by the Contractor at his own cost. All necessary bolts, nuts & gaskets required for installation of the system shall also be supplied by the Contractor. For details of Motor Actuators, Section-II of Volumn-II/E/1 shall be referred.



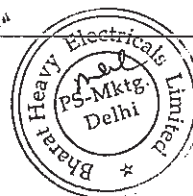
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- 4.01.04 All flanged manhole and manhole covers, flanged tees with blank flanges appearing on above piping are included in the scope of work. Also all flanged tees and blank flanges for tapping water supply from these pipelines to meet the necessity of Owner's other equipment are included. All materials required for the same shall be supplied by the Contractor.
- 4.01.05 Steel hanger, supports, saddles, clamps etc. required for all the pipes at locations as indicated in the attached drawings and as required will be designed, fabricated and erected by the Contractor after approval of the relevant drawings. Supports, clamps etc. for pipeline in pipe trenches, if any and other places are also to be designed by the Contractor and fabricated and erected by Contractor after approval of his relevant fabrication drawings. All materials required for the same and also the trenches shall be made by the Contractor at his own cost.
- 4.01.06 All angle rings and annular rings that are to be welded in the piping for grouting in the wall openings are included. All necessary seating plates for all pipe supports with anchoring arrangement including steel straps, wearing plates to be welded to the piping system etc. are included. The concrete pedestal, thrust blocks etc. where required, shall have to be provided by the Contractor. The seating plate shall also be grouted by the Contractor. Necessary anchor bolts, nuts, sleeves etc. shall be supplied by the Contractor.
- 4.02.00 **Miscellaneous Steel Tanks**
- The miscellaneous steel tanks to be designed, supplied, fabricated and erected under this specification.
- 4.02.01 The connections, accessories and fittings to be supplied with each tank shall be as indicated in the respective drawings, specification and as required. The piping material required inside or outside up to the flanged terminal shall be supplied by the Contractor.
- Tank connections shall be provided with suitable counter flanges with necessary bolts, nuts & gaskets by the Contractor.
- 4.02.02 The tank, where applicable, shall be complete with supporting structure, legs or pedestals, base plate, anchor bolts, nuts & sleeves etc. as required.
- 4.02.03 The special fittings, e.g. conservation vent valves, level indicators etc. shall be supplied by the Contractor.
- 4.03.00 Preparation of detailed design, fabrication drawings, bill of materials, tag and piece numbers, welding procedure, etc.
- General layout showing pipe routing, location of expansion joints, butterfly valves, etc. shall be furnished by the Contractor.
- 4.04.00 This specification covers supply of steel plates, structural steel, pipes etc. as required for complete installation.
- 4.05.00 The scope of work under this specification shall include excavation and backfilling work required for installation of pipes running underground.

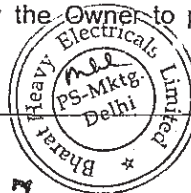


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- 5.01.06 The pipe circumferential weld shall be done in such a way that the longitudinal welds become staggered in any two consecutive sections.
- 5.01.07 Pipe sections in straight lengths delivered at erection site shall be of suitable length to minimise field joints as far as possible. End preparations shall be done at the fabrication yard to facilitate site welding.
- 5.01.08 The piping shall be prepared cold rolled to true cylindrical shapes in a number of passes in a plate bending machine so that no undue stresses are developed.
- 5.01.09 Manholes shall be provided wherever required and the sizes shall conform to the requirement. All manholes shall be provided with flanged covers with handle, gasket, bolts, nuts etc. Manhole pits shall be provided for buried piping at regular intervals of 100 m. Valve pit, if required shall be provided for buried piping system for accessibility and maintenance of the valves. The design of the valve pit shall be approved at the detail Engineering Stage.
- 5.01.10 Gaskets shall be 3 mm thick full-face rubber.
- 5.01.11 Bolts and nuts shall be hexagonal head conforming to IS-1367 (latest revision).
- 5.01.12 The pipe sections shall be carefully placed on the sand bed prepared as specified before and then welded. The method of holding the pipe sections in position for welding during erection shall be approved by the engineer. All joints before welding shall be thoroughly cleaned and requisite welding gap maintained.
- 5.01.13 Welding shall be carried out as per provisions laid down in IS-816 (latest revision). Welding shall be done by experienced and good operators who have been qualified by tests as specified in IS-817 (latest revision).
- 5.01.14 Welding sequence shall be done in such a way so as to minimise the distortion due to welding shrinkage. Any distortion will be duly rectified by the Contractor.
- 5.01.15 Welding shall not be carried out when the surface of the parts to be welded are wet for any cause and during periods of rain and strong winds unless the welder and work are properly shielded.
- 5.01.16 The unpainted ends of pipe surface shall be painted after completion of jointing. Precaution shall be taken to prevent any crack or damage in the external coating during installation. Pipes shall be laid in trenches excavated along the route and the overground portion shall be installed as per final layout drawings furnished to the Contractor.
- 5.01.17 On completion of all welding in the pipe lines, the same shall be tested hydrostatically and after successful testing, shall be covered by sand wrapping and backfilling with earth as specified elsewhere in this specification.
- 5.01.18 Installed pipe shall be closed up at both ends at the end of each day by watertight plug or other means approved by the Owner to prevent debris/ animals/human beings from entering the pipe.

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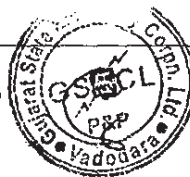
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- 5.02.00 **Steel Storage Tanks**
- 5.02.01 Tanks shall be suitably constructed for safe, proper and continuous storage of liquid described. The design code, material standard, minimum plate thickness, size and other details shall be as per the specified Codes and Standards as applicable.
- 5.02.02 For cylindrical tanks, the plates shall be cold rolled through plate bending machine by several number of passes to true curvature. For rectangular pressed steel tank, the plates shall be heated uniformly in a furnace and formed in a press, each of which is capable of taking the whole part at a time. Alternatively, the plates may be pressed cold, the flanges made by V-die and the corners welded provided no cracks are developed.
- 5.02.03 Vessel seams shall be so positioned that they do not pass through vessel connections. For cylindrical vessels consisting of more than two sections, longitudinal seams shall be offset.
- 5.02.04 Where possible, the inside seam weld shall be ground smooth, suitable for application of corrosion resistant primer.
- 5.02.05 For vessels with dished ends, Bidder shall submit in his quotation details of the proposed dished ends. The details shall comprise of the following :
- The method of manufacture.
 - Knuckle and crown radii and length on straight.
 - Whether dished ends are fabricated in one piece or segmented.
 - A sketch showing number of segments and seam arrangement, if segmented ends are proposed.
- 5.02.06 Proper means shall be provided against the chance of over-turning effect of wind on an empty vertical cylindrical tank.
- 5.02.07 Due consideration for wind load and/or earthquake effect shall be given by the Contractor in the design of tanks. Data for wind load and earthquake shall be taken as indicated in the Vol. IIA. Maximum allowable stresses for design loadings combined with wind or earthquake shall not exceed 133% of stress permitted for the design loading condition but in no case shall exceed 80% of specified minimum yield strength of the material.
- 5.02.08 Except where otherwise indicated in the Owner's drawings/ specifications, if the stiffening of the shell and/or roof is necessary the same shall be stiffened from outside.
- 5.02.09 Reinforcement pads in tank connections shall be provided as per applicable code & the reinforced connection shall be completely preassembled into a shell plate. The completed assembly including the connection shall be thermally stress-relieved as per API Standard 620 if specified.

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5.02.10 All welding shall be done as per IS803, 817, 823 and IS:816, latest revision as applicable. All welds are to be continuous welds. Bidder shall clearly state in his offer the make and type of welding rods proposed by him for fabrication. Inspection of welding shall be carried out in accordance to IS-822, IS-823. Welding sequence shall be adopted in such a way so as to minimise the distortion due to welding shrinkage, Contractor shall indicate in his Drawing the sequence of welding proposed by him, which should meet prior approval of the Engineer.

5.02.11 Tank Connections

- a) Bidder shall furnish all piping material required for the tank connections.
- b) Unless otherwise specified, for all flanged connections Bidder shall furnish suitable counter flanges and the necessary nuts, bolts, gasket.
- c) Flange faces of all nozzles shall be machined and square with the vessel centrelines.
- d) Unless otherwise stated bolts and nuts shall be of hexagonal head conforming to IS:1367, latest revision.

The material and thickness of gaskets shall be suitable for the specified service. On completion of hydraulic test, contractor shall replace the gaskets used during testing at his own cost.

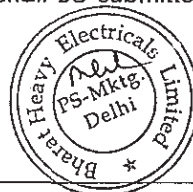
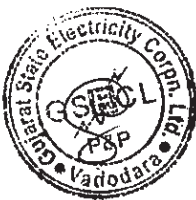
- e) All tanks shall be provided with connections for drains, vent and overflow. Condensate storage tank shall be provided with pump recirculation connections. Blank flanged spare inlet and outlet- 2 (two) each shall be provided for condensate storage tank and one (1) each for others. Each of the above spare connections shall be provided with isolating valves.

5.02.12 Accessories

The tanks shall be provided with accessories as indicated in the Specification. All the accessories shall conform to relevant Indian Standard. The following broad guidelines are given for some of the accessories.

- a) Conservation Vent Valve/Breather

Where continuous venting to atmosphere directly is not permitted for the stored liquid, a conservation vent valve or a breather of approved make & design shall be provided on each of the vent/overflow connection of the condensate storage tank. The conservation vent valves where provided, shall be designed to relieve the pressure or vacuum corresponding to plus or minus 55mm water gauge in the space above liquid in the tank. Detail cross-sectional drawing indicating materials of construction shall be submitted along with the proposal.



b) Level Indicator

Float operated or tubular gauge glass type indicator of high-grade workmanship shall be provided on each tank. Tank of height not exceeding 3m shall have tubular gauge glass and others float operated level Indicator. For tubular gauge glass, isolating valves and protective guards against mechanical shock shall be provided.

c) Level Switch

Where specified level switch of approved make & type shall be furnished along with instrument root valves. Repeat accuracy of operation shall be $\pm 1\%$ of the full range. At least two level switches one for High-level actuation and other for Low Level actuation shall be provided for each tank to motor operated gate valves at inlet lines of specified tank.

d) Dip Hatch

Each large dia cylindrical tank shall be fitted with one dip hatch. Dip hatch shall have screwed end and shall be fitted with brass cap and chain.

e) All tanks shall be provided with vertical rung ladder. In addition to this, internal vertical ladder is to be provided in all tanks where the tank height exceeds 3M, vertical ladder is to be provided with cage.

f) Top Manhole shall be provided in all tanks. Besides manhole at the side of tank shall be provided in case of condensate storage. Manhole size shall be 600mm NB(min.).

5.02.13 When installation of tank is specified the recommendation regarding installation in IS:803 shall be followed in general. In addition to those recommendations, the following shall also be taken care of.

5.02.14 The finished tank grade for cylindrical tank shall be crowned from the outer periphery to the centre with a slope. The sloping factor shall be taken as 1:36 unless otherwise specified.

Sufficient number of plugged holes shall be provided in the bottom plate of the vertical tanks for bottom testing as specified in IS-803.

5.02.15 Welding shall be done in accordance with IS-803, IS-817 & IS-823.

5.02.16 Welding sequence shall be adopted in such a way so as to minimise the distortion due to welding shrinkage. Contractor shall indicate in his drawing the sequence of welding proposed by him, which should meet prior approval of the Engineer.

5.03.00 Rubber Expansion Joints

Design of the Expansion Joint shall take care of the axial, angular or rotational movement of the bellow and/or the equipment vibration. Axial compression or elongation of RE joint under design pressure from free condition shall be 10 mm (max.). Lateral deflection of RE joint under design pressure from free



condition shall be 10-mm. Lateral deflection with simultaneous axial elongation and compression shall be 10 mm. These figures shall be confirmed based on the final details of condenser and C.W. pumps. Pressure compensating expansion bellow shall be designed to suit the requirement of condenser.

The general design and constructional features of various components of the Expansion Joints shall be as follows :

5.03.01

Body

- a) Expansion bellow shall be manufactured from abrasion resistant natural or synthetic rubber.
- b) The Expansion Joints shall have integral flanges at both ends complete with split retaining rings. The flanges shall be made of tough non-compressible duck to resist stresses set up when the flange bolts are tightened. The flange compound shall be designed to resist flow under bolting pressure. The boltholes drilled on the flanges shall be thoroughly coated with self-vulcanizing rubber so that edges of the plies are not exposed.
- c) 2 sets of split retaining rings shall be installed on each Expansion Joint to increase resistance to pressure. The rings shall be made of rolled steel IS-2062, split, bevelled and galvanized. They are to be placed directly against the flange of the Expansion Joint and bolted through it to the metal flange of the pipe. Steel washers shall be used at the points where the rings are split.

5.03.02

Carcass

Fabrics of high strength synthetic fibers (High quantity canvas duck and polyester chord, reinforced) shall be used in suitable number of plies to hold the shape of the bellow at the working condition. All fabric plies shall be impregnated with rubber or synthetic components to permit flexibility between them.

Copper coated steel wire or solid endless rings embedded in the carcass shall be used for reinforcement of the expansion bellow.

5.03.03

Cover

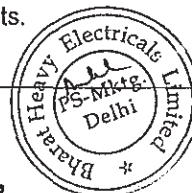
The exterior and interior surfaces of the bellow shall be of Neoprene 3 mm thick shore hardness 65 ± 5 deg. durometer. Protective hypalon coatings shall be applied at the exterior.

5.03.04

Control rod assembly

Expansion Joint shall be supplied with control rod assembly to prevent excessive elongation or contraction of the bellow. Control rod assembly shall consist of long bolt, nuts & lock nuts, washers/spherical washers, connecting plates (gusset plate) for fixing the assembly with companion flanges.

Control rod assembly shall allow transverse and rotational movements under limiting axial conditions of the expansion joints.



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Design of the control rod assembly shall take care of the maximum axial thrust across the bellow calculated on the basis of maximum fluid internal pressure and the internal diameter of the arch.

5.03.05 Joints shall be provided with companion flanges. Companion flanges shall be flat faced, slip-on and shall be fabricated from steel plates or forged.

5.04.00 **Spring Supports**

5.04.01 The spring rate for the springs to be adopted shall be around 40 Kg/mm. The no. of springs and their initial compression for each type of support shall be selected accordingly. The above details shall be furnished along with the offer.

5.04.02 Each spring selected shall not be loaded more than 60% of its maximum rated load while carrying the load.

5.04.03 The spring supports shall be taken from the ground floor and the method of attachment shall be detailed by the Bidder.

5.04.04 The material of construction of component parts shall be equal to or superior than the following :

- | | | | |
|----|--------------------|---|---|
| a) | Spring | : | Spring steel conforming to IS-1570 Gr.50 Cr.1 V-23 or equal |
| b) | Spring housing | : | Carbon Steel to IS-2062 |
| c) | Base plate, anchor | : | Carbon Steel Hot dip galvanised bolts, nuts, etc. |
| d) | Saddle | : | Carbon Steel to IS-2062 |
| e) | Support Table | : | Carbon Steel to IS-2062 |

All other materials used shall be compatible with the service requirement and shall be of tested quality. In case resilient seating is found necessary, details of same with hardness, material etc. shall be indicated in the tender.

5.04.05 All the mounting plates, base plates, along with foundation bolts, nuts, washers etc. as required shall be supplied by the Tenderer. All items required for completing the installation of the spring assemblies shall be supplied under this section.

5.04.06 The support saddles shall be welded to the respective C.W. pipe at site by the Bidder. Bidder shall ensure that the supports can be placed in their respective position with the C.W. pipes already installed.

5.04.07 The spring assemblies shall be set at shop for loads when filled up with water. The design shall, however, permit that at site load adjustment to an extent of $\pm 10\%$ of specified loads shall be possible and even after this adjustment, the system will allow free movement of C.W. pipes under loaded and empty conditions. The offer shall clearly indicate method of adjustment proposed.

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5.04.08 The locking device to be provided for the spring assemblies should be such that it is possible to easily unlock the springs even when there is certain amount of unbalance between the load applied on the springs and the spring reactions. This is very important as there might always be certain difference between the theoretically calculated load for which the springs will be pre-compressed at shop and the actual load that will be applied on the springs during operating conditions.

5.04.09 After installation of the spring supports at site with pre-compressed springs in locked condition, the C.W. pipes will be filled up with water and then the springs will be released by unloading the springs. If water in C.W. pipe is required to be drained out for any repairs/maintenance works, the springs will be locked first and then the water from the pipes will be drained out so as to avoid undue upliftment of the pipe because of loss of weight due to draining of water from the pipe. The system will be restored after repair/maintenance works by filling up the pipes with water and then releasing the locks of the springs.

The above operation of the spring supports shall have to be demonstrated by the tenderer at site to the entire satisfaction of the Owner.

5.04.10 It shall be possible to take out the whole spring assembly for maintenance. Arrangement for lubrication of springs and other frictional parts shall also be provided to reduce frictional resistance.

The spring box housing shall have drain plugs to allow draining of accumulated water/other liquid etc.

5.05.00 **Butterfly Valve**

5.05.01 Butterfly valve and its operator shall be of heavy duty construction and shall be designed to withstand all working conditions i.e. shall be able to open/close or hold from/at any intermediate disc position, as required, without any difficulty under different combinations of flow and pressure.

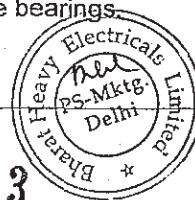
5.05.02 The design of the valve shall take into consideration the Water Hammer effect for accidental closure of the valve disc.

5.05.03 Shaft of butterfly valves may be of single piece extending completely through the valve disc or in two pieces, stubbed into the disc hubs. The shaft diameter shall take into consideration the maximum differential pressure across the valve disc when the valve is closed and the shock load due to accidental closure of the valve disc.

5.05.04 Disc of butterfly valve shall have no external ribs transverse to the direction of flow. The disc shall be of a design that permits removal and replacement at site and shall be securely clamped on the body or disc of the valve.

5.05.05 Each butterfly valve shall be fitted with two (2) sleeve type shaft bearings, contained in the hubs of the valve body. Bearings shall be of self-lubricated type and shall not have any harmful effect due to handling fluid.

Shaft seals for butterfly valves shall be provided both at drive and non drive end of the shaft to prevent fluid flow to valve bearings.



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- 5.05.07 Design of the gear reducers for butterfly valves shall conform to AWWA standard.
- 5.05.08 Butterfly valves to be used for flow regulation/control shall be designed to accommodate extra velocity through the valve passage to ensure normal service life. The design shall take care of the pressure drop across the valve disc due to control of fluid flow and shall take care of the erosion and cavitation effect on the body and the disc due to such operation.

For detail specification refer Annexure-II.

6.00.00 **EXCAVATION AND BACKFILLING**

6.01.00 **Scope**

This specification covers excavation in pipe trenches in all types of soil (including rock) including shoring, dewatering, back filling under pipes, transportation of earth within station premises, backfilling the excavated trenches with selected spoils, concrete encasement of pipe, compaction of fills and approaches, protective fencing, lighting and other safety measures as may be applicable, removal of surplus spoils to selected areas etc. and other works for underground pipe installations. The scope of work also covers protection of adjacent structures and protection, maintenance or removal of other pipes and conduits.

6.02.01 **Materials to be used**

Earth to be used for filling under pipes shall be clean, graded and free from harmful and deleterious material. Borrow material, if required, for backfilling the excavated trenches, shall be excavated from approved locations & levels and shall consist of granular material free from roots, vegetations, decayed organic matter, harmful salts and chemicals, free from lumps and clods.

Materials for shoring shall be of best commercial variety and approved by the Engineer and the same shall be arranged by the Contractor at their own cost.

Shoring materials required for the work under this clause shall be arranged by the Contractor at his own cost.

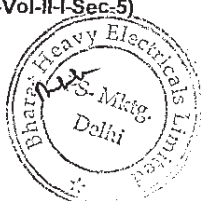
6.03.00 **Execution**

6.03.01 **Setting out & levels**

On receiving the approval from the Engineer on working drawings the Contractor shall set out the work from the control points furnished by the Engineer and fix permanent points and markers for ease of future checking. These permanent points and markers will be checked by the Engineer and certified by him after whom the Contractor will proceed with the work.

The Contractor will help the Engineer with men, materials, tools & instruments for checking purpose. It should be noted that this checking by the Engineer prior to start of the work will in no way absolve the Contractor of his responsibility of carrying out the work to true lines and levels and grades as per drawings and subsequent corrections, if necessary, free of cost to the Owner in case any errors are noticed in the Contractor's work at any stage.

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The clearance for starting excavation work in different areas within the work may be given separately by the Engineer in co- ordination with other Project work. As such prior approval of the Engineer shall be obtained by the Contractor in each individual case.

6.03.02 Cleaning and Grubbing etc.

The area to be excavated shall be cleared out of fence, trees, logs, stumps, bush, vegetation, rubbish, slush etc. and levelled up. Trees up to 300 mm girth shall be up-rooted.

6.03.03 Excavation in Trenches

All excavation shall be done to the minimum dimensions as required for safety and working facility, wherever necessary and/or as directed by the Engineer, shoring - 'close' or 'open' type - shall be provided depending upon the nature of soil, the depth of trench and location of adjacent structures already constructed. It shall be the responsibility of the Contractor to take all necessary steps to prevent the sides of trenches and pits from collapsing.

The rough excavation may be carried up to a maximum depth of 150 mm above the final level. The balance shall be excavated with special care. If the excavation is done to a depth greater than that shown on the drawing due to the Contractor's fault, the excess depth shall be filled up to the required level at the latter's cost with cement concrete not leaner than 1:4:8 ordinary concrete or richer as directed by the Engineer.

The excavation must be carried out in the most expeditious and efficient manner.

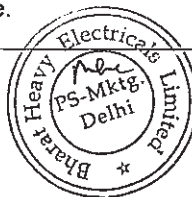
6.03.04 Dewatering

All excavations shall be kept free of water. Grading in the vicinity of excavations shall be controlled to prevent surface water running into excavated areas. The Contractor shall remove by pumping or other means approved by the Engineer any water inclusive of rainwater and subsoil water accumulated in excavation and keep the trench dewatered until the installation and backfilling work are complete. All pumps, cables and other materials required for dewatering shall be arranged by the Contractor at his own cost.

6.03.05 Backfilling in trenches with earth

Earth used for filling shall be free from salts, organic or other foreign matter. All clods of earth shall be broken to small pieces or removed. Filling shall be done on the sides and on top of pipes in layers not exceeding 150 mm, watered (if required depending upon moisture content of the fill material), rammed and consolidated, taking care that no damage is caused to the pipe.

Here also, the fill should rise the same on each side and coincidentally be tamped in layers. As the backfilling is progressed, temporary bracings and struts supporting the shoring planks may be dismantled progressively. The ultimate removal of shoring planks shall only be done after the backfilling work on both sides of the pipe is complete.



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Earth for backfilling may be obtained from :

- a) The excavated spoils being stacked at a suitable nearby place as directed by the Engineer.
- b) Some borrow pits at distance as specified by the Engineer.
- c) Stacks of excavated spoils left by other agencies.

The final surface shall be trimmed and levelled to proper profile as desired by the Engineer.

6.03.06 Testing and Acceptance Criteria for Backfilling work

The degree of compaction required will be as per the stipulation laid down in IS:4701. The density of soil in field shall be determined in accordance with IS:2720 (Part-XXVIII) or IS:2720 (Part-XXIX). The work of backfilling will be accepted after the Engineer is satisfied with the degree of field compaction achieved. The Engineer at his discretion may ask the Contractor for performing the Standard compaction tests at some specified locations for determining the degree of compaction. The Contractor shall do the testing at some approved laboratory at his own cost and forward test results, in triplicate, to the Owner.

6.03.07 Disposal of Surplus Spoil

Surplus material from excavation, which is not required for backfilling, will be disposed of in designated disposal areas. The spoils shall be dumped in a systematic manner and spread in layers not exceeding 150 mm thick and consolidated with the help of compacting equipment.

7.00.00 CIVIL WORKS

All Plain and Reinforced Concrete work covered in this section shall generally conform to Specification for Cement Concrete (Plain & Reinforced) :

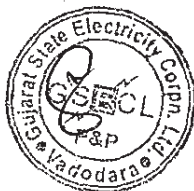
Section - V of Vol.-IIG/3 unless noted otherwise.

8.00.00 TESTING AND INSPECTION

8.01.00 Large Diameter Piping

8.01.01 After complete pipe lines have been laid and joined, the same shall be tested hydrostatically as specified in Vol.-II A, for hydrostatic test pressure of circulating water piping, Auxiliary Cooling Water Piping.

8.01.02 All the longitudinal and circumferential welded seams shall be subjected to chalk and kerosene test prior to hydraulic testing of the complete pipe line. This shall be done at the presence of the Owner/Consultants. In addition to this, test coupons shall have to be provided for each longitudinal seams for mechanical tests (tensile and bend), if considered necessary by the Owner. The test coupons are to be broken in presence of the Owner. Contractor



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shall satisfy the Owner that work is being carried out in accordance with the specification drawings and other conditions. Owner shall have full access to the Contractor's working area.

8.02.00 Performance Tests for Steel Storage Tanks

8.02.01 Vertical Cylindrical Storage Tanks shall be tested generally as per IS:803 (latest edition) including the following :

- a) Spot radiography if joint efficiency factor of 0.85 is specified.
- b) Bottom plate testing by air or vacuum box.
- c) Shell testing by filling with water.
- d) Fixed roof testing by air.

8.02.02 Horizontal cylindrical tanks manufactured in accordance with BS:2594 shall be tested hydraulically at 0.7 bar at the top of tank, unless otherwise specified.

8.02.03 Pressed steel tanks shall be hydraulically tested by filling with water up to the top of tank as per IS:804.

8.02.04 Radiography & hydrostatic tests shall be guided by IS:2825 for pressure vessels.

8.02.05 Hydraulic & other performance tests shall be conducted on all accessories of the tank as per applicable standard.

8.02.06 All tanks shall be leak tested twice, after completion of fabrication and after application of anti-corrosion painting/ lining. The tanks shall be filled up with water in stages as directed by the Engineer. The duration of leakage test shall not be less than eight (8) hours.

8.03.00 Shop Inspection and Testing for Expansion Joints

8.03.01 The manufacturer shall conduct all tests requirement to ensure that all the component parts of the Expansion Joints offered conform to the requirements of applicable codes and standards.

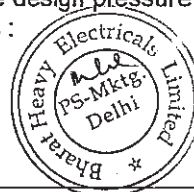
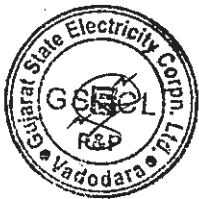
8.03.02 Dimensional inspection

Each Expansion Joint shall be inspected for dimensional accuracy acceptance limits of which shall be mutually agreed upon.

8.03.03 Hydrostatic pressure test & leakage test

All Expansion bellows shall be subjected to internal hydrostatic pressure test at a value of one and a half (1.5) times the design pressure for a period of 10 min. under each of the following conditions :

- a) Free position of the bellow



- b) With permitted (design) elongation & lateral deflections and
c) With design contraction and lateral deflection.

Inspection for leakage from the bellow shall be carried out during pressure test.

After the hydro test is over, the bellow shall be dimensionally inspected to check deformation, if any.

During the test, the control assembly shall be suitably adjusted to obtain the test conditions of the bellow.

8.03.04 Vacuum Test

All Expansion Joints shall be subjected to vacuum test at a pressure of 700 mm of Hg for a period of 10 min. under each of the three conditions mentioned in clause 8.03.03 above.

8.03.05 Chemical Analysis

Test for chemical composition of the bellow material, split retaining ring, control rod assembly shall be carried out, if asked for in data sheets.

9.00.00 PAINTING

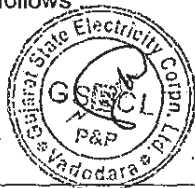
9.01.00 For Large Diameter Piping

9.01.01 Before application of the paint, the internal and external surfaces shall be thoroughly cleaned with wire brush or white metal blasting as per SA 2.0 standard as required for removal of loose dirt, mill scales etc. Manufacturer's recommendation shall strictly be followed in the application of paint.

9.01.02 Inner surface of each section of the pipe shall be given adequate number of coats of epoxy resin based red oxide primer paint or approved equal so as to achieve a dry thickness of minimum 0.8 mm. Inner surface painting shall be applied at the fabrication yard before laying the pipes in position, leaving about 200 mm at both ends for welding of joints. This portion shall be painted after completion of laying and jointing.

9.01.03 Outside surface of pipes and fittings including hangers and supports that will be overground or in a pit shall be given one (1) coat of red lead primer before despatch from fabrication yard. After installation, the part of the pipeline from where priming coat has been rubbed off shall be retouched with primer. Then two coats of Synthetic Enamel paint of approved quality and colour shall be applied.

9.01.04 Outside surface of buried pipes and fittings shall be provided with corrosion protection as follows :



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One coat of coal tar primer (min. 2 mm) of approved quality followed by a final coating of epoxy resin & coal tar blend (min. 1 mm) and then two layers, each 2mm thick of coal tar tape as outer wrap shall be applied to the external surface of the coating. FRG reinforced plastic or coal tar wrap shall be used conforming to AWWA-C-203/IS10221 or approved relevant codes/ standards. Contractor shall submit detailed protection procedure for approval.

9.01.05 The pipes that will be buried underground shall be spark tested after completion of wrapping of each sections/field jointing to check the quality of insulation that has been provided on the pipe.

9.02.00 **Painting for Steel Storage Tanks**

9.02.01 Surface preparation :Internal white metal blasting and external wire brushing.

9.02.02 Primer - i) internal - epoxy based Zn rich primer

ii) external - Synthetic Red lead.

9.02.03 Finish Coat - i) internal - Coal tar epoxy

ii) external - Synthetic enamel

9.02.04 Outside of bottom surface shall have 3 coats of Bitumastic paints.

10.00.00 **DRAWINGS, CURVES & INFORMATION REQUIRED**

10.01.00 The Tenderer shall submit with his formal proposal the following besides the different information required elsewhere under this section of specification.

10.01.01 Outline and fabrication drawings of the tanks indicating plate thickness, details of structural support, stiffeners and details of connections provided.

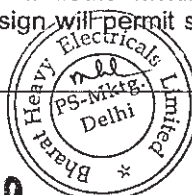
10.01.02 Illustrative literature and drawings and the equipments supplied for the accessories supplied with tanks.

10.01.03 General Arrangement and Sectional drawings with data on weight and material of construction for each category of Expansion Joints with control rod assemblies.

10.01.04 A comprehensive write-up or brochure on the manufacturing and testing facilities in the shop of the manufacturer for rubber expansion joints.

10.01.05 Complete technical details of each type of spring support. The Bidder shall also submit outline drawings showing the support arrangements indicating principal dimensions and weight of the supports. Whenever necessary, cross-sectional details shall be furnished showing the details of assembly of components and their material of construction.

10.01.06 The Bidder shall clearly indicate for each type of support the number of spring used, rated load of springs, actual load to be carried, initial compression requirement, etc. The Bidder shall also indicate maximum and minimum spring compressions within which his design will permit spring movement for loaded and empty working conditions.



10.02.00 After finalisation of contract, various drawings, data and instruction manual shall be submitted for review/approval of Owner and afterwards for final distribution in quantities following the procedure as set up in the applicable clauses in General Conditions of Contract.

The various drawings/data to be furnished shall include the following :

- 10.02.01 Detailed fabrication drawing showing the sizes, materials and weld edge preparation etc. The fabrication drawings shall give all necessary information for fabrication; erection and painting of steel work in accordance with provisions of this specification. Welding symbols used shall be in accordance with the requirements of IS:813 - latest revision and shall be consistent throughout. Weld lengths called on the drawings shall be net effective lengths.
- 10.02.02 Tenderer shall submit working drawing for excavation and backfilling purpose as mentioned earlier.
- 10.02.03 The Contractor shall also submit detailed calculations in support of the final pipe thickness adopted.
- 10.02.04 Instruction Manuals covering maintenance, repair and replacement of equipment fabricated and supplied by them.
- 10.02.05 Details of welding procedure and weld roots to be used.
- 10.02.06 Design calculations for plate thickness etc., considering all applicable loads, seismic effect, wind load etc.
- 10.02.07 Test procedures for tanks and test certificates.
- 10.02.08 General Arrangement drawing of each size and type of Rubber Expansion Joint with control rod assembly giving principal dimensions and weights.
- 10.02.09 Cross-sectional assembly drawing of each size and type of Rubber Expansion Joint complete with data on materials of construction, control rod assembly etc.



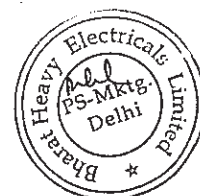
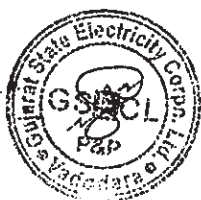
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ANNEXURE-I

SPECIFICATION OF MISCELLANEOUS STEEL TANKS

Sl. No.	Description	Shape	Size	Nominal Capacity (Cu.M) Minimum	Nos. Reqd.
1.	DM Water make up Tank in DM CW system	Horizontal Cylindrical With flat ends		5	1
2.	Drinking water Tank	Rectangular/Cylindrical with flat roof		50	1
3.	Service Water Tank	Vertical		150	1
4.	Condensate Storage Tank	Vertical		500	1



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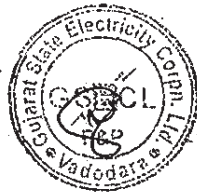
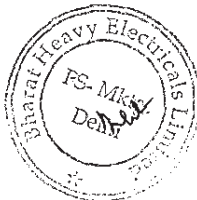
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ANNEXURE-II

CAST IRON BODY BUTTERFLY VALVE

- | | | |
|---------|---------------------------|---|
| 1.00.00 | Valve classification Code | : CIBF |
| 2.00.00 | Basic Design Code | : AWWA-C-504 |
| 3.00.00 | Pressure | : To be suitably chosen by the Bidder according to requirement, but not less than class 75A as per AWWA-C-504. |
| 4.00.00 | Construction | : Cast Body and Disc |
| 5.00.00 | Material | |
| | a) Body | : 2% Ni Cast Iron as per IS-210 Gr. FG260 with 2% Ni. |
| | b) Valve Disc | : -Do- |
| | c) Valve Shaft | : Stainless Steel ASTM-A-479 type 304 |
| | d) Seat ring | : Clamping ring Stainless Steel ASTM-A-479 type 304 |
| | e) Shaft Bearing | : Ferrobestos LA-33 |
| | f) Gland Packing | : Impregnated Teflon |
| | g) Seal | : Nitrile Rubber |
| 6.00.00 | End preparation | : Flanged, Drilled as per ANSI B16.1. Necessary counter flange nuts, bolts, gaskets are to be provided with each valve. |
| 7.00.00 | Testing | : As per AWWA-C-504. However valve disc strength for both forward reverse flow is to be carried out as per BS5155. Certificate for proof of design test for similar type of valve is to be furnished. |



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TITLE:
1X800 MW WANAKBORI STPP
TECHNICAL SPECIFICATION FOR
CONDENSATE POLISHING UNIT

SPECIFICATION NO.: PE-TS-408-155-A001

VOLUME II-B

SECTION -C2-A

REV. NO. 00

SECTION-C2-A
CUSTOMER SPECIFICATION
(TECHNICAL REQUIREMENT)
POWER CYCLE PIPING, VALVES AND SPECIALTIES IN
SERVICE VESSEL AREA

VOLUME : IID

SECTION-I

POWER CYCLE PIPING VALVES AND SPECIALTIES

1.00.00 GENERAL INFORMATION

1.01.00 This section covers all the piping, valves and specialties which connects the different equipment like the boiler, turbine, condenser, pumps, heaters etc. to make the power cycle complete.

2.00.00 PERFORMANCE REQUIREMENT

The piping system acts as the pressure boundary for the fluid in circulation; water and steam in this case, which is subject to high pressure, temperature, change of phase and various types of transient and steady state operation. The piping system shall be designed and constructed for integrity, long life, high reliability acceptable pressure drop, smooth and good operation and control from start-up to the maximum sustained load.

3.00.00 CODES & STANDARDS

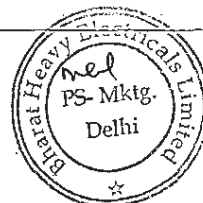
3.01.00 The design, manufacture, inspection and testing of the equipment covered under this specification shall conform, in general, to the standards and codes (latest edition) mentioned below :

- 3.01.01 ANSI B-31.1 : Code for Pressure Piping - "Power Piping".
- 3.01.02 Indian Boiler Regulations : (IBR), with latest amendment.
- 3.01.03 ANSI B-16.5 : "Steel pipe flanges and flanged fittings".
- 3.01.04 ANSI B-16.9 : Wrought steel Butt welding fittings.
- 3.01.05 ANSI B-16.11 : "Socket Welding Ends".
- 3.01.06 ANSI B-16.25 : "Butt Welding Ends".
- 3.01.07 ANSI B-16.34 : "Steel Valves - Flanged and Butt Welding Ends".
- 3.01.08 Design fabrication, assembly and testing of pipes, fittings shall generally conform to the requirements of ANSI B-31.1. But the portions, which come under the purview of Indian Boiler Regulations (IBR), shall completely comply the requirements of IBR as a minimum.
- 3.01.09 Any other internationally accepted codes and standards are also acceptable. However, the compliance of ANSI codes and IBR will be considered as minimum for acceptance of the piping and all appurtenances.



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4.00.00 SCOPE OF WORK

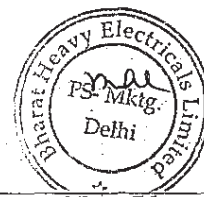
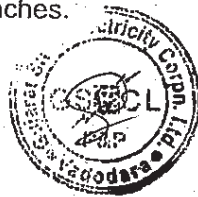
4.01.00 Scope of Supply

Scope shall include complete piping, valves & specialties as required for all systems, units and auxiliaries.

Items not mentioned but deemed necessary by the Bidder for making the system complete, reliable and efficient shall also be included.

4.01.01 The equipment and materials to be supplied under this specification shall include but not be limited to the following :

- a) Supply of all power cycle piping including bends, elbows, tees, branches, laterals, crosses, reducing union, couplings, caps, saddles, shoes, flanges, blank flanges, Y-pieces etc. as required for the piping system under the scope of this specification.
- b) Matching pipes, matching pieces like reducers/enlargers etc., counter flanges with bolts, nuts, washers, temporary and permanent gaskets, threaded union etc. for all terminals as required.
- c) Supply and machining work of flanges, pipe spools and matching pipes to connect flow measuring orifices/nozzles with the main pipe work. The pipe spools shall be supplied along with necessary test certificates of the pipes, after necessary machining to the required bore, for assembly of flow nozzle element. The assembled flow nozzle shall be installed in the piping system. Additional length of pipes equal to length of all fully assembled flow nozzle & orifice plates pipe piece shall be supplied and the same shall also be erected prior to cleaning of the pipes by flushing or steam blowing or chemical cleaning or both. After completion of cleaning of piping the assembled flow nozzles shall be erected replacing the temporary pipe spools.
- d) All motorised valves, manually operated isolating and regulating valves, non-return valves, steam traps, relief/safety valves, strainers, pressure reducing orifices, expansion joints and other flexible connections, complete with the counter flanges and matching connecting pieces as required within the terminal points of entire power cycle piping system.
- e) Anchors, hangers & supports, vibration dampeners, restraints, shock absorbers etc. as required. Any platform necessary for maintenance and operation of valve and equipment located 1.5m above any permanent floor including access ladders, supporting structures etc.
- f) All secondary structural steel members required for pipe supports from building steel structures and from embedded steel including pipe supports in trenches.



- g) Funnels, tundishes for drips & drains including all miscellaneous drain piping and drain piping from tundish outlet up to drain points. All drain and vent lines shall be conveniently terminated either in Blowdown tank/flash tanks or permanent drain trenches of the Power Station.

All steam and saturated water open drains shall be drained through a water seal in drain funnels/tundish with a water connection in funnels/tundish for maintaining water seal level in them.

All oily effluent drains should be separately routed and connected to separate pit.

- h) For the isolation and check valves located on the main steam, hot reheat, cold reheat L.P. bypass and extraction lines, suitable line drains shall be provided just upstream and downstream of each of these valves. No drain is needed at the downstream of L.P. bypass isolation valve. Each of these drains shall be independently led to the condenser with branching off to atmosphere.

Line drains from MS, HR, CR, L.P. bypass & high pressure (above 40 Kg/Sq.Cm.) extraction lines shall be provided with double isolation valves in series for each branch - each located at the two extreme ties of the line drain route. The valve near the condenser should be motorised one. The balance line drains shall be provided with only one isolation valve for each branch.

- i) Bolts, nuts, washers, temporary and permanent gaskets, fasteners as required for interconnecting piping, valves & fittings as well as for terminal points.
- j) Complete insulation material for piping, valves, specialties & auxiliary equipment specified in this specification and as called for in the specification for thermal insulation.
- k) Painting of all piping, valves & specialties at site.

4.01.02 Bidder shall furnish his own layout and technical details of piping, valves, specialties and accessories along with his offer.

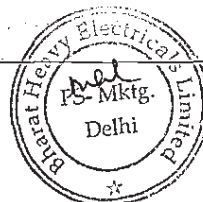
Following general requirements shall however be provided :

- a) Instrument Connections

The following instrument tapings shall be provided :

- i) Pressure Tappings

The Contractor shall furnish stubs and root valves for all gauge, transmitter and pressure test connections as required. The number of root valve for each connection shall be two (2) for system design pressure equal to or greater than 40 KG/Sq.cm.g.



ii) Temperature Tappings

The Contractor shall supply all stubs and mount the thermowells.

iii) Flow Measurement Tappings

The Contractor shall provide stubs and root valves similar to the above for all differential pressure taps at flow nozzle and orifice plate installations.

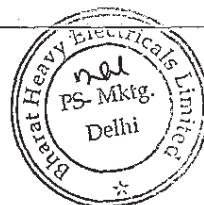
- b) Pipe stubs and blanking plates required for chemical cleaning and hydro testing.
- c) Flanges, spool pieces, gaskets, ring joints, jointing materials, aluminium and stainless steel forged marking plate and temporary piping for steam blowing.
- d) Drain/drip pockets on steam piping as per stipulation of ASME, TDP Vol.-I and general requirement.
- e) Expansion marker for high temperature steam lines.
- f) Fine threaded Radiography holes with stubs and suitable matching plugs, which shall be finally seal welded for piping, more than 25 mm nominal thickness.

For conducting performance test of Turbo-Generator and Boiler, the required pressure, temperature, flow measurement points shall be provided.

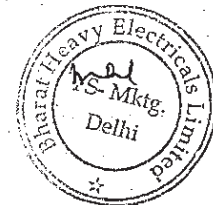
- g) Provision for creep measurement on the piping operating in creep region viz. main steam and hot reheat.

- 4.01.03 Electrodes and filler wires required for stainless steel and alloy steel welding during shop fabrication at works and erection/installation at site.
- 4.01.04 All temporary pipes and accessories, supporting arrangement for cleaning, flushing and steam blowing of the main steam, cold reheat and hot reheat piping including HP/LP by pass piping and auxiliary steam piping.
- 4.02.00 **Scope of Services**
- 4.02.01 The Contractor shall design the piping system and perform necessary stress analysis of all piping and dynamic analysis as necessary.
- 4.02.02 For stress analysis purpose, individual piping systems shall be considered. All anchors are to be designed, supplied and erected by the Contractor.
- 4.02.03 Stress analysis and hanger selection for all piping including piping attachment for hangers/supports, all auxiliary supporting structures are included in the scope of the Contractor.

- 4.02.04 The Contractor shall submit the design calculations for pipe sizing, thickness with specified diameters of pipes and stress analysis data to Owner/Engineer for review/reference/records. Pressure drop calculation for main steam, cold reheat and hot reheat piping to be submitted by the Contractor to show the adequacy pipe sizes.
- 4.02.05 Preparation of detailed fabrication drawings (isometric) of shop fabricated piping which are of size 50 mm NB and above should be based on the "Released for Construction" drawings.
- "As built" drawings of the power cycle piping layout shall also be prepared by the Contractor based on any layout modifications made at site over "Released For Construction Drawings".
- 4.02.06 The Contractor shall design and detail all piping supports including restraints, guides, stops, snubbers, dampers etc. based on the final stress analysis and hanger load data. The Contractor's design of all supports shall be submitted to the Engineer for review.
- 4.02.07 The Contractor shall furnish separate sketches for each support, restraint, anchor, snubber, dampers etc. These sketches shall include the location with reference to column co-ordinates, identification number, bill of material, design loads, operating load, spring stiffness, amount of spring pre-compression, etc. and method of attachment to the pipe and steel structure.
- 4.02.08 In order to ensure that all piping, supporting elements, anchors and restraints have been installed and adjusted in accordance with the drawings and other written instructions of the Contractor, the hangers associated with the main steam, hot reheat, cold reheat, HP & LP by-pass, feed water, auxiliary steam piping etc. shall be inspected as follows :
- After hydro test, with the piping in the cold position, with all travel stops removed, with the pipe completely insulated and in all respects ready for start-up.
 - Piping in the hot position, with the unit operating at maximum load.
 - Piping in the hot position after 6 months of operation.
 - Piping in the cold position during first complete shutdown after at least 6 months of operation.
- The contractor shall depute his personnel for this purpose to site if the plant is officially handed over to the owner before such inspection after 6 months of operation.
- 4.02.09 At the time of each inspection, the Contractor shall determine the necessity for revision, adjustment or replacement of pipe supporting elements, restraints and anchors. Any changes proposed shall be incorporated by the Contractor after Owner/Engineer's concurrence.
- 4.02.10 All shop tests satisfying the requirements of Indian Boiler Regulations (IBR), ANSI standards, the standards enumerated herein and/or as specified.

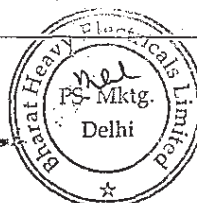


- 4.02.11 Furnishing drawings, data, design calculations, stress analysis results.
- 4.02.12 Furnishing certified copies of test results for all tests and examinations specified in the specification and for the mandatory tests and analysis required by the ASTM material specification, for the materials used for piping and the pressure parts of the valves.
- 4.02.13 Obtaining approval from Chief Inspector of Boilers as per Indian Boiler Act, including the following :
- a) For all pipelines coming under the purview of Indian Boiler Regulations (IBR) necessary approval of the design and layout drawings shall be obtained from the Chief Inspector of Boilers, and furnished to the Purchaser/Engineer. Necessary certificates of design, manufacture and tests in specified Form of IBR, for each fabricated pipe with proper identification shall be submitted.
 - b) For fittings & specialties, viz. valves, flanges, traps & other specialties, etc. of all pipelines coming under the purview of IBR, Certificate of design, manufacture and tests in specified Form of IBR with appropriate identification shall be furnished to the Owner/ Engineer.
 - c) Erection & testing of the pipe lines coming under the purview of IBR shall meet all the requirements of IBR and certificate of manufacture & tests in specified Form of IBR, for each of the erected pipe lines shall be submitted to the Purchaser/ Engineer prior to the application of insulation and/or flushing the line before commissioning
- 4.02.14 Steam blowing or chemical cleaning of piping systems, as specified elsewhere in the specification, after complete erection is to be carried out, which also includes supply, erection and dismantling of temporary piping, valves and fittings.
- 4.03.00 Omission of specific reference to any item or material or work which is necessary for completion of the piping systems, shall not relieve the bidder of the responsibility of furnishing all material and services for a complete installation satisfying the operational and other requirements stated in the specifications.
- 4.04.00 Drawing indicating the layout of pipe work shall be prepared in line with the flow diagrams and shall be provided as part of the Contract. These drawings shall indicate the position of all supports, guides, restraints and anchors; all drain and vent connections and the position of all pipes. All piping systems shall be arranged to allow adequate falls in the direction of flow, except where otherwise approved by the Engineer. At the points of drainage, drain pockets of ample size and approved construction shall be fitted as per details indicated in the enclosed drawings.

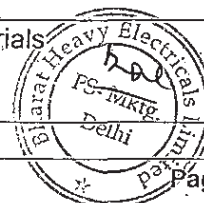


5.00.00 SPECIFIC DESIGN CRITERIA

Sl. No.	Item	Criteria
1.00	Design, fabrication & Erection	
1.01	Design, fabrication, testing & erection of Power Cycle Piping, valves & specialties for critical piping system under purview of IBR, as specified.	To satisfy IBR, ANSI/ ASME B31.1 latest code.
1.02	Design, fabrication, testing & erection of Power cycle piping, valves & specialties for non-critical piping system, which are not purview of IBR, as specified.	To satisfy ANSI/ASME B31.1 latest code.
1.03	Design of safety valve installation.	To conform with the Non-mandatory rules for the design of safety valve installation of ANSI/ASME B31.1. Open discharge installation preferred.
2.00	Piping Flexibility Analysis	
2.01	Piping to be analysed	All piping having sizes equal to or above 50 mm NB & design temperature 100 Deg.C and more.
2.02	Code to be followed	ANSI/ASME B31.1 latest & also satisfying IBR latest.
2.03	Loading conditions to be considered Note: Contractor shall justify with reasoning in case any one of the specified loads is not considered in analysis.	a) Internal pressure b) Thermal loads due : i) Piping thermal expansion ii) Anchor displacement due to thermal movements of piping anchors. c) Piping weight consisting of weight of piping, valves, bends, fittings, insulation etc. as well as weight of support components like clamps, shoes, suspension rods, trapeze etc. & weight of contained fluid. d) Test or cleaning fluid load. e) Equivalent static loads due to discharge of safety valve (SV), Electromatic relief valve (ERV), simultaneous discharge of SV & ERV where applicable. f) Dynamic load due to steam hammer (if applicable). g) Seismic loads due : i) Equivalent static load due to seismic inertia effect. ii) Equivalent static load due to seismic anchor displacement. h) Wind load where applicable.



Sl. No.	Item	Criteria
2.04	Loading Combinations Note: Contractor shall clearly indicate the basis of his judicious selection or loading combination for support, restraints and anchor design.	Design load for supports, restraints, anchors & supporting structures shall be obtained by proper selection of one or combination of two or more of the loads as per item 2.03 above based on the possibility of independent or simultaneous occurrence. Component of thermal expansion reaction range expected to appear at cold condition, as per Equation 9 & 10 of ANSI/ ASME B31.1 shall be considered in loading combinations. An overload factor of 1.30 shall be considered over the computed loads except occasional loads before combining them.
2.05	Combination of Stresses	The computed stress under different loading conditions shall be combined as per Equation 11, 12 & 13 of ANSI/ASME B31.1 & the stress shall be within allowable limits.
2.06	Allowable Stress Values	For piping materials other than ASME/ ASTM materials, values shall be derived as per the criteria defined in Appendix-P of ASME Boiler & Pressure Vessel Code, Section-VIII, Division 1 while computing pipe wall thickness, and flexibility analysis shall be conducted as per ANSI/ASME B31.1. However higher pipe wall thickness derived between IBR regulation & ANSI/ASME B31.1 code shall be considered.
2.07	Factor to be considered in flexibility analysis	a) Contractor shall consider value of stress range reduction factor "F" for cyclic conditions due to temperature reversals equal to ONE. b) Stress intensification factors at all transitions, fittings & all branches as per ANSI/ASME B31.1. c) Variation in supporting effort by variable spring due to pipe movements.
2.08	Piping layout	Flexibility analysis of Piping is to be conducted as per the offered piping layout. In case any modification of piping layout is felt essential to maintain stresses & terminal reactions within allowable ranges, same are to be carried out by the Contractor after discussion with Owner.
3.00	Design Pressure & Temperature	As per IBR. Wherever not clearly stipulated in IBR, criteria stipulated in ASME/ ANSI 31.1 for selecting design pressure & temperature shall be followed.
4.00	Material of construction of piping, valves & specialties	ASME/ASTM materials



Sl. No.	Item	Criteria
5.00	Hangers, supports etc.	
5.01	Type	<p>a) Variable spring :</p> <p>i) Where the variation in supporting effort between hot and cold condition does not exceed 20% of the load, which is higher of the operating condition, and cold setting load.</p> <p>ii) The resulting effect of load take-up/release by a group of hangers in a span does not overstress the piping span or cause overloading at equipment terminals.</p> <p>iii) Thermal deflection between hot & cold conditions does not exceed 40 mm.</p>
		b) Constant load - For thermal deflection between hot and cold conditions exceeding 40 mm. and or, for above variation beyond 20%
		c) Spring hangers should not be loaded more than 80% of the spring travel range.
		d) Rigid hangers & restraints - To be judiciously selected, without exceeding the stipulated limits of terminal forces & moments & stress level. Struts shall be considered where compressive load is expected.
		e) Snubbers, dampers etc. - To take seismic/dynamic loads, thrust due to safety valve discharge. Effort shall be made to limit its use by judicious placement of rigid hangers.
		f) Bottom support spring hangers to be avoided as far as possible.
5.02	Design, materials, fabrication testing and erection of hangers, supports, anchors, guides etc.	a) As per ANSI/ASME B31.1 latest code.
		b) Hanger suspension rods, tie-rods/struts should have proper arrangement & adequate length, so that thermal movements in direction which are free are not constrained and should not make an angle more than 4 degrees with vertical due to horizontal pipe movements.

Note : In case turbine steam stop valve is not anchored, steam hammer analysis of the main steam & HP/LP By-pass pipe line on stop valve closing shall be carried out.

6.00.00 DESIGN AND CONSTRUCTION

6.01.00 General Considerations

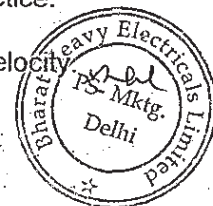
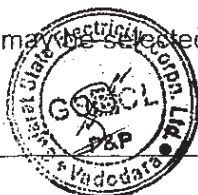
6.01.01 Pipe sizing and piping system design shall conform to the requirements of power piping code ANSI B31.1. Statutory requirements as laid down in Indian Boiler Regulations (latest edition) will also be taken care in pipe system designs. Pipe wall thickness as calculated by ANSI Code formula will also be checked for IBR requirements for piping systems falling under IBR purview.

6.01.02 Inside diameters of piping shall first be calculated for the flow requirement of various systems. The velocity limits for calculating the inside diameters are listed below :

- | | | |
|----|------------------------------------|--|
| a) | Main Steam hot & cold reheat pipes | 75 m/sec. |
| b) | Auxiliary steam | 40-50 m/sec. |
| c) | Feed Water | |
| | i) Suction | 2.0 m/sec. |
| | ii) Discharge | 6.0 m/sec. |
| d) | HP bypass | |
| | i) Upstream | 75 m/sec. |
| | ii) Downstream | 150 m/sec. |
| e) | LP bypass | |
| | i) Upstream | 75 m/sec. |
| | ii) Downstream | 150 m/sec. |
| f) | Extraction steam | |
| | i) Superheated steam | 60 m/sec. |
| | ii) Saturated steam | 30 m/sec. |
| g) | Condensate | |
| | i) Discharge | 5.0 m/sec. |
| | ii) Suction | 1.5 m/sec. |
| h) | Heater Drains: | 1.5 m/sec |
| i) | Heater Vents: | 25 m/sec |
| j) | Other piping | As per good proven engineering practice. |

Note: This standard sets the maximum limits of the flow velocity

Lower velocities may be selected if found necessary.



Inside diameters thus calculated shall be checked for allowable pressure drop for various systems. Pressure drop in main steam line shall not be more than 90% of the pressure differential between superheater outlet header and HP turbine inlet valves at BMCR. Similarly, combined pressure drop in cold and hot reheat piping will not exceed 90% of the available pressure differential between HP turbine exhaust and LP turbine inlet valves minus the reheater drop. The available pressure differential in the complete reheat line from HPT exhaust to IPT inlet shall not be more than 10% of the pressure at HPT exhaust. Wherever possible 5D/6D radius bends will be used to minimise the pressure drop in the main steam, cold & hot reheat piping systems.

Pipes shall be sized for the worst (i.e. maximum flow, temperature and pressure values) operating condition. In case of BFP suction pipe sizing "transient analysis" shall be carried out for optimum sizing of the system in order to establish the pipe inside dia for minimum pressure drop in system to match with the pump NPSH requirements under worst operating conditions. The Boiler Feed Discharge pipe-work shall be designed for the maximum final feed water temperature down-stream of H.P. heaters and the maximum closed valve pressure of the boiler feed pump in the following two cases, whichever gives a higher pressure.

- a) Temperature of water from deaerator
- b) Deaerator storage tank working at its maximum possible pressure with saturated water.

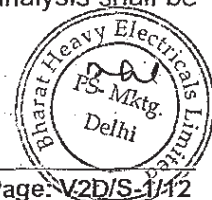
In addition to this the rest of the design basis shall be same as for other water services described above.

- 6.01.03 Thickness calculations shall be made on the basis of procedure and formula given in ANSI B31.1. Stress values of piping material for calculation shall be selected from tables given in ANSI B31.1. Thickness, thus calculated shall be checked as per the formula of IBR and the more stringent of the two shall then be selected. If it is seen that sizes arrived at for main steam, hot reheat and boiler feed pumps discharge pipes are not in the standard range of the manufacturers, ID controlled piping, shall then be selected for these piping systems.
- 6.01.04 No pipe work shall be run in trenches carrying electrical cables.
- 6.01.05 Pipes shall not be less than 20 mm bore unless authorised by the Engineer.
- 6.01.06 Site fabricated pipes shall be installed only where they do not exceed 50 mm. bore and where their use has been approved in writing and shown on a scale drawing.
- 6.01.07 All piping shall be identified by means of colour strips and by adequate lettering, conveniently spaced and located. Identification colours and lettering shall be as approved.
- 6.01.08 Air release and drain branches shall be provided wherever necessary depending upon the layout and arranged so that the drains and air release valves are located for easy operation.

- 6.01.09 All valved drains in vacuum services shall be provided with screwed cap.
- 6.02.00 **Stress and Flexibility Analysis**
- 6.02.01 Overall procedure of stress & flexibility analysis shall be as per latest revision of ANSI B31.1/IBR and according to material used.
- 6.02.02 Complete and comprehensive stress and flexibility analysis of the piping shall be done by computer using an approved standard programme.
- 6.02.03 All piping of design temperature exceeding 100 Deg.C and nominal size equal to or above 50 mm except otherwise mentioned in Specific Design Criteria shall be stress analysed considering the effects stipulated therein.
- 6.02.04 The method of analysis due to seismic effects on static equivalent basis shall be submitted to Owner for approval prior to start of the analysis.
- 6.02.05 Stresses in pipes and fittings due to the above effects shall be limited to level prescribed by IBR wherever applicable. Other stress criteria not prescribed by IBR shall be guided by ANSI B31.1. Suitable stress intensification factors shall be assumed. Allowable stresses shall be computed by methods prescribed by IBR wherever applicable. However, such allowable stresses shall not be more than those prescribed by the relevant codes/standards.
- 6.02.06 The results of stress analysis shall be submitted for approval by Engineer before start of Fabrication or Erection clearly confirming the following :
- a) The terminal forces and moments are within permissible limit.
 - b) Forces and moments on supports, anchors and restraints attached to building/supporting structures are within permissible limit.
 - c) Stresses on piping are within acceptable limit stipulated in the applicable codes.
 - d) Pipe movements are acceptable for the spacing in between adjacent pipes and between pipes and adjacent structures/ equipment etc.
 - e) Stress checking for occasional loading.
 - f) All other stress/flexibility checking as stipulated in IBR/ American codes whichever is stringent.

Above stress analysis results shall be used for checking the piping design.

- 6.02.07 The finalised flexibility analysis in the form of a report indicating procedure of analysis, pipe sizing based on specified diameter, spring hanger summary, design load charts for Anchors. Restraints and hanger supporting structures delineating different loading conditions, stress charts, loading on terminal anchors, along with isometric drawings of piping for flexibility analysis shall be submitted to Purchaser for review.



6.02.08 All high temperature lines shall be provided with expansion markers with scales at certain hanger locations, as decided by the Engineer. The Contractor shall guarantee and prove during trial run, after a few cycles of operation that the range of thermal movements in three directions from cold to hot condition at the expansion marker locations are within $\pm 20\%$ of the calculated values.

If the error exceeds the above limit, necessary adjustments and rectifications shall be carried out by him at no extra cost, till the above requirement is fulfilled.

6.03.00 **Material Specification**

6.03.01 Material for pipes and fittings shall be as stipulated in Annexure-I enclosed. Bidder may note that ASTM materials have been considered for Main Steam, Hot reheat, Cold reheat, HP & LP bypass pipings and all the tendering information in the specification for such pipes have been given based on this material of piping. In case bidder wants to offer alternative piping material, same may be accepted by the Purchaser depending on the merits of alternative material. In that case pipe stress analysis, hanger selection etc. for such pipings are to be carried out by the Contractor accordingly.

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

6.03.03 For rubber lined pipe, lining should be applied in three (3) layers, giving a total thickness not less than 4.5 mm.

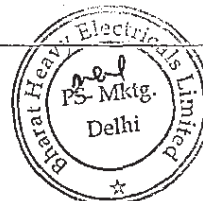
6.04.00 **Fabrication**

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

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

Unless otherwise specified, for all welded lines with pressure above 7 kg./sq. cmg. and/or temperature above 200 Deg.C branch connections for branch sizes up to 25% of welded mains shall be made with special forged steel welded fittings.

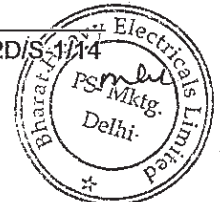
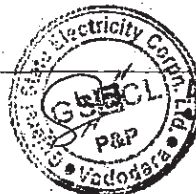
6.04.01 The piping systems shall be constructed in accordance with the requirements of ANSI B31.1. The requirements of IBR 1950 (with latest amendments) shall be complied with for the piping systems, which are under the purview of IBR.



- 6.04.02 Piping shall be fabricated in the shop in the largest transportable sections to minimise the number of field weld joints. The choice of field weld joints locations shall be based on the traverse of the pipe through walls, floors, sleeves or other restrictive areas. Support attachments for major piping shall be done at shop.
- 6.04.03 All workmanship shall be carried out using methods and procedures of best recognised pipe fabrication practice and must be done in a good and workman like manner in accordance with latest revisions. ANSI standards, ASME Codes, PFI standards and IBR as applicable.
- 6.04.04 All high-pressure steam valves and accessories shall have welded connections.
- 6.04.05 Mitred bends and elbows will not be accepted unless otherwise specified. Only forged tees, 90 Deg. elbows and 45 Deg. elbows are acceptable. In case the Bidder wants to deviate from this requirement on the ground of non-availability of such forged items, he may submit his alternative offer for Owner's consideration with sufficient documents to justify the same. In such a case the concerned fittings shall be manufactured with necessary reinforcing pads, bend thinning allowance etc. to satisfy code requirements.
- 6.04.06 All pipes bends shall be made true to angle with no negative tolerance and shall have a smooth surface free of flat spots, crease and corrugations.
- A cross section through any bend portion of the pipe shall be true in diameter. All pipe bends shall have a radius of not less than 3 times the nominal pipe size unless otherwise mentioned. Pipe bends shall be made from straight pipe pieces of sufficiently higher thickness so that after thinning, the minimum thickness of bends shall not be less than the minimum thickness required for the straight pipe. Thinning allowance shall be considered as per ANSI B 31.1. The ends of pipe and welded fittings shall be bevelled according to details shown in the relevant piping codes.
- 6.04.07 Pipes of size 65 mm NB and above shall be shop fabricated and of size 50 mm-NB and below shall be field run.
- 6.04.08 All welding shall be made in such a manner that complete fusion and penetration are obtained without any excessive amount of filler metal beyond root area. The reinforcement shall be applied in such a manner that it shall have a smooth contour merging gradually with the surface of adjacent pipe and welded fittings. Backing rings shall not be used on any pipe welds, unless otherwise approved by the Engineer.

Pipe and attachments shall be properly aligned prior to welding. If tack welds are used the tacks shall be either fused into the first layer of weld or else chipped out.

All welding for steam and feed pipe work shall be electrical welding using the shielded arc process and electrodes in accordance with the relevant code. For pipes up to and including 100 mm. bore, provided the pipe does not exceed 12.7 mm. in thickness, gas welded butt joints will be accepted without backing rings.



Welded joints in pipe work shall be pre-heated to a temperature as required by the agreed standard or code or to the approval of the Engineer. The temperature shall be maintained during the welding operation and a record of metal temperature shall be obtained by means of a recording thermometer throughout the welding operation.

All welds shall be built-up by the application of multiple layers or passes. The thickness of metal applied for each layer or pass shall not exceed 3 mm. Each layer shall be cleaned and lightly peened before the next layer is applied.

Before being assigned to welding work, each operator shall have passed a qualification test as prescribed in the applicable Code/ Regulations. Each approved welder shall have an identification number which shall be indicated on all welds.

6.04.09 Welded joints shall be stress relieved as per ANSI B31.1/IBR. Stress relieving temperature shall be measured by thermocouple pyrometers or other suitable equipment. Readings of temperature against time shall be recorded.

6.05.00 **Welding**

6.05.01 **General**

Full scale joints preparation sketches (to be included with the welding procedure) shall show all dimensions including tolerances for bevel angle, land size and off-set and root gap. Adequate copies of detailed welding procedure for approval of IBR shall be furnished.

6.05.02 **Cutting and Bevelling**

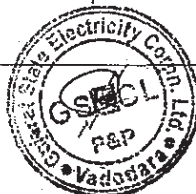
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|----|---------------------|---|--|
| a) | Carbon steel piping | : | End preparation for butt welding shall be done by machining/flame cutting. |
| b) | Chrom-Moly steel | : | End preparation for butt welding shall be done by machining. |
| c) | Socket welding | : | Socket weld end preparation shall be done by saw or machine cutting. |

6.05.03 **Welding Electrodes and Rods**

All special welding electrodes and filler wires to be supplied and used for the work under this specification shall be of reputed make, approved/tested quality with valid test certificate and shall have proven performance record for similar application. Approval of the Owner as well as IBR should be sought in selection of the electrodes for specific uses.

The certificate of electrode shall incorporate all the chemical and physical test data and tests witnessed by a representative of the Inspecting Authority recognised under IBR.

- 6.06.00 Hangers, Supports, Anchors and Restraints
- 6.06.01 Hangers and supports shall be capable of carrying the sum of all concurrently acting loads.
- 6.06.02 All the hangers/supports shall be of reputed make, approved/tested quality and shall have proven performance record for similar application. They shall be designed to provide the required supporting efforts and allow pipeline movement with thermal changes without causing overstress. The design shall also prevent complete release of the piping load in the event of spring failure or misalignment and all parts of supporting equipment shall be fabricated and assembled so that they will not be disengaged due to movement of the supported piping. Necessary guides, anchors, braces and structural steel to be attached to building/boiler structure as well as any braces and/or dampeners required to eliminate piping vibration and seismic loading shall be provided.
- 6.06.03 In general piping shall be supported in such a manner to maintain drainage slopes, prevent interference with structure and piping and keep flexible supports in proper adjustment so that they will move within their design operating ranges. Normally pipe supports and anchors shall be selected at those points in the building where provision has been made for the loads imposed. The cutting of floor/roof beams or the reinforcement in slabs will not be permitted. Piping attached to a plant item shall be supported in such a way that the weight of the piping is not taken by the plant item.
- Support spacing shall be as per good engineering practice. However, in no case it shall be less than support spacing stipulated in ANSI B31.1.
- 6.06.04 The design of the pipe supports and hangers and their locations shall be guided by the following general principles:
- Criteria of loading shall be as per "Specific Design Criteria" enclosed.
 - Design loads for anchors, restraints, hanger supporting structures shall be as per the criteria stipulated in "Specific Design Criteria".
 - Supports shall be adequate for extra loading due to hydrostatic tests and when piping system is full of water during chemical cleaning.
 - Supports for relief valve stacks shall be adequate for both the pipe weight and the thrust developed when the valve is open.
 - There should not be any interference of the hangers with other piping, pipe supports, cable trays structure, equipment etc.
 - Besides vibration elimination, hangers shall ensure that the amplitude of oscillations in the pipe work owing to shock and vibration due to variation of fluid flow from zero to full capacity remains within approved limits.
- 6.06.05 Attempts shall be made to use variable spring and rigid hangers as much as possible. Rigid hangers shall preferably be used where vertical movement of the pipe is negligible.



Variable spring supports/hangers may be used provided the following conditions are met.

- a) The variation in supporting effort between hot and cold condition does not exceed 20% of the load, which is higher of the operating condition, and cold setting load.
- b) The resulting effect of load take-up/release by a group of hangers in a span does not overstress the piping span or cause overloading at equipment terminals.
- c) Thermal deflection between hot and cold conditions does not exceed 40 mm.

Otherwise, constant load type support/hangers must be used. On the other hand rigid hangers can be used where possible without exceeding the stipulated limits of terminal forces and moments and the stress subject to the Purchaser/Consultant's approval.

An exception may be made in the instance where the piping movement occurs at a hanger supporting a portion of a piping riser on which rigid support is also located. In this case, variable spring hangers may be used for any amount of expansion up to the full recommended working range of the spring, provided the change in the supporting effect of the variable spring is added to the design load of the rigid support assembly. However, the acceptance of such a system will be at Purchaser's/Consultant's discretion.

- 6.06.06 All design and fabrication including loading and allowable stresses shall be in accordance with ANSI B31.1. Note shall be taken of the requirements against earthquake at site. Hangers and supports for systems shall be completely engineered and prefabricated for all piping 50 mm. and above. Sufficient random materials shall be furnished for field support of all lines of smaller diameter.
- 6.06.07 For pipes of design temperature 100 Deg.C. and more, bottom supports shall be avoided as far as possible and hanger type supports shall only be used. However, where bottom support cannot be avoided, the same shall be provided with suitable shoes along with balls/rollers/rockers to minimise frictional resistance against thermal movements. The material of shoe as well as the ball/rockers/rollers shall be suitable for the design temperature of the supported pipe and shall be of sufficient hardness so as to permit a reasonably long life keeping its roundness and maintaining a low friction factor. Where a constant load type support is required, the bottom support shall also be of constant load type.
- 6.06.08 Where stress analysis calculations are performed, the location of anchors, guides and restraints shall be based on the results of the final stress analysis. Such anchors, guides and restraints shall be designed for the maximum forces and moments encountered. Spring hangers shall be selected to allow the movements determined by the stress analysis.
- 6.06.09 The Contractor shall design and provide all supplementary steel required to properly secure and support all pipe supports, guided restraints, anchors, shock absorbers, etc. furnished. Purchaser shall provide only the main steel work or, embedded plates in the concrete.

- 6.06.10 Accurate weight balance calculations shall be made to determine the required supporting force at each hanger location and the pipe weight load at each equipment connection.
- 6.06.11 Provision shall be made for support of piping, which may be disconnected during maintenance work.
- 6.06.12 Supports shall be designed to prevent transfer of excessive loads from support to support or to equipment as the line expands or contracts. Support components shall be attached in places where they will not damage other construction either during or after installation. Cantilever type support shall not be taken from brick wall. Brackets may be used where piping is adjacent to vertical surfaces, suitable for support use, these shall be supported from columns/RCC structures.
- 6.06.13 All large pipes and all long pipes shall have at least two supports each arranged so that any length of pipe or valve may be removed without any additional supports being required.
- 6.06.14 Support steel shall be of structural quality. Perforated strap, wire or chain shall not be used. Support components shall be connected to support steel by welding, by bolting or by beam clamps. Boltholes shall be drilled, not burned. Support components may be bolted to concrete using approved concrete anchors.
- 6.06.15 Double nuts or lock-nuts shall be used on hanger rods and bolts in all cases.
- 6.06.16 Variable springs shall be furnished with travel stops. The travel stops shall be factory installed at the "cold" position.
- 6.06.17 Spring hangers should not be loaded more than 80% of the spring travel range.
- 6.06.18 Both constant load and variable spring support/hanger shall be provided with outside indicators for deflection and load. Provision for the site adjustment of load at least $\pm 10\%$ shall be incorporated. Also spring locking arrangement and turnbuckles of load/position adjustment shall be provided for all hangers.
- 6.06.19 Constant load type spring support/hangers shall be so selected as to permit, for the specific load, an over-travel of at least 25 mm or 20% (whichever is greater) of the specified range of vertical travel. The initial setting of the hangers/supports shall be such that half of the "over-travel" is allowed in either direction. Constant support hangers shall have a support variation of no more than 6% throughout the total travel range.
- 6.06.20 Rigid support shall be designed with adequate margins of safety so that variations in load distribution on them are of little consequence. All rigid hangers shall be provided with means for vertical adjustment after erection.
- 6.06.21 Where the piping system is subject to shock loads, such as thrust imposed by the actuation of safety valves (SV), hanger design shall include provision for shock absorbing devices of approved design.

Vertical restraints near safety valves shall be preferred for taking SV discharge thrust, provided equipment terminal reactions remains within allowable limit.

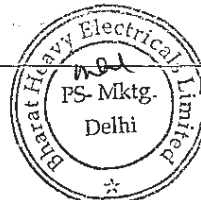
Attempts shall be made to avoid use of shock absorbers, dampers etc. as far as possible to take care of occasional loading like seismic effect etc. by proper engineering of the piping design and effective use of restraints. However, shock absorbers, VISCO- dampers, wherever felt necessary are to be supplied and erected by the bidder.

- 6.06.22 Layout of piping shall be properly designed to avoid excessive vibration by effective use of restraints. However, wherever felt necessary, shock absorbers, VISCO-dampers shall be supplied and erected by the bidder.
- 6.06.23 Hanger rods (except Rigid hangers where both tension and compression may occur) shall be subjected to tensile loading only. At hanger locations where lateral movement is anticipated, suitable linkage and rocking washers shall be provided to permit swing.
- 6.06.24 For all hangers, the length of suspension shall be so selected that the hanger rod may never make an angle of more than 4 Deg. with vertical due to horizontal pipe movements. If this cannot be avoided by erecting the hanger vertically for cold condition, it shall be suitably off set so that the above requirement is fulfilled in cold as well as hot conditions. Hangers shall be designed so that they cannot become disengaged by movements of the supported pipe.
- 6.06.25 Supports, guides and anchors shall be so designed that excess heat will not be transmitted to the building steel.
- 6.06.26 Tie rods/struts shall preferably be used for restraints to achieve low friction restraining.

The Tie-rods/struts shall have proper arrangement and adequate length, so that, thermal movements in other directions, which are intended to be free are not constrained and there is no appreciable shift in centreline of pipe or the elevation of the supporting point on pipe due to sway. The design shall have provisions for adjusting the length to take up any slack and securely locking in position permanently once adjustment is done.

- 6.06.27 All relevant hangers shall be designed to take the dynamic movements for dynamic loading in addition to the thermal movements.
- 6.07.00 **Valves and Accessories**
- 6.07.01 **General Requirements**

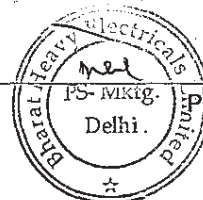
- a) All valves shall be of approved make and type and shall have cast/ forged steel bodies with covers and glands of approved construction. The valves shall be provided with electric motors/solenoids and actuators as required.



- b) Valves and specialties to be supplied shall be used for various steam and water services of the power cycle system and shall be located indoor/ outdoor and on horizontal/vertical runs of the pipe lines. However, locating the valves on vertical runs should be avoided as far as possible.
- c) All valves shall, unless otherwise approved, have ends prepared for butt-welding and the internal diameter shall be the same as the internal diameter of the pipes to be joined. Where valves are accepted with flanges, they shall comply with the requirements of the approved Code of Practice for the respective pressure and temperature conditions of the piping system.
- d) All valves shall receive tests at Manufacturer's or Contractor's works in accordance with the specific requirements of the approved Codes of Practice so that the same is acceptable to IBR where applicable. Valves shall be rising stem or otherwise as approved by the Purchaser.
- e) Gate valves have been specified with the intention of achieving isolation and tight shut-off. In full open condition, these valves should offer minimum of resistance to fluid flow.
- f) Globe valves have been specified with the intention of achieving good control of fluid passing. The plug and seat will have therefore suitable profiles for obtaining such controlling action.
- g) Check valves have been specified in order to prevent reverse flow through them.
- h) Steam traps with strainers will be used in the drain lines from various steam pipes such that only condensed steam can be drained.
- i) All valves shall function smoothly without sticking, rubbing or vibration on opening or closing.
- j) Material, design, manufacture, testing etc. for all valves and specialties along with the accessories shall conform to the latest editions of codes as specified or approved equivalent and acceptable to IBR.
- k) By-pass valves shall be provided for high pressure and larger size valves as per standards followed and as felt necessary for smooth and easy operation, even though not specifically mentioned in the specification.
- l) Motor operated valves shall be designed as specified hereinafter.
- m) Valves subjected to vacuum shall have sufficient long deep-seated packing. Valves in general shall preferably be of such design as to permit repacking while in service by providing back-seating arrangement duly tested during manufacture.



- n) All flanged valves and specialties shall be provided with two (2) counter flanges, bolts, nuts, washers, gaskets etc.
- o) Valves and specialties along with counter flanges coming under the purview of IBR shall meet all the requirements of IBR duly approved by the Purchaser.
- p) For pneumatically actuated valve, if any, the Bidder shall provide necessary instrument air connection near the valve. All accessories including solenoid valves etc. as necessary for the actuation of this valve shall be supplied.
- q) For all sizes below 50 mm, socket welded end valves may be used.
- r) All valves shall have outside screwed spindles and screwed thread of spindle shall not pass through or into the stuffing box. Where valves are exposed to the weather, protective covers shall be provided for the spindles, which shall be subject to approval.
- s) Valves requiring sealing water shall be adequately deep and shall be equipped with lantern ring to admit pressurised water for gland-sealing. Gland sealing water shall be tapped from one tapping point on the condensate extraction pumps discharge header and shall be reduced in pressure as per the requirement.
- t) The stops which limit the travel of any valve in the "Open" or "Shut" position shall be arranged exterior to the valve body.
- u) All regulating valves shall be designed to prevent erosion of the valve plugs and seats when the valves are operated partially opened. The valves shall have contoured plug.
- v) Approved access arrangements shall be provided for all valves and particular attention shall be given to those valves fitted with gearing, which require lubrication of the valve itself.
- w) Valves which cannot be operated from the floor or walkways shall be provided with suitable extension rods and linkages. If such a valve is provided with integral bypass then similar arrangement shall be done for the bypass valve also. The extension shall be such that the hand wheel is at a height of approximately one metre above the level of the floor or platform from which the valve is to be operated. Where required they shall be provided with head-stocks and pedestals of rigid construction and where gears or level wheels are used these shall be of cast steel or suitable quality cast iron with machine cut teeth. Where extension spindles are fitted, all thrust when opening or closing the valves shall be taken directly on the valve body. The extension linkage shall be so designed to take care of the thermal movements of the valve body with the pipe on which the valve is installed. The connection of the extension spindle to the valve stem shall be through a flexible coupling.

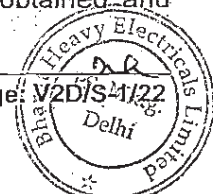


The extension spindle shall be of the same materials as that of the valve stem. The floor stands shall have column, not less than Group-B of ASTM-126. Necessary nuts and bolts for mounting the floor stands on foundation shall have to be provided. Adequate means of easy lubrication shall have to be provided for valves and operating extension components.

- x) Stems shall preferably be arranged vertically with gland at the top, however, in no circumstances must the stem be inclined downward from horizontal or gland be at the bottom. Globe valves shall be installed with the pressure under the disc. Valves shall not be fitted in inverted position.
- y) Where necessary, for accessibility, grease nipples shall be fitted at the end of extension piping and where possible these shall be grouped together and mounted on a common panel situated at a convenient position. A separate nipple shall be provided to lubricate each point. The Contractor shall supply the first fill of oil or grease for these parts. The Contractor shall supply a suitable manually operated grease gun for the standard type of nipple provided.
- z) The spindles for all valves for use outside the building shall have weatherproof protection covers of approved construction.
- aa) All valves with nominal size above 50 mm, shall be fitted with indicators so that it may be readily seen whether the valves are open or shut. In the case of those valves fitted with extended spindles, indicators shall be fitted both to the extended spindles and to the valve spindles.

For valves with nominal size of 50 mm and below, indicator is not required for rising stem type valves.

- bb) Plastic or bakelite valve hand wheels will not be accepted.
- cc) All valves shall be closed by rotating the hand wheel in a clockwise direction when looking at the faces of the hand wheel. The face of each hand wheel shall be clearly marked with the words 'Open' and 'Shut' with arrows adjacent to indicate the direction of rotation to which each refers.
- dd) Each valve hand wheel shall be fitted with a circular nameplate of a approved material indicating the valve tag number, duty or service intended and the function of the valve. The nameplates shall incorporate the colour code corresponding to the service of the piping.
- ee) Wherever practicable, heavy valves of total weight including actuator, drive motor, integral by-pass etc., equal to or greater than 500 kg. shall be provided with suitable lugs to permit direct suspension by hanger rods or direct resting on bottom support, as applicable.
- ff) Special attention shall be given to the operating mechanism for large size valves in order that quick and easy operation is obtained and maintenance is kept to a minimum.



- gg) Eyeboits shall be provided where necessary to facilitate handling heavy valves or parts of valves.
- hh) The Bidder shall supply with his bid and in addition during the course of the Contract, comprehensive drawings showing the design of valves, test pressure and working pressure/temperatures. They should include a parts list referring to the various materials used in the valve construction.
- ii) For high temperature application above 600 Deg.F (315 Deg.C), all gate valves shall preferably be of wedge type construction.
- jj) All sampling and root valves shall be of integral body bonnet type.

6.07.02 Design Requirements

- a) Design working pressure and temperature as well as pressure rating of all valves and specialties has been listed in Annexure-II of this Section. Valves and Specialties are to be supplied conforming to specified pressure rating.
- b) Steel body gate valves shall preferably be in accordance with American Petroleum Institute, U.S.A., Standard No.API-600 or other approved international standards.

Carbon steel gate valves in size 50 mm and below shall be in accordance with API-602 or any other approved international standards.

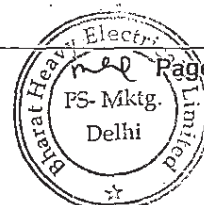
- c) Globe valves shall generally conform to BS-1873 or approved international standards, subject to other requirement specified in the specification.
- d) Check valves shall conform to BS-1868 or approved international standards and shall be of swing check type.

The body seat for swing check valves shall be inclined at such an angle as to minimise chatter.

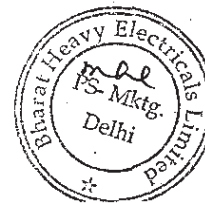
To enable the internal parts to be examined or renewed without removing the valves from the pipeline, the flanged cover should be used. The body shall be stamped with an arrow to indicate the correct flow direction.

- e) Safety Valve

The safety relief valves shall be direct spring loaded type and shall be provided with casing levers. The valves shall be of rugged construction suitable for long periods of uninterrupted service. The safety relief valves shall conform to the requirements of ASME Boiler and pressure vessel code, Section-VIII and IBR as applicable and shall be installed as per recommended rules for the design of safety valve installations in ANSI B31.1.



- f) Motor Operated Valves
- i) Motor operated valves shall be fitted with both hand and motor operating gears and where a by-pass valve is provided this also shall be provided with both hand and motor operated gear and interlocks to ensure that the by-pass valve is opened before the main valve. Each valve shall be complete with a device for automatically stopping the motor when the valve gate has reached the "full open" or "full close" position (with a minimum increase in the torque). The motor shall be placed in such a position relative to the valve that there is no possibility of leakage of liquid, steam or corrosive gas from valve joints on the motor or control equipment.
 - ii) The hand operating and motor operating mechanism shall be so interlocked that the hand operating mechanism is disconnected before the motor is started. Valves shall be provided with seating control and except where specifically approved by the engineer for small valves, a slipping clutch or other torque-limiting device shall be incorporated in the motor drive. The opening or closing the valve shall be controlled by means of push buttons labelled respectively "open" and "stop". The control shall be so arranged that the motor can be stopped with the valve in any position by means of "stop" push button and after having been stopped, can be re-started in either direction by the "open" or "close" push buttons hand operating mechanism shall be placed in an accessible position from the floor.
 - iii) Necessary output signal (4-20 mA) shall be given for provision of positioning indicator in U.C.B.
- g) For reheater isolation, for hydraulic testing as well as wet lay up reheater isolating devices shall be provided on cold reheat and hot reheat lines, at boiler outlet. Isolating device shall consist of a robust cast steel body with carbon steel (ASTM A216 GR WCB) material for cold reheat application and alloy steel (ASTM A 217 GR WC 9) for hot reheat application suitable for pressure and temperature condition which they will be subjected. These shall be of welded type construction and shall form part of the pipeline during normal operation without any leakage. Before hydrostatic test top cover and bonnets are removed and a separate test closure assembly with sealing rings are inserted to close the flow patch. The test closure assembly shall be of disc type construction with appropriate seal and a preloading lever to form a complete tight assembly for effective closure during hydraulic testing. Drains shall be provided on both side of the device to detect leakage.



h) Drain Valves, Steam traps and Strainers

i) Drain Valves

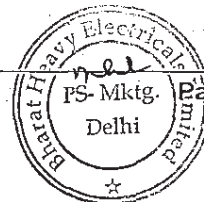
All drain valves shall be of approved type and shall have cast or forged steel bodies with covers and glands of approved construction. Spindles shall be of stainless steel and the materials of internal parts shall be suitable for operation at the maximum working pressure and temperature of the piping to which they are connected. Valves should be full-way type, unless otherwise specified and in full open position the bore of the valve should not be obstructed by any part of the gate. The internal diameter of all valves at the bore and at the ends adjacent to the pipe work shall be similar to the internal diameter of the connecting pipe work. Valves shall be designed for continuous operation in partially open condition without erosion of the valve seats or faces. Where valve seats are shrouded the design of the shroud shall be such as to prevent foreign matter lodging in the valve seat.

All drain traps shall be of approved make, size and type and shall be complete with air cock and casing mechanism. All internal parts shall be constructed from approved material and shall be renewable. Trap bodies and covers shall be of cast or forged steel and shall be suitable for operation at the maximum working pressure and temperature of the steam piping to which they are connected.

ii) Steam Traps and Strainers

- The steam traps shall be inverted bucket or thermo-dynamic type complete with integral or separate strainers.
- The internal components of traps shall be of AISI-316 stainless steel construction. Material of construction of the body shall be selected by the Bidder based on the service conditions stipulated.
- All Y-type strainers, wherever provided with steam traps or otherwise, shall have AISI-316 stainless steel screen of not more than 20 mesh size. Screen open area shall be at least three (3) times the pipe internal cross-sectional area. The strainer shall have a screwed blow-off connection with a removable plug. Material of construction of the body shall be selected by the bidder based on the duty conditions specified.

All traps and strainers shall have socket weld ends as per ANSI B16.11 for size NB 50 mm and smaller and butt weld ends as per B 16.25 for size NB 65 mm and above.



- Steam drain traps shall be provided with strainers, inlet and discharge valves and by-passes and test cocks as schematically indicated in the enclosed drawing. Materials and other details of these valves shall meet the specified requirement.

i) Pump Suction Strainer

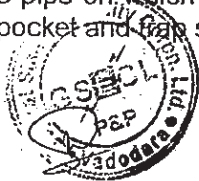
The strainer at condensate Transfer pump should be removable type conical strainer assembly. The spool pipe shall have flanged ends suitable for direct mounting on condensate Transfer pump suction flange. The material of construction of spool pipe shall be the same as that of pumps suction piping. The strainer element shall be of perforated sheet with aperture size of 6 mm and wrapped with AISI-316 stainless steel wire mesh of 500 micron nominal aperture. The clear opening area of the strainer shall be at least 5 times the pipe area.

j) Non-return Valves

- i) All non-return valves shall be of approved type and make and the pressure drop shall be subject to approval. Non-return valves for steam services and on pump discharge sides shall be provided with approved dash pots, where required, and with prior approval.
- ii) The body seat for swing check valves shall be inclined at such an angle as to minimise chatter.
- iii) To enable the internal parts to be examined or removed without removing the valves from the pipeline, the flanged cover should be used. The bodies shall be stamped with an arrow to indicate the correct flow direction.
- iv) Provision shall be made to drain both sides of a horizontal non-return valve where such a valve adjoins an isolating valve for non-return valves mounted on vertical pipe integral by-pass shall be used to facilitate draining as stated earlier.

k) De-super heaters

De-super heaters along with spray water supply and control system shall be provided on the auxiliary steam lines, etc. as required. A de-superheater shall be designed for the design conditions of the piping on its upstream side and shall also take care of its severe condition of working. As far as possible, the de-super heaters shall be mounted on a vertical line to avoid the problem of water accumulation in it. However; if installed horizontally, the inside diameter of the de-superheater shall be the same as that of the pipe on which it is mounted and the pipe shall be provided with drain pocket and trap station.



7.00.00 INSPECTION, TESTING AND INSTALLATION

7.01.00 Testing of Piping at Works

7.01.01 Material Test and Analysis

All materials shall be furnished in strict accordance with the codes specified and in accordance with the detailed specification. All sources of material shall be disclosed and relevant test certificates for the physical and chemical properties of the material shall be made available to the Owner/Engineer before the final shop inspection.

7.01.02 Hydrostatic Test

All piping shall be subjected to the hydrostatic test pressure at manufacturer's works as required by the IBR or any other applicable standards. Test pressure shall however be not less than the following :

$$\text{Test Pressure} = 1.5 \times \text{Design Pressure}$$

The Contractor shall guarantee his work as capable of withstanding such hydrostatic tests and consent to repair or replace at his expense any item, which fails to pass such tests at site. Hydrostatic test of all pipes coming under IBR shall be offered for witnessing by the representative of the Inspecting Authority recognised by IBR.

7.01.03 Wall Thickness Tests

Wall thickness tests shall be made on a length of pipe of each type to determine the actual wall thickness at outer wall of bend on such piping.

The tests shall be done before fabrication on the piping system and results submitted to Owner/Engineer for approval.

7.02.00 Capacity Tests for Pipe Supports

Each constant load and spring support shall be tested before delivery to ensure that the variation in support capacity provided through the specified ranges (i.e. the difference in load between hot conditions and cold condition) does not exceed 6 percent for constant load supports and 20 percent for variable spring supports.

All materials shall be of tested quality. Hanger springs shall be properly calibrated.

7.03.00 Testing of Valves & Specialties at Works

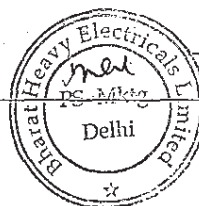
7.03.01

All materials shall be of tested quality and the contractor shall submit the relevant material test certificate as per QAP for the approval of Owner/Consultant.



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- 7.03.02 All Valves and Specialties as well as counter flanges to be used in steam service shall have IBR certification marked on them and IBR certificates in appropriate proforma, shall be submitted.
- 7.03.03 Gate valves shall be subjected to shop tests in accordance with API-598 including the high-pressure closure test. Globe valves shall be tested in accordance with BS-1873 and check valves in accordance with BS-1868.
- 7.03.04 All gaskets used for test shall be of the same material and design as specified for the finished product.
- 7.03.05 Each relief valve shall be subjected to hydrostatic test, seat pressure test, seat leakage test and test for relieving capacity.

The valve body test pressure shall be 1.5 times the design pressure as per ASME Sec. VIII, Div. 1 and seat test pressure will be less than set pressure about 6% for Safety Valve and 10% for Safety Relief Valve.

The seat test pressure should be at least equal to the set pressure. During this test, the valve seat shall be demonstrated to be watertight for a period of at least two (2) minutes.

- 7.03.06 Functional tests: The fully assembled or completed valves including the operators and accessories shall be functionally tested to demonstrate the operability of the valve and the operator. This may be done by cycling typical valves 3 or 4 times from open to close position. The manual operation of the motor operated valves using the manual override to demonstrate freedom from friction shall also be conducted.

7.04.00 **Tests on Strainers and Traps at Works**

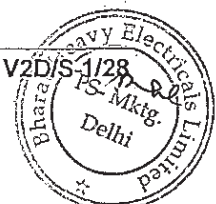
- 7.04.01 All strainers shall be subjected to hydrostatic test. The test pressure shall be twice the design pressure.
- 7.04.02 All steam traps shall be subjected to hydrostatic test at twice the design pressure. IBR certification shall be furnished for all steam traps.

- 7.05.00 Test reports and certificates of the mentioned tests and other tests as required to ensure satisfactory operation shall be submitted to Owner/ Consultant before despatch of equipment IBR certification as required shall be furnished.

- 7.06.00 All rubber lining should be subjected to tests as per IS:4682 (Part-I).

7.07.00 **Tests at Site**

Contractor shall carry out tests at site to prove to the Owner that the equipment of the plant complies with requirements stipulated and is erected in accordance with requirements. Before the plant is put on trial run the Contractor will be required to conduct tests to demonstrate to the Owner that each item of the plant is capable of correctly performing the functions for which it was specified. These test may be conducted concurrently with those required under commissioning sequence. Tests required shall in general be as follows :



- a) All piping, valves and specialties after installation, will be tested hydraulically at a pressure, one half times that of the maximum attainable pressure in the system or 2 times the design pressure whichever is higher, to check against leak tightness.
- b) All manually operated valves/gates shall be operated throughout 100% of the travel and these should function without any trouble whatsoever.
- c) Visual check on all structural components, welding, painting etc. and if doubt arises these will be tested again.
- d) All test instruments and equipment shall be furnished by the Bidder to the satisfaction of the Owner.
- e) Checks on electrical items as mentioned in relevant electrical specification.

7.08.00 **Pre-Commissioning Testing**7.08.01 **Alignment Test**

After completion of erection and before start-up, alignment test shall be carried out by the Contractor to check levelling, clearance, eccentricity etc. Measurement will be witnessed and acceptance will be certified by the Engineer.

7.08.02 **Heat Treatment**

All necessary preheating, post heating and stress relieving operation of welds/fabricated, items are part of the erection work and shall be supervised by the Contractor in accordance with relevant regulations and standard.

The Bidder shall arrange all required supervising staff for heat treatment and stress relieving works.

Heat treatment may be required to be carried out at any time during day and night to ensure the continuity of the progress. The Contractor shall provide supervising staff accordingly.

All data such as heating temperature, heating rate, sparking time, maximum temperature during heat treatment shall be properly recorded. All the data recorded during heat treatment shall be the property of the Owner.

7.08.03 **Radiography Test**

The Contractor shall carryout radiography tests of all field-welded joints coming under IBR the acceptability standard of which shall be as per IBR (latest revision). For other field welded joints radiography or other ND testing methods shall be employed as per ASME or equivalent. All radiography shall be carried out in presence of a competent supervisor of the contractor and his certificate of identification of the films of the radiographs shall be given invariably in all cases.



The repair work shall be suggested by the Contractor immediately after detection of the defective zone to the complete satisfaction of the Engineer. Regarding acceptance of the joints, decision of the Engineer shall be final.

All X-ray films of joints radiographed at site shall become the property of the Owner.

Contractor shall carryout the following optional non-destructive tests after completion of erection of all piping and equipment.

Ultrasonic test per weld joint.

Hardness test for 10% weld joints for each system of piping and/or as specified in the approved Field Quality Plan (FQP).

7.08.04 Hydrotest

Hydrotesting shall be conducted for all pressure parts after installation at required pressure irrespective of carrying out 100% radiography of field welded joints. All necessary blanking arrangement required for such hydrotesting shall be furnished by the Contractor. The hydro testing of piping coming under the I.B.R. shall meet the requirements of I.B.R. and all necessary test pump, temporary piping etc. shall be supplied by the Erection Contractor, irrespective of carrying out radiography on 100% basis of the field welded joints.

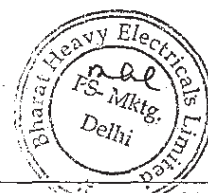
After the hydrostatic test, the Erection Contractor shall carry out thorough flushing of all lines with water to ensure removal of foreign materials like welding rods, metal chips etc. to the satisfaction of Engineer. After the flushing of the lines, all the water shall be drained and the piping shall be blown with air for drying the cleaned surface and the lines shall be air blasted to ensure proper cleaning of line to the satisfaction of engineer.

As a rule, hydro test shall be performed after all eventual pipe branching have been completed and valves installed. Should it be required to hasten erection work, hydrotest may be performed in sections.

All safety valves coming under purview of Indian Boiler Regulation shall be set and other tests shall be conducted to the satisfaction of concerned Boiler Inspector. All other safety valves shall also be set and sealed to the satisfaction of the Engineer.

All instruments necessary for the tests shall be supplied by the Contractor and calibrated before test as per relevant code.

The Contractor shall make necessary changes and corrections without any extra cost as may be felt by the Owner/Engineer to meet the guarantee and other technical particulars.



7.09.00 Installation

7.09.01 For all steam blown lines temporary strainers shall be installed at the equipment terminals so as to prevent any inflow of particles where that may cause any damage or harmful effect. For example, such strainers shall be placed on main steam and hot reheat line terminals at turbine end unless the turbine stop valves/interceptor valves have integral strainers suitable for the purpose. The temporary strainers shall be kept on line for sometime after the plant starts normal operation, as per the discretion of the Engineer. So, the design of strainers shall be based on the design conditions of the pipes on which they are installed. Where flow meters are to be installed in pipes requiring steam blowing, initially the pipes shall be erected with the flow meter branch pipes replaced by temporary spool pieces. After the end of steam blowing operation the temporary spool pieces shall be removed and the flow meter branch pieces shall be erected in position. In case such a pipe has also to be subject to cold pull-up, temporary anchoring of the main pipe on either ends of the temporary spool piece shall be done before replacing it by the flow-meter branch pipe.

All piping shall be installed in a manner such that expansion will take place in the direction desired and so that vibrations will be minimised. The contractor shall be responsible for the expansion provisions and flexibility of all field run piping. No piping shall be cold-sprung or cold-pulled unless there remains absolutely no other means to bring down the hot stress or terminal forces/moments within acceptable limit. All such cold pull up shall be shown in the piping drawings, along with a write-up describing clearly the method adopted for cold-pulling. All necessary attachments for cold-pulling, along with temporary anchors, as and wherever required, shall be provided.

The forces and moments on the temporary anchors and attachments shall be submitted. The cold pull-ups and all the above-mentioned documents shall be subject to the approval of the Owner.

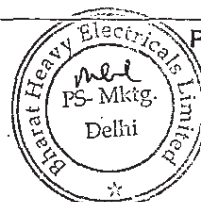
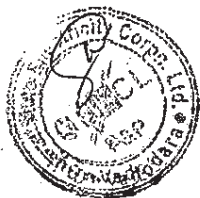
7.09.02 All expansion bellows shall be installed with a minimum of two tie rods or bolts across each bellows to prevent the bellows from opening under pressure. The connection of the tie rods or bolts to the pipe shall make adequate provision for angular movement of the pipe and bellows.

Pump suction pipes shall be installed in such a manner that no air can be trapped in the suction piping. Suction pipes shall be supported in such a manner that there will be no high spots where air can be trapped. The in trades of suction branch lines shall be in no place lower than the in trades of the manifold at the point where the branch line connects to the manifold.

Standard "Factory Made" fittings shall be used in all power cycle piping. Shop or site fabricated mitred fittings shall not be used unless accepted by the Owner.

7.09.03 During erection no weights must be lifted by means of tackle fastened to the beams or slabs of the floor or roof except where provision has been specifically made for this purpose.

Supporting straps around flanges of pipes or valves or around welded joints will not be accepted. Anchors shall be attached to pipe by approved means.



All supports should be shop fabricated and should be positioned before erection of the piping takes place and near to joints & valves wherever possible.

- 7.09.04 The Contractor shall provide all the necessary wall boxes and collars where pipes pass through walls, floors and roofs, also the necessary supports for any trenched pipes. Roof collars shall be fitted with a high sealing to prevent water falling through the holes.

The wall boxes and floor collars shall be constructed so that they can if necessary be erected after the pipes are in position. Pipes passing through roof collars shall be provided with an approved pipe sleeves, weather hood and cowl which shall be fixed by the Bidder. Floor collars shall extend to an approved height above the floor level and the pipes shall be fitted with hoods where required.

- 7.09.05 Drainpipe work shall be designed as per ANSI B31.1.

High pressure drains (above 40 kg/sq.cm) shall have two valves in series and that near the condenser or flash box shall be motor operated arranged to open and close to ensure minimum wear on one valve.

High-pressure drains shall have a screw-down non-return valve at the point of discharge near the manifold of the Flash tank to prevent backflow of flashed steam.

Low-pressure drains shall have steam traps of an approved design complete with strainers, isolating valves and by-pass valves.

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

Pipe wall thickness shall be as per international standard approved by Owner/Engineer during detailed engineering.

Drain pockets of an approved size and construction shall be provided for all steam lines.

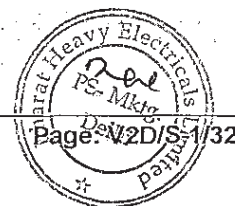
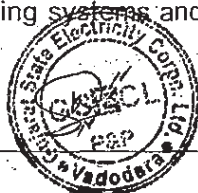
Arrangement of valves in the drain line shall be as shown in the Bidder's P & I Diagram.

- 7.09.06 All electrical actuators and pneumatic/hydraulic actuator shall be erected, aligned, adjusted and finally set to the satisfaction of the Owner. This includes adjustment and setting of torque and limit switches.

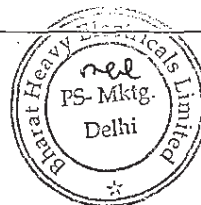
8.00.00 DRAWINGS, DATA, INFORMATION & MANUALS

- 8.01.00 Drawings, data, Information to be furnished by the Bidder along with the Bid

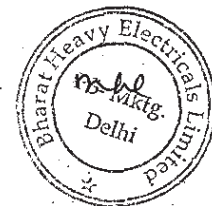
- 8.01.01 A complete list of all piping systems and corresponding materials included in the scope of work.



- 8.01.02 A complete list of all valves with their quantities and ratings.
- 8.01.03 Manufacturer's catalogue indicating design and construction of spring hangers, valves, specialties offered.
- 8.01.04 Manufacturer's catalogue indicating complete range of available size and rating of pipes and fittings.
- 8.02.00 **After Award of Contract**
- 8.02.01 Layout drawings as well as Isometric drawings (for line sizes NB 50 mm and larger) showing the routing of various piping and location of hangers, restraints, anchors, valves etc.
- 8.02.02 Detail fabrication drawings of all shop fabricated piping system indicating design parameters and complete bill of material (Relevant Standards and grades to be indicated) and information/ data pertaining to the hydrostatic and non-destructive test requirements.
- 8.02.03 Detail dimensioned drawing of each valve, specialties, indicating tag no., pressure rating, manufacturing standard, bill of material and hydrostatic test pressures. The drawing shall include the end preparation details and shall indicate the position of the hand wheel/operator. Technical particulars of motor operators wherever applicable shall also be indicated.
- 8.02.04 Detail dimensioned drawing of each type of hangers and supports including guides, anchors, snubbers etc. with bill of materials (relevant standards and grades to be indicated).
- 8.02.05 General arrangement drawing for each hanger/support/anchor etc. indicating identification number, auxiliary supporting structural details, other details and information as required in the specification and typical details of Hangers & supports drawing enclosed with the specification.
- 8.02.06 Wiring diagram for all limit switches of motor operated valves.
- 8.02.07 Detail drawing with design calculation for the special Y-fittings on pipes, if any.
- 8.02.08 The loading data required for design of structures.
- 8.02.09 Miscellaneous Data/Documents
- a) Complete schedule of pipe lines in a format as approved by the Engineer indicating at least the line number, line description, pipe class (as per specification designation) design pressure and temperature, hydrostatic test pressure, insulation thickness, valve specification code, pipe material indicating standard and grade, number of BW/SW/Flanged joints and whether IBR certification needed.
- b) Complete schedule of valves in format as approved by the Engineer indicating at least tag no, location, size, pressure class, design parameters, operation, make, quantity, special requirement if any etc.



- c) Bill of material of hangers and supports in a format approved by the Engineer indicating at least the hanger/support number, type, operating load, cold setting load, Hydrostatic test load, movement of attachment point in X, Y and Z direction, line no. on which the hanger/support is located, insulation thickness of the pipe line, hanger rod length, angular deflection of hanger rod from vertical under hot and cold conditions etc.
- d) Approval certificates from IBR in relevant forms regarding design, fabrication and testing of piping and valves for the piping system which are under the purview of IBR.
- e) Design calculation for pipe wall thickness finally adopted.
- f) Reinforcement calculations as per ANSI B 31.1 for all set on type branch connections.
- g) A document containing the flexibility analysis procedure and results showing the forces and moments at various support points, anchors, equipment terminals etc. as elaborated before in this specification.
- h) Procedure of shop and site tests, test reports and test certificates for all tests conducted at shop.
- i) Quality assurance schedule, including report containing all pertinent details of the heat-treating cycle for all pipes, fittings, valves, specialties etc.
- j) Detailed erection procedure for piping, valves, specialties and auxiliary equipment including complete details of welding of joints to be done at site. All necessary instructions/recommendation shall be given for satisfactory erection of piping, valves specialties and auxiliary equipment.
- k) Erection, operation and maintenance manuals.

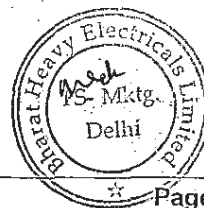


ANNEXURE-I

MATERIALS OF CONSTRUCTION FOR PIPING & FITTINGS

Materials used in piping, fittings & specialties shall be as stipulated in the IBR and various codes as specified. However, the following basic guidelines shall in any case be followed for pipe materials :

Service	Material, Equivalent/Superior to
i) Temp. Up to 410 Deg.C	Carbon Steel, ASTM A-106, Gr. B or C Seamless. ASTM A-105/ A-234 WPB/WPC
ii) Temp. Above 410 Deg.C to 510 Deg.C	Alloy Steel, ASTM A-335, P11 ASTM A-182 F11; A-234, WP11
iii) Temp. Above 510 Deg.C to 540 Deg.C	Alloy Steel, ASTM A-335, P22/P91 ASTM A-182 F22/F91; A-234, WP22/91
iv) Temp. Above 540 Deg.C to 600 Deg.C	Alloy Steel, ASTM A-335, P91 ASTM A-182 F91; A-234, WP91
v) Corrosive	Stainless Steel.



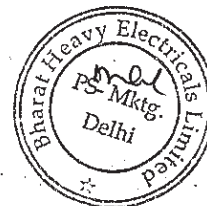
ANNEXURE-II

MATERIALS OF CONSTRUCTION FOR VALVES

Materials for Valves shall be equivalent/superior to the following, for non-corrosive services:

Working Class	Valves Size	Material	
		Body Bonnet Cover	Stem Hinge Pin
i) Temp. Up to 410 Deg.C	65 mm & above	ASTM A-216, Gr. WCBWCC	13% Cr. Steel (ASTM A-182, Gr. F6a)- min. hardness 200 HB
	50 mm & below	ASTM A-105	
ii) Temp. Above 410 Deg.C to 510 Deg.C	65 mm & above	ASTM A-217, Gr. WC6	ASTM A-182, Gr. F6a - min. hardness 200 HB
	50 mm & below	ASTM A-182, Gr. F11	
iii) Temp. Above 510 Deg.C to 540 Deg.C	65 mm & above	ASTM A-217, Gr. WC9	ASTM A-182, Gr. F6a - min. hardness 200 HB
	50 mm & below	ASTM A-182, Gr. F22	
iv) Temp. above 540 Deg.C to 600 Deg.C	65 mm & above	ASTM A-217, Gr. WC/C12	ASTM A-182, Gr. F6a - min. hardness 200 HB
	50 mm & below	ASTM A-182, Gr. F91	

Note : Non-return valves in corrosion service shall be swing check type; suitably lined.





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SPEC NO: PE-TS-408-155-A001

VOLUME: II-B

SECTION: C2-A

REV NO: 00

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



TITLE:
**1X800 MW WANAKBORI STPP
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1.00.00

CODE & STANDARDS

1.01.00

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

IS : 778	-	Gunmetal gate, globe and check valves for general purpose.
IS : 1239	-	Mild steel tubes and fittings - Part I & II.
IS : 1536	-	Centrifugally cast (spun) iron pipes for water, gas and sewage.
IS : 1537	-	Vertically cast iron pressure pipe for water, gas and sewage.
IS : 1538	-	Cast iron fittings for pressure pipes for water, gas and sewage.
IS : 1703	-	Ball valves (horizontal) plunger type including floats for water supply purposes.
IS : 2379	-	Colour for the identification of pipe line.
IS : 2685	-	Code of practice for erection, installation, and maintenance of sluice valves.
IS : 14846	-	Sluice valve for water works purposes (150 to 1200 mm).
IS : 3042	-	Single faced sluice gates (200 to 1200 mm).
IS : 3589	-	Electrically welded steel pipes for Water gas & sewage (200 to 2000 mm).
IS : 4038	-	Foot valve for water works purposes.
IS : 4984	-	High Density polyethylene pipes.
IS : 4985	-	Unplasticised PVC Pipes.
IS : 5312	-	Swing check type reflux (non-return) valve Part-I.
IS : 458	-	Concrete pipes (with and without reinforcement).
IS : 3952	-	Cast Iron butterfly valves for general purposes.
ASTM-A 106	-	Gr.C Seamless carbon steel pipe.
ASTM - 53	-	Seamless carbon steel.
AWWA-C-504	-	Standard for butterfly valve.
BS : 5156	-	Standard for Diaphragm valve.
IS : 554	-	Pipe thread for pressure tight joints.
IS : 1363	-	Black hexagon bolts, nuts and lock nuts.
IS : 1364	-	Precision and semi-precision hexagon bolts, screws, nuts and lock nuts.
IS : 2062	-	Structural steel fusion welding quality.
IS : 4736	-	Hot dip zinc coating on steel tubes.
IS : 2825	-	Code of unfired pressure vessels.
IS : 2712	-	Gaskets.
IS : 4192	-	Part-I Rubber lining.
IS : 3006	-	Acid resistant SWG Pipe.
IS : 783	-	Code of practice for laying RCC pipes.
IS : 3114	-	Code of practice for CI Pipes.



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- BS : 5142 - Cl globe valve.
 ANSI:B 16.5 - Steel pipe flanges and flanged fittings.
 ANSI:B 31.1 - Power Piping code.

2.00.00 DESIGN, CONSTRUCTION AND ERECTION

2.01.00 Piping and Fittings (General)

2.01.01 Design

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

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

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

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

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

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

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

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

2.01.08 The portion downstream of the isolation valves of pipe lines conveying flushing water shall be of the material & type as that of the chemical pipelines which is being flushed.



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

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

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

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

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

2.02.00 For calculating the pump head, at least 10% margin shall be taken over the pipe friction losses.
Material & Dimensional Standards for Piping

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

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

i) Pipes up to 150 NB		
a) IS:1239 Part-I		(Heavy grade-Black)
b) ASTM-A-53 Grade B Type-E	(Welded),	Sch 80 up to 2 inch nominal size. Sch 40 above 2 inch nominal size.
ii) Pipes 200 NB and above		
a) IS:3589 - Grade 410		
b) ASTM - A53, Type-E Grade B (Welded) - Sch. 40		
iii) Pipe 500 NB and above	In this case pipes shall be rolled and butt welded. These pipes may be fabricated by the bidder at site. The plates conforming to IS:2062 (Tested quality) or SA-285 Gr.C. or equivalent.	



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

- 2.02.03 Pipes for the Air Service shall conform to the above clause 2.02.02 and shall be galvanized to IS:4736.
- 2.02.04 Pipes to be used for the rubber-lined construction shall conform the above clause 2.02.02 and inside surface shall be completely de-beaded and made suitable for lining.
- 2.02.05 Other piping materials shall conform to the following standards.
- i) IS:4984 - Class-5-High density polyethylene pipes.
 - ii) IS:4985 - Class-4 - PVC Pipes.
 - iii) ASTM A-106, Gr. C, Schedule 80 - Seamless carbon steel pipe.
 - iv) ASTM A-312 Grade TP-316 Schedule 40s - Stainless Steel pipes.
 - v) ASTM A-312 - Grade TP-316 Schedule 40 - Stainless Steel pipes (ERW OR Seamless)
- 2.02.06 Fittings
- (a) Fittings to be used with carbon steel pipes shall conform to IS:1239 Part-II (Heavy grade) for sizes up to 150 NB.
 - (b) For sizes 200 NB & above steel fittings shall conform to ASTM A 234 Gr. WPB. However for sizes above 350 NB fabricated fittings (meter bends etc) may be used. Forged elbows of long radius shall be used.
 - (c) However inside surface of all the fittings used for the rubber lined application shall be de-beaded and made suitable for rubber lining.
 - (d) For Galvanized pipe application all the fittings shall be galvanized as per IS:4736.
 - (e) Fittings to be used in other type of piping shall conform to relevant IS/BS ANSI Standards and in conformity with the parent pipe standard.
 - (f) Unless otherwise shown eccentric reducers shall be installed with straight side at the top of piping connection.
- 2.03.00 **Design of Piping Systems**
- 2.03.01 For water, air and other services where steel pipes are used, joints of this size range shall be screwed/flanged type.
- 2.03.02 All unlined steel pipes 65 NB and above (other than CI pipes and air service pipes) shall be joint by butt-welding.
- 2.03.03 All rubber lined pipes shall have flanged joints.
- 2.03.04 Steel pipe flanges shall be generally slip on flat face type. Weld neck flanges shall be used when flange follows immediately after a butt-welding or where it is required with respect to service conditions. When weld neck or socket weld flanges are used, their bore must be made the same as that of the pipe being welded to. Socket welded or threaded flanges may be used, with the appropriate piping system for connection of pipe to the flanged equipment.
- 2.03.05 All the piping flanges and counter flanges & their drilling shall conform to ANSI B 16.5 of relevant pressure & temperature class. However wherever the interferences is involved with the Owner's pipe, the flange/interconnection details shall be designed to match the piping and the details of which will be intimated later. Flanges shall conform to ANSI B.16.5 class 150 (min.) for service other than condensate polisher pipelines.
- 2.03.06 For easy handling & removal of equipments, valves etc. and for maintenance purpose, break up flanges for 65 NB and above sizes and suitable type of compression flexible coupling for flanged joints of 50 NB and below size shall be provided. The over ground piping wherever routed inside building, shall have a clear head room of minimum 2.1 meter from operating floor.



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- 2.03.07 Pipes shall generally be routed above ground but where specifically indicated/specified the pipe may be laid in trenches or buried. Buried piping shall be generally installed so that the top of pipe is 1.0 metre below the ground level unless otherwise specifically mentioned. Full length of buried piping shall be provided with 100 mm thick sand bed.
- 2.03.08 Butt-welding edge preparation shall be done as per ANSI B 16.25.
- 2.03.09 Meter bends will not be accepted for steel pipes of 350 NB and below. For sizes above 350, the meter bends shall conform to BS:534. The bend radius shall be used for all pipes 1.5 times the nominal pipe diameter.
- 2.03.10 Hangers and supports shall be capable of carrying the sum of all concurrently acting loads. They shall be designed to provide the required supporting effects and allow pipeline movements as necessary. All guides, anchors, braces, dampener, expansion joint and structural steel to be attached to the building/structure, trenches etc. shall be provided. Type of hangers and components for all piping shall be selected and approval obtained from the ENGINEER.
- 2.03.11 For rubber lined pipe, lining should be applied in two (2) layers, giving a total thickness not less than 3 mm. Surface hardness of rubber lining shall be $65 \pm 5^\circ$ Shore A
- 2.03.12 Pipe coming under purview of IBR should meet its requirements and getting the IBR approval shall be under Vendors scope.
- 3.00.00 VALVES & GATES**
- 3.01.00 Valves will be used to start/stop or control flow. Gates will be primarily used for isolation of flow in open channels although these should be capable of throttling the flow too. Sample valves will be used in sample collection lines.
- 3.02.00 (a) All valves, shall be suitable for service conditions i.e. flow, temperature and pressure under which they are required. All the valves shall be of standard pressure rating of the relevant design standard.
- (b) All the actuators of the valves shall be designed to handle the maximum expected pressure differential across the valves and to overcome friction forces and unbalance forces due to the flow through valve.
- 3.03.00 Valves in Raw water, Clarified & Filtered water application**
- 3.03.01 Either Butterfly type or sluice/gate valves shall be used for isolation purposes.
- 3.03.02 Sluice/gate valve shall conform to IS 14846 of rating PN 1.6 (min.). Stem, seat ring and wedge facing ring shall be of stainless steel construction. Other parts shall be as per IS:780. Flanges shall be designed as per ANSI B 16.5 Cl. 300 (min.) to meet with the piping flanges. Valves shall be of outside screw and rising stem type.
- Sluice valves for sizes below 50 NB and below shall conforms to IS:778 Class-2/ANSI B16.34 straight, rising stem; without side screw.
- 3.03.03 Sluice valves shall be provided with the following accessories in addition to the standard items.
- a) Hand wheel
- b) Manual Gear reduction unit operator for valves 250 NB and above.
- c) Bypass valve for valve of sizes 350 NB and above.
- d) Draining arrangement wherever required.
- e) Arrow indicating flow direction.
- f) Position indicator.
- 3.03.04 Sluice Valves shall be provided with back seating bush to facilitate gland renewal during full open condition.
- 3.03.05 Butterfly valves shall be of double flanged or lugged wafer type of low leakage rate confirming to AWWA-C-504 class 300 (min.) or BS:5155 PN 10 (min.)
- 3.03.06 The various components of butterfly valves shall be of the following



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

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

3.03.08 All the butterfly valves shall be provided with Hand wheel or lever as per the requirements.
For larger sizes i.e. 150 NB and above hand wheel shall be provided. For lever/wrench operated valves, means shall be provided for positively holding the disc in not less than three intermediate positions.
Manually operated valves shall be provided with reduction gear unit for valves of size 250 NB and above. Valve provided with motorized or pneumatic actuator shall be provided with a hand wheel for manual operation.
All the valves shall be equipped with adjustable mechanical stop-limiting devices to prevent over travel of the valve disc in the open and closed positions. The valve operators (Hand wheel or Gear reduction unit or Motor actuator etc.) shall be designed as per relevant International Standard.

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

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

a) **Ball Valves**

- i) Design Standard : BS:5351 Class 300 (min.)
- ii) Type : Welded/Flanged ends; Full bore: Split Body & Seat supported construction.
- iii) **Material of Construction**
- Body : Carbon Steel/Cast Iron
- Ball : Stainless steel ANSI 420
- Seat ring : PTFE
- Stem : Stainless steel AISI 420
- Seats : Nitrile rubber; PTFE.
- iv) Valves shall be designed to be directly operatable by a wrench / Hand lever.
- v) Suitable stops shall be provided for both the fully open & close condition.
- vi) All the valves shall be provided with an indicator for showing the position of the ball port.



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

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

iii) **Material of Construction**

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

For sizes above 50 NB

- i) Design Standard : IS:780/IS:2906 rating PN 1.0 min. or Equivalent/BS 5150 PN 10. (min.)
- ii) Type : Double Flanged or wafer body, outside screw and rising stem type.
- iii) **Material of construction**
- Body : Cast iron : IS:210 Gr. FG 260/BS:1452 Gr.14.
- Stem : Stainless steel AISI 410/ 13% chrome steel.
- Disc : Cast iron IS:210 Gr.260/ BS:1452 Gr.14.
- Packing : PTFE
- Seat & seat rings : 13% chromium steel
- Gland & gland nut : AISI 420
- Hand wheel : Cast iron or Malleable iron.

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

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

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

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

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

3.04.00 **Valves for Demineralised water application**

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

3.04.02 The diaphragm valves shall conform to the following requirements.

- a) Design Standard : BS:5156 or equivalent of required rating/class. (minimum rating of valves should be PN 10).
- b) Type : Flanged and lined body ends, sealed bonnet, weir pattern, tight shut off type.
- c) **Material of Construction**
- Body/Bonnet : i) Cast Iron IS:210 Gr.FG.260 or equivalent.



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II) Cast steel ASTM A-216 Gr. WCB.

Body lining	:	Soft Natural rubber, Ebonite polypropylene, PVDF.
Diaphragm	:	Reinforced rubber, hypalon/app. equal.
Hand wheel	:	Cast Iron
Compressor	:	Stainless Steel
Stem & Bush	:	Stainless Steel

- d) Flanges shall conform to ANSI B 16.5 Cl.300 and shall be cast/integral with the body.
- e) Hand wheels shall be marked with the direction of closure.
- f) Valves shall be provided with a position indicator to show the open and closed condition.
- g) Valves provided with pneumatic actuators shall be provided with a hand wheel for manual operation. The valves operators shall be designed as per relevant International Standard.

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

- a) Body shall be lined (minimum 3 mm) with natural rubber, ebonite, polypropylene or PVDF.
- b) Disc shall be lined with PVDF, polypropylene, or natural rubber.
- c) Seat rings shall be of Nitrile rubber or Hypalon.

3.05.00 Valves for Acid & Alkali Services

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

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

3.06.00 Valves for Lime Slurry / Solutions

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

3.06.02 The plug valves shall conform to the following requirements.

- | | | | |
|----|--------------------------|---|---|
| a) | Design Standard | : | BS:5353 Class 300 or Equivalent. |
| b) | Type | : | Flanged and non lubricated, regular pattern, plug valves. |
| c) | Material of Construction | | |
| | i) Body | : | Cast Iron IS:210 Gr FG 260 or Equivalent |
| | ii) Plug | : | Stainless Steel AISI 316 |
| | iii) Body Sleeve or Seat | : | PTFE |
| | iv) Seat | : | PTFE |
| | v) Gland | : | AISI 304 / AISI 316 |
| | vi) Cover | : | Cast Steel ASTM A216 Gr WCB |
| | vii) Gland Nut | : | AISI :304 / AISI 316 |
- d) Valves shall be operated by permanently fitted wrench or Hand lever. Wrench shall be mounted so that they are parallel to the valve bore axis when the valve is in fully open condition.
- e) All valves shall be provided with an indicator for the position of the plug part.



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- f) Suitable stops shall be provided for the fully open and fully closed positions of the valve.
- g) Valves of size of 250 NB and above shall be provided with a suitable reduction gear unit.

3.07.00 **Resin Transfer Line**

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

3.08.00 Butterfly valves in the condensate polisher service vessels.

3.08.01 They shall be lugged wafer type.

3.08.02 The material of construction shall be as below:

- i) Body : Cast Steel (Please refer note written below)
- ii) Disc : SS-316
- iii) Shaft : SS-316
- iv) Seal : Teflon
- v) Seat : Teflon with Titanium back-up rings

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

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

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

3.09.00 **Valves for Air pipe line application**

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

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

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

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

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

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

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

3.10.02 The valves shall conform to the following specifications.

- i) Design Standard : IS:5312, BS:1868, BS:5153 API 594/
API 60 or Eqvt.
- ii) Type : Swing check Type and Flanged ends.
- iii) Material of Construction (For non corrosive application)
- a) Body & Cover : Cast iron IS:210 Gr.FG 260/or
Hinge Disk/Door Cast Iron BS:1452 Gr.220 or Eqvt.
- b) Hinge Pin and : Cast steel ASTM A 216 Gr.
Door/Disc Pin WCB.



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High tensile Brass IS:320 HT 2 or BS:2872 eqvt.

- c) Disc facing ring : Stainless steel
- d) Body Seat ring : Stainless steel
- e) Bearing bushes : Leaded Tin Bronze IS:318 Gr.2
- f) Bolts : Carbon Steel
- iv) For the application of lime, corrosive water (DM water), and air, the body, cover & Disc shall be lined with natural Rubber, PTFE or Viton. The Hinge, Hinge Pin & Disc Pin shall be coated with PVDF, or suitable elastomer. The bearing bushes shall be PTFE or Eqvt. material. Bolting shall be of stainless steel. In the absence of lining/coating, the complete valve shall be of stainless steel construction (AISI 316) for the above application.
- v) For acid services, the valves shall be of lined construction as specified in (iv) above, or of Hastalloy 'B' construction and Body/Disc facing ring shall be of resilient materials such as natural rubber, PTFE or Viton.
- vi) For alkali services, the complete valve shall be stainless steel construction (AISI-316).

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

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

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

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

3.12.00 **Gates**

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

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

3.12.03 Material of Construction

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

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

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

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

3.13.00 **STRAINERS**

3.13.01 **Basket Strainers**

- a) Basket strainers of simplex design shall have the following materials of construction for raw/clarified/filtered water application.
 - i) Body : Fabricated mild steel : IS:2062 (Tested quality)
 - ii) Strainers : Wire shall be stainless steel (AISI:316 18 BWG 30 mesh suitably reinforced. Reinforcement material shall also be of stainless steel construction.
 - iii) Drain Plug/Nuts : Gun metal



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- b) Inside and outside of basket body shall be protected with one coat of high build zinc phosphate primer and three coats of Chlorinated rubber paint to a total thickness of 200 microns.
- c) Suitable Vent and drain valves shall be provided for the strainers.
- d) Screen (strainer) flow area shall be at least four times pipe sectional area. Flow area in any portion of Basket strainer assembly shall not be less than the pipe cross sectional area.
- e) Pressure drop in clean condition shall not be more than 1.0 MWC.
- f) Basket Strainer shall be provided with lifting lugs and suitable mounting arrangement.
- g) For DM water service, body shall be rubber lined to minimum 4.5 mm thickness (soft rubber of shore Hardness $65 \pm 5^\circ\text{A}$).

3.13.02

Y-Type Strainer

- a) Y-Type strainer for water application shall be constructed of following materials :
 - i) Body : Cast Iron IS:210 Gr. FG 260
 - ii) Strainers : Wires of stainless steel AISI-316, 18 BWG 30 mesh suitably reinforced. Reinforcement material shall also be of stainless steel construction.
 - iii) Drain Plug/Nuts : Gun metal (threaded construction)
- b) Y-Type strainers shall also conform to Cl. 3.14.01 (b), (d), (e) and (f).
- c) Body of the Y-type strainers of alkali, and demineralised water shall be of Cast Iron (IS:210, Gr.FG 260) and lined with soft or hard rubber to a thickness of 4.5 mm.
- d) For acid services, apart from the rubber lined body material, the screen material, shall be Polypropylene or HDPE wire cloth of suitable mesh and thickness.

3.14.00

General Requirements for Valves, Gates, Strainers

3.14.01

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

3.14.02

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

3.14.03

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

3.14.04

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

3.14.05

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

3.14.06

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



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TECHNICAL SPECIFICATION FOR METERING PUMPS



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1.00.0 GENERAL

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

2.00.0 GENERAL DESIGN FEATURES

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

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

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

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

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

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

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

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

2.00.09 Suitable gland seal shall be provided to prevent leakage.

2.00.10 Electric drive motor particulars should follow enclosed electrical chapters.

3.00.00 TESTING

3.01.00 Testing and Inspection at Manufacturer's Works

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

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

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

3.01.04 The pump casing shall be hydraulically tested at 200% pump operating pressure or 150% of design pressure whichever is higher. The test pressure shall be maintained at least for $\frac{1}{2}$ an hour.

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



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- 3.01.06 All pumps shall be tested at the shop for capacity, volumetric accuracy, repetitive accuracy, power and volumetric efficiency. The tests are to be done according to the requirements of the "Hydraulic Institute" of U.S.A. and Indian Standards as applicable.
- 3.01.07 The pump accessories e.g. gear box, speed reduction unit etc. will be subjected to tests as per manufacturer's standards. The test results shall be furnished to the Owner.
- 3.01.08 The combined variation of the pump and motor should be restricted within limits specified by Hydraulic Institute Standard, USA when the pump operated singly or in parallel.
- 3.01.09 All pumps shall be subject to strip down examination visually to check for mechanical damages after performance testing at shop.
- 3.01.10 Diaphragm of the metering pump shall be type tested as per applicable code/standard.
- 3.01.11 Performance test shall be carried out for the setting of pressure relief valve.
- 3.01.12 Test reports and certificates of all the above-mentioned tests to ensure satisfactory operation of the system shall be submitted to the Owner for approval before dispatch.

3.02.00 Test at Site

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