
	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° 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 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.
- 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) Eyebolts 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°F (315°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 thermodynamic 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 shop as required by the IBR or any other applicable standards. Test pressure shall however be not less than the following :

Test Pressure =

$$1.5 \times \frac{\text{Allowable Stress at Room Temp.}}{\text{Allowable Stress at Design Temp.}} \times \text{Design Pressure}$$

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 for the approval of Owner/Consultant.

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 at least twice the set pressure.
- 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 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.

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- 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.

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- 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.
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- 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°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°C to 510°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°C to 540°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°C to 600°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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**TECHNICAL SPECIFICATION FOR
PRESSURE & STORAGE VESSEL**

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1.00.00 GENERAL

The following principal pressure and atmospheric vessels for the system has been covered in this part of specification.

1. Condensate Polisher Service vessels.
2. Condensate Polisher Resin Separation and Cation Regeneration vessel.
3. Condensate Polisher anion regeneration vessel.
4. Condensate Polisher mixed resin storage Vessel.
5. Alkali diluent Heating cum Storage Vessel.(hot water tank)
6. Activated carbon filter
7. Alkali Preparation Tank
8. Alkali Day Tank
9. Resin Injection Hopper
10. Acid Measuring Tank.
11. Acid Storage Tank
12. DM storage tank.
13. Alkali storage tank

1.01.00 Of these, the items specified from Sr. no. 1 to 6 shall be designed as pressure vessels and the rest shall be atmospheric vessels.

1.01.01 All other vessels, not specifically listed here, but required for the Bidder's system shall also meet the general requirements of this specification.

1.01.02 Process requirements of these vessels shall be governed by the requirements of the Condensate Polishing System, which will determine their design conditions. Following sections only indicate some of the minimum requirements which must be met, and the actual design of these vessels shall be better than these, if that is required from process considerations.

2.00.00 GENERAL DESIGN FEATURES

2.01.00 Design

2.01.01 Design of all pressure vessels shall conform to ASME Section VIII or acceptable equivalent international standard. Design pressure shall be the maximum expected pressure to which the vessels may be subjected to plus 10% additional margin. Maximum expected pressure for vessels placed in the discharge line of pumps shall be based on the shut-off head of the pumps plus static head at pumps suction if any. Design pressure of condensate service vessels is indicated elsewhere in this specification. For all other pressure vessels, design pressure shall be at least 10 Kg/cm² (g) minimum or as per system design whichever is higher.

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- 2.01.02 Design of all vertical cylindrical atmospheric storage tanks containing water, acid, alkali and other chemicals shall conform to IS: 803.
- 2.01.03 Design of all horizontal cylindrical atmospheric storage tank containing water, acid, alkali and other chemicals shall conform to BS EN12285-2:2005.
- 2.01.04 Design temperature of all pressure vessels and storage tanks shall be 10 deg. C higher than the maximum temperature that any part of the vessel/tank is likely to attain during operation.
- 2.01.05 In case, tank is subjected to vacuum; the same shall be taken care in designing the tank.
- 2.01.06 The design of Demineralised water storage tanks (Vertical type) shall conform to IS: 803. Supporting frame where required shall be in accordance with IS: 800. The tank shall be "Non-pressure" fixed roof type with atmospheric vents.
- 2.02.00 All vessels / tanks without inside rubber lining shall have a corrosion allowance of minimum 2 mm and mill allowance (minimum 0.3 mm) for shell and dished ends. Thinning allowance of 2 mm (minimum) shall be considered for dished end. Vessel / tanks ends shall be of dished design and constructed by forging, pressing or spinning process. Conical or flat ends shall not be accepted. All dished ends shall be stress relieved.
- 2.03.00 All the atmospheric tanks shall have sufficient free board above the "Level High"/"Normal Level" as the case may be. The overflow level shall be kept at least 30 cm or 10% of vessel height above the "Level High"/"Normal Level" for all the tanks except for the DM tanks for which a minimum height of 300 mm shall be provided over the "High Level". Further, a minimum 300 mm free board shall be provided above the top of overflow level to the top of the tank. Wall thickness of atmospheric tanks shall not be less than 6 mm.
- 2.04.00 Vessels coming under preview of IBR shall be designed accordingly.
- 2.05.00 Interior surfaces of all tanks shall be clear of stiffeners and other structural supports. Tanks shall be reinforced and stiffened externally as required.
- 2.06.00 All welds on inner tank surface shall be free of voids, gaps craters, pits, high spots, sharp edges, abrupt ridges and valleys or undercut edges. High spots, irregularities and sharp edges shall be removed by grinding. Inside weld seams shall be ground flush and smooth applicable for corrosion resistant coating or lining.
- 2.07.00 All internal baffles, wear plates, pipes etc. shall be continuously welded on both sides at all contact points with full fillet welds which shall be free of voids, gaps, craters, high spots, sharp edges, and undercutting. Sharp edges shall be ground to a 3 mm minimum radius.
- 2.08.00 Weld splatter shall be removed.
- 2.09.00 All welding shall be performed by ASME qualified welders under Section-IX of ASME Boiler and Pressure Vessel code and welding electrodes shall be as per relevant Codes/Standards viz. AISC Section 1.17 etc.
- 2.10.00 The plates for cylindrical tanks shall be accurately formed in bending rolls to the diameters called for, and the completed shells be concentric and plump. Plates shall be cold-rolled by plate bending machine in a number of passes to true curvature and joined by welding.
- 2.11.00 Vessels seam shall be so positioned that they do not pass through vessel connections.

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3.00.00 MATERIAL OF CONSTRUCTION

3.01.00 All pressure vessels shall be fabricated from carbon steel plates as specified in datasheet A of this specification and lined internally. All atmospheric tanks shall be fabricated of material as specified in datasheet A and lined internally.

4.00.00 APPURTENANCES

4.01.00 Manholes

4.01.01 All the pressure vessels and horizontal type storage tanks shall be provided with manhole of 500 mm diameter minimum size, preferably at the top head, complete with cover plate, lifting handle, davit cap, nuts, bolts, gaskets etc. to ensure leak tightness at the test pressure.

4.01.02 The vertical type storage tanks shall be provided with a manhole of 500 mm dia on the top cover, if the diameter of the tank is 1200 mm or more. For the DM water storage tanks, manholes shall be provided as per IS:803.

4.01.03 All the vessels and tanks shall be normally provided with a six inch gasketed handhole located near the bottom of the straight side.

4.01.04 The required lining/coating for the inside surface of the manhole/handhole, nozzle and cover plate of the manhole/handhole shall be same as that of the respective vessel/tank.

4.01.05 Sight Glasses

All the vessels mentioned shall be provided with pad type sight glasses on their vertical sides. Locations of these sight glasses shall be as follows:

4.01.06 One with the centre line at the normal level of the bed top, and one near the bottom of the straight side, for each of these vessels.

4.01.07 In addition, item no. 1.00.00 shall be provided with sight glasses, with their center lines at each of the normal separated resin interfaces.

4.02.00 Lifting Lugs

All vessels of diameter 1200mm or greater shall be provided with a minimum of 4 lifting lugs. Smaller vessels shall be provided with at least 2 lifting lugs.

4.03.00 Vessels Supports

Adequate supporting arrangements like straps, saddles, skirt rings, or legs of steel shall be provided to transfer all loads to the respective skid structures.

4.04.00 Vessel Internals

The internals for pressure Vessels shall be designed for a low pressure drop to promote uniform distribution and flow through the vessels and to withstand the full design pressure of the vessel in both directions.

Specification requirements for vessel internals are as follows:

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4.05.00 Inlet water and Regenerant Distributors

Hub and laterals with diffuser splash plates or header and perforated laterals. Material of construction shall be type 316 stainless steel, except for acid service which shall be of Hastelloy B.

4.06.00 Underdrains

Same as above with screened laterals with internal perforated pipes, and rubber-lined false bottom. For resin separation/regeneration/mixed resin vessels, it may have fully screened bottom (NEVA – clog type with para Septanurse screen, fully supported by subway grid, or equal).

4.07.00 For lined vessels, they shall also be lined in the same manner as the internal surfaces of these vessels. For the caustic diluent heating/storage tank, they shall be of type 304 stainless steel construction.

4.08.00 Internal Fasteners

All internal fasteners shall be of type 316 stainless steel and heavy duty locknuts shall be used throughout.

4.09.00 Piping Connections

All lined vessel connections and connections in unlined vessels 25 NB and larger shall be to ANSI 300 lb class. Flat face flanges shall be used throughout. Nozzle material shall be ASTM-A-106. Grade B. schedule 80 pipe. All flanged connections shall be supplied complete with matching counter flanges, nuts, bolts and full-face gaskets.

4.10.00 All vessel connections in unlined tanks smaller than 25 NB shall be screwed to ANSI 2.1 for schedule 80 pipe.

4.11.00 Resin Traps

Outlets of each of the condensate polisher service vessel and the waste effluent header of the common external regeneration facility, shall be provided with a resin trap. These resin traps shall be a minimum, conform to the following:

4.11.01 The resin trap shells shall be of steel construction and lined internally with saran or Polypropylene. The internals for all traps shall be johnson well screen type, of 316 stainless steel in both directions, resin traps located in processes effluent lines shall have a screen opening that does not exceed 120 percent of the associated process vessel under drain screen opening. Resin traps located in waste effluent headers shall have a screen opening of approximately 60 mesh.

4.11.02 Each resin trap shall be fully piped and valved for inplace manual back flushing.

5.00.00 SPECIFIC DETAILS

5.01.00 Alkali Diluent Heating – Storage Tank (Hot water tank)

hot water tank for heating of alkali diluent water with (2X60%) electric heating coil, of MOC as specified in sub section –IA of this specification shall be provided by bidder. The capacity of tank shall be minimum 20% higher than the maximum water demand. This tank shall be provided with burn out protection, pressure relief valve, level switches, temperature indicator etc. The heaters shall be sized for heating the water from a temperature of 15 to

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50 deg. C in 5 hours at the outlet of ejector.

All tank internals, including the inlet water tail pipe, shall be fabricated of type 304 stainless steel.

5.02.00 **Atmospheric Tanks**

Wall thickness of these tanks shall not be less than 6mm.

5.03.00 **Resin Injection Hopper**

The supplier shall provide a hopper type tank for resin make-up, using water slurry, to the condensate polishing systems. This make-up system will constitute a portion of the condensate polishing external regeneration system. The resin hopper shall have a conical bottom and a flat top. The top shall have a piano type hinged port, having a lifting handle, of sufficient size for easy resin loading. The resin shall discharge through a bottom connection to a water ejector for transport. Water shall be added to the hopper to assist in the resin transfer. The ejector discharge shall be to the resin separation-cation regeneration vessel. Demineralized water shall be used throughout for the resin transfer. Piping of the resin make-up system shall be the responsibility of the Bidder as a part of the external resin regeneration system.

a) **Capacity**

The resin make-up hopper tank shall be sized to handle up to 150 liters of as received new resin per single injection.

b) **Material**

The resin make-up hopper tank shall be fabricated of mild carbon steel having a minimum thickness of 6mm and lined.

5.04.00 **Chemical preparation and day tanks**

These shall be vertical cylindrical tanks. They shall be of carbon steel fabrication, lined and provided with full height level gauges right up to the overflow levels.

The alkali preparation tank shall be provided with a dissolving basket of type 316 stainless steel constructions, and a motorized slow speed stirrer mounted eccentrically to the tank by a bracket fixed to the side wall. The stirrer shall have impellers of type 316 stainless steel.

The alkali day tank shall be provided with an airtight cover complete with a breather arrangement, to prevent absorption of carbon dioxide from the atmosphere by the alkali solution contained in it. The overflow connection shall also be provided with a suitable seal for this purpose.

The tanks for ammonia solution (if applicable) shall also be provided with similar arrangements to prevent escape of ammonia vapour to outside.

5.05.00 **LINING**

All internal lining of vessels provided under this specification shall be of natural rubber, meeting the following minimum requirements.

5.05.01 **Hardness**

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Lining used may be soft rubber having a shore durometer reading or 65 on the A scale, or semi-hard rubber having a durometer reading of 65 on the A scale. Variations in hardness of the rubber lining between the different areas of a specific tank shall be within +/-5 durometer reading.

5.05.02 **Chemical Resistance**

The lining material shall be suitable for prolonged service in the chemical environment described below:

- Hydrochloric acid, 2 to 8% concentration, at temperature from 10 deg C to 50 deg C.
- Sodium hydroxide, 1 to 4% concentration, at temperature from 30 deg C to 50 deg C.
- 100 to 500 mg /l of sulphuric and hydrochloric acid combined. Ratio of concentration of these two acid 1 : 5 to 5 : 1 and temperatures from 10 deg C to 40 deg C.
- 1 to 10mg/l of sodium hydroxide at temperature from 10 deg C to 40 deg C.

The linings will be subjected to the condition (a) or (b) for intermittent periods of approximately one hour out of eight hours, and to conditions (c) or (d) remainder of the time.

5.05.03 **Thickness**

The lining shall be applied in three layers, resulting in a total thickness of not less than 4.5 mm anywhere on the internal surfaces of the vessels. The lining shall extend over the full face of all flanged connections and shall have a minimum thickness of 3 mm in all such external areas.

5.05.04 **Surface Preparation**

Prior to rubber lining all surfaces must be prepared in the following manner.

- Degrease surface prior to blasting.
- The surface is to be blasted with steel grit or sharp silica sand to a white and bright metal surface.
- All traces of grit and dust should be removed with a vacuum cleaner or by brushing. Care must be taken to avoid contaminating the surface.
- Immediately after blasting and removal of grit, the first coat of primer or cement shall be applied and allowed to dry.

5.05.05 **Protection**

After the lining is completed the vessels shall not be subjected to any prolonged exposure to direct sunlight in course of its transportation erection, etc. They shall not also be stored in direct sunlight. No further welding or burning shall be carried out on the vessel, after application of the lining.

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All lining projecting outside of the vessel, shall be protected adequately from mechanical damages during shipment, handling, storage etc.

Suitable warning, indicating the special care that must be taken with respect to these lined vessels, shall be stenciled on their outside surfaces with the letter at least 12mm high.

Example:

“Warning – Tank is lined”

“Do not weld or Burn”

“Do not Store in Direct Sunlight” etc.

6.00.00

CODES AND STANDARDS

The design, manufacture, shop testing, site fabrication and erection, testing and commissioning of the pressure and storage vessels shall conform to the latest revisions of the following standards, in addition to other standards mentioned elsewhere in the tender document subject to any modification and requirement, as specified here in after.

- | | | | |
|----|---------|---|--|
| a) | IS: 803 | - | Code of practice for design, fabrication and erection of Vertical Mild Steel cylindrical welded oil storage tanks. |
| b) | IS: 816 | - | Code of practice for use of metal arc welding for general construction in mild steel. |
| c) | IS: 817 | - | Code of practice for training and testing of metal arc welders. |
| d) | IS: 822 | - | Code of procedure for inspection of welds. |
| e) | IS:1363 | - | Black hexagonal bolts, nuts and locknuts (dia 6 to 39 mm) and black hexagon screws (dia to 24 mm). |
| f) | IS:1367 | - | Technical supply conditions for threaded fasteners. |
| g) | IS:2062 | - | Specification for weld able structural steel. |
| h) | IS:2002 | - | Steel plates for pressure vessels for intermediate and High temperature service including boilers. |
| i) | IS:2825 | - | Code of unfired pressure vessels. |
| j) | IS:3133 | - | Manhole and inspection opening for chemical equipment. |
| k) | IS:4049 | - | Specification for formed ends for tanks and pressure vessels. |
| l) | IS:4682 | - | Code of practice for lining of vessels and equipment for chemical processes Rubber Lining. |
| m) | BS:2594 | - | Specification for carbon steel welded horizontal cylindrical storage tanks. |
| n) | ASME | - | Boiler and pressure vessel Section VIII code. |

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o) ASTM - American Society for Testing and Materials.

7.00.00 FABRICATION

7.01.00 The vessel ends for storage tanks of vertical type shall have flat bottom. However, the ends of horizontal storage tanks, and all the pressure vessels shall be dished design of Tori-spherical type designed.

7.02.00 The plates to be used for fabrication shall preferably have a minimum width of 1500 mm.

7.03.00 All the joints (circumferential / longitudinal) shall be continuous butt welded, inside and outside. Connection shall be flush with inner surface of tanks and welded continuously on both sides of shell. Sharp inside edges shall be rounded to a minimum 3 mm radius.

7.04.00 Welding sequence shall be adopted in such a way so as to minimize 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 engineers. Welding shall not be carried out when the surface of the parts to be welded are wet from any cause and during periods of rain and high winds unless the welder and work are properly shielded.

7.05.00 All pressure vessels and storage tanks except Demineralised water (D.M.) shall be fabricated complete and tested at manufacturer's works to ensure better workmanship.

7.06.00 Tank Connections

7.06.01 Bidder shall furnish all pipe material required for tank connection for the process requirement. In addition to these, additional connections, if required by the Owner for the inter-connection of their piping, instrumentation etc. shall also be provided. Such additional requirement will be intimated to the successful Bidder later and Contractor shall provide these fittings to match with the Owner's items. Adequate pipe support attachments in the external surface of the tank/vessel shall be provided for Owners pipes for all the vessels/tanks. All lined vessels connections shall be conforms to ANSI 300 lb class. Nozzle material shall be ASTM-106 Grade B, Schedule 80.

7.06.02 All flanged connections should be supplied complete with matching counter flanges, nuts bolts and gasket materials. The flange design, (thickness and drilling etc.) shall match with the interconnected piping flanges.

7.06.03 Bolts and nuts to be used externally to the vessels shall be of hexagonal head conforming to IS:1367. However, internal fasteners if any, shall be of IS:316 /SS-304 or Hastalloy-B as per the duty conditions.

7.06.04 Gaskets shall be of full face type.

7.06.05 Sight glasses shall be provided for the tanks/vessels as specified in the standard specification. The material for sight glass shall be high quality transparent PLEXIGLASS of sufficient thickness to withstand the test pressure. The sight glass shall be provided with suitable gaskets and bolts to ensure leak tightness at the test pressure.

7.07.00 Vessels Supporting Lifting Lugs

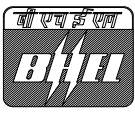
7.07.01 Adequate supporting arrangements like straps, saddles, skirt boards, pillars etc. shall be provided to transfer all loads to civil foundation. All foundation bolts, inserts etc. shall also be provided.

7.07.02 All vessels of internal, diameter of 1200 mm or greater shall be provided with minimum four

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(4) lifting lugs for safe and effective handling during erection. Smaller vessels shall be provided with at least two (2) lifting lugs.

- 7.07.03 Material of construction for these vessel supports, saddles, lugs shall conform to IS:2062 of tested quality.
- 7.08.00 **Special Accessories Storage Tanks**
- 7.08.01 Vessel internals wherever required shall be provided as detailed out elsewhere in the specification.
- 7.08.02 All the pressure vessels and tanks shall be provided with drain connections along with drain valves of suitable size. Further all the atmospheric storage tanks shall be provided with over flow connection designed for the filling rate of the respective tank.
- 7.08.03 All the pressure and tanks shall be provided with the vent connections. The design shall be as to offer adequate area for venting. Venting area shall be such that over pressure/vacuum is not created in the tank during maximum filling/drain-off rate. The maximum draw off rate for the DM storage tanks shall be intimated later to the successful bidder.
- 7.08.04 Various instrumentation and the fittings required for the same shall be supplied as elaborated in data sheets.
- 7.08.05 Water seal shall be provided for the overflow line of DM and degassed water storage tanks. The vent and overflow lines of alkali preparation /measuring / day tanks and vent line of DM storage tanks shall be provided with Carbon dioxide absorber of proven design to prevent contamination from atmospheric air. Carbon dioxide absorber shall preferably be located at ground level. The vent and overflow lines of Acid measuring tanks shall be provided with fume absorber using suitable packing material, such as pall rings/raschig rings.
- 7.08.06 Conservation vent valves shall be provided in the vent line of DM storage tanks so that, at a vacuum to the extent of 65 mm water column, the valve shall open to relieve the vacuum. Body and trim of the valve shall be Die Cast Aluminum.

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**TECHNICAL SPECIFICATION FOR
HORIZONTAL CENTRIFUGAL PUMPS**

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TECHNICAL SPECIFICATION FOR CONDENSATE POLISHING UNIT		

1.00.0 SCOPE

- 1.01.0 This specification covers the design, material, construction features, manufacture, inspection, testing the performance at the Vendor's/Sub-Vendor's Works and delivery to site of Horizontal Centrifugal Pumps.

2.00.00 CODES AND STANDARDS

- 2.01.0 The design, material, construction, manufacture inspection and performance testing of Horizontal Centrifugal Pumps shall comply with all currently applicable statutes, regulations and safety codes in the locality where the Equipment will be installed. Nothing in these specifications shall be construed to relieve the Vendor of this responsibility. The Equipment supplied shall comply with the latest applicable Indian Standards listed below. Other National Standards are acceptable, if they are established to be equal or superior to the Indian Standards.

2.02.0 List of Applicable Standards.

1	IS : 1520	Horizontal Centrifugal Pumps for clear cold fresh water.
2	IS : 5120	Technical requirements of roto dynamic special purpose pumps.
3	API : 610	Centrifugal pumps for general refinery service.
4	IS : 5639	Pumps Handling Chemicals & corrosion liquids.
5	IS : 5659	Pumps for process water.
6	HIS	Hydraulic Institute Standards, USA
7	ASTM-1-165-65	Standards Methods for Liquid Penetration Inspection.

- 2.03.03 In case of any contradiction with aforesaid standards and the stipulations as per the technical specifications as specified hereinafter the stipulations of the technical specifications shall prevail.

3.00.00 DESIGN REQUIREMENTS

- 3.01.00 The Pump shall be capable of developing the required total head at rated capacity for continuous operation. Also the pumps shall be capable of being operated to give satisfactory performance at any point on the HQ characteristics curve over the operating range of 40% to 120% of the duty point. The maximum efficiency of pump shall be preferably be within +/- 10% of the rated design flow as indicated in the data sheets.

- 3.02.00 The total head capacity curve shall be continuously rising from the operating point towards shut-off without any zone of instability and with a minimum shut-off head of 15% more than the design head.

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3.03.00 Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load division. The head Vs capacity and BHP Vs capacity characteristics should match to ensure even load sharing and trouble free operation throughout the range. Components of identical pumps shall be interchangeable.

3.04.00 Pumps shall run smoothly without undue noise and vibration. Peak to peak vibration limits shall be restricted to the following values during operation:

SPEED	Antifriction Bearing	Sleeve Bearing
1500 rpm and below	75.0 micron	75.0 micron

3.05.00 The noise level shall not exceed 85 dBA. Overall sound pressure level reference 0.0002 microbar (the standard pressure reference for air sound measurement) at a distance of 1 M from the equipment.

3.06.00 The pumps shall be capable of starting with discharge valve fully open and close condition. Motors shall be selected to suit to the above requirements. Continuous Motor rating (at 50 deg.C ambient) shall be atleast ten percent (10%) above the maximum load demand of the pump in the entire operating range to take care of the system frequency variation and no case less than the maximum power requirement at any condition of the entire characteristic curve of the pump.

3.07.00 The kW rating of the drive unit shall be based on continuously driving the connected equipment for the conditions specified. However, in cases where parallel operation of the pumps are specified, the actual motor rating is to be selected by the Bidder considering overloading of the pumps in the event of tripping of operating pump(s).

3.08.00 Pumps shall be so designed that pump impellers and other accessories of the pumps are not damaged due to flow reversal.

3.09.00 The Contractor under this specification shall assume full responsibility in the operation of pump and motor as a unit.

4.00.0 DESIGN CONSTRUCTION

4.01.00 Design and construction of various components of the pumps shall conform to the following general specifications. for material of construction of the components, data sheets shall be referred to.

4.02.0 Pump Casing

4.02.01 Pump casing shall have axially or radially split type construction. The casing shall be designed to withstand the maximum shut-off pressure developed by the pump at the pumping temperature.

4.02.02 Pump casing shall be provided with a vent connection and piping with fittings & valves. Casing drain as required shall be provided complete with drain valves, piping and plugs. It shall be provided with a connection for suction and discharge pressure gauge as standard feature. It shall be structurally sound to provide housing for the pump assembly and shall be designed hydraulically to minimum radial load at part load operation.

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4.03.00 Impeller

4.03.01 Impeller shall be closed, semi-closed or open type, and it shall be designed in conformance with the detailed analysis of the liquid being handled.

4.03.01 The impeller shall be secured to the shaft, and shall be retained against circumferential movement by keying, pinning or lock rings. On pumps with overhung shaft, impellers shall be secured to the shaft by a lockout or cap screw which tightness in the direction of normal rotation.

4.04.00 Impeller/Casing Wearing Rings

4.04.01 Replaceable type wearing rings shall be provided at suitable locations of pumps. Suitable method of locking the wearing ring shall be used. Wearing rings shall be provided in pump casing and/or impeller as per manufacturer's standard practice.

4.05.00 Shaft

4.05.01 The critical speed shall be well away from the operating speed and in no case less than 130% of the rated speed.

4.05.02 The shaft shall be ground and polished to final dimensions and shall be adequately sized to withstand all stresses from rotor weight, hydraulic loads, vibration and torques coming in during operation.

4.06.00 Shaft Sleeves

4.06.01 Renewable type fine finished shaft sleeves shall be provided at the stuffing boxes/mechanical seals. Length of the shaft sleeves must extend beyond the outer faces of gland packing of seal end plates so as to distinguish between the leakage between shaft and shaft sleeve and that past the seals/gland.

4.06.02 Shaft sleeve shall be fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation.

4.07.00 Bearings

4.07.01 Heavy duty bearings, adequately designed for the type of service specified in the enclosed pump data sheet and for long, trouble free operation shall be furnished

4.07.02 The bearings offered shall be capable of taking both the radial and axial thrust coming into play during operation. In case, sleeve bearings are offered additional thrust bearings shall be provided. Antifriction bearings of standard type, if provided, shall be selected for a minimum life 16,000 hrs. of continuous operation at maximum axial and radial loads and rated speed.

4.07.03 Proper lubricating arrangement for the bearings shall be provided. The design shall be such that the bearing lubricating element does not contaminate the liquid pumped. Where there is a possibility of liquid entering the bearings suitable arrangement in the form of deflectors or any other suitable arrangement must be provided ahead of bearings assembly.

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4.07.04 Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearings housing.

4.08.00 Stuffing Boxes

4.08.01 Stuffing box design should permit replacement of packing without removing any part other than the gland.

4.08.02 Stuffing boxes of packed ring construction type shall be provided wherever specified. Packed ring stuffing boxes shall be properly lubricated and sealed as per service requirements and manufacturer's standards. If external gland sealing is required, it shall be done from the pump discharge. The Bidder shall provide the necessary piping valves, fittings etc. for the gland sealing connection.

4.09.00 Mechanical Seals

4.09.01 Wherever specified in pump data sheet, mechanical seals shall be provided. Unless otherwise recommended by the tenderer, mechanical seals shall be of single type with either sliding gasket or bellows between the axially moving face and shaft sleeves or any other suitable type. The sealing faces should be highly lapped surfaces of materials known for their low frictional coefficient and resistance to corrosion against the liquid being pumped.

4.09.02 The pump supplier shall coordinate with the seal maker in establishing the seal chamber of circulation rate for maintaining a stable film at the seal face. The seal piping system shall form an integral part of the pump assembly. For the seals under vacuum service, the seal design must ensure sealing against atmospheric pressure even when the pumps are not operating. Necessary provision for seal water supply along with complete piping fittings and valves as required shall form integral part of pump supply.

4.10.00 Pump Shaft Motor Shaft Coupling

4.10.01 The pump and motor shafts shall be connected with an adequately sized flexible coupling of proven design with a spacer to facilitate dismantling of the pump without disturbing the motor. Necessary coupling guards shall also be provided.

4.11.00 Base Plate

4.11.01 A common base plate mounting both for the pump and motor shall be provided. The base plate shall be fabricated steel and of rigid construction, suitably ribbed and reinforced. Base plate and pump supports shall be so constructed and the piping unit so mounted as to minimize misalignment caused by mechanical forces such as normal piping strain, internal differential thermal expansion and hydraulic piping thrust. Suitable drain troughs and drip lip shall be provided.

4.12.00 Assembly and Dismantling

4.12.01 Assembly and dismantling of each pump with drive motor shall be possible without disturbing the grouting base plate or alignment.

4.13.00 Drive Motor (Prime Mover)

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- 4.13.01 The kW rating of the drive shall be based on continuously driving the connected equipment for the conditions specified. In case, where parallel operation of the pumps are specified, the actual motor rating is to be selected by the tenderer considering overloading of the pumps in the event of tripping of operating pumps.

5.00.00 TESTING FOR HORIZONTAL CENTRIFUGAL PUMPS

The manufacturer shall conduct all tests required to ensure that the equipment furnished shall conform to the requirements of this specification and in compliance with the requirement of applicable Codes and Standards. The particulars of the proposed tests shall be submitted to the Owner for approval before conducting the tests.

5.01.00 Hydrostatic Tests

All pressure parts shall be hydraulically tested at 200% of pump rated head or at 150% shut off head whichever is higher. The test pressure shall be maintained for 1/2 hr. and no leakage shall be permitted. While arriving at the above pressure, the maximum suction head specified in Data Sheet shall be taken into account.

5.02.00 Performance Tests

- 5.02.01 All the pumps shall be tested in the Manufacture's Works at rated speed for capacity, efficiency and brake horse power. Pumps shall be given running test over the entire operating range covering from the shut off head to the maximum flow. The duration of test shall be minimum one (1) hour. A minimum of seven readings approximately equidistant shall be taken for plotting the curves with one point at design flow. Testing of pumps shall be in accordance with stipulations of Hydraulic Institute Standards or as applicable equivalent
- 5.02.02 The test shall be preferably conducted with the actual motor being furnished.
- 5.02.03 Only those pumps shall be subjected to strip down examination visually to check for mechanical damages after testing at shop in case abnormal noise level and excessive vibration is observed during the performance test. Otherwise strip down examination is limited to bearing inspection only.
- 5.02.04 The pump accessories e.g. the thrust bearing, couplings etc. shall be subjected to tests as per manufacturer's standards.

5.03.00 Mechanical Balancing

All rotating components of the pumps shall be statically balanced. In addition to static balancing, rotating components of the pumps shall be balanced dynamically at or near the operating speed. Tenderer shall furnish acceptance norm for this test.

5.04.00 Visual Inspection

Pumps shall be offered for visual inspection by the bidder before shipment. The components of the pumps shall not be painted before inspection.

5.05.00 NPSH Test

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NPSH test shall be conducted with water as medium if required. NPSH shall not be mandatory in case type test certificates are furnished for the similar rating of pumps.

5.06.00 Noise and Vibration Measurement

Noise and vibration shall be measured during the performance testing at shop as well as during the site test.

- 5.06.01 The noise level shall not exceed 85 dBA. Noise level measurement will be made as per applicable internationally acceptable standard. The measurement shall be carried out with calibrated integrating sound level meter meeting the requirement of IEC:651 or BS:5969 or IS:9779. Sound pressure level will be measured all round the pump and motor set at a distance of one meter from the nearest surface of the machine and at a height of 1.5 m from the floor level. A minimum of six (6) points should be covered for measurement. The measurement shall be done with a slow response on the A-weighted scale. The average of the A-Weighted sound pressure measurements expressed in decibels to a reference 0.0002 microbars shall not exceed the specified value.

The tests shall be carried out on the machine operating at rated speed and as near as possible to the rated power. Corrections for background noise and correction on account of test environment will be considered in line with applicable standard. For this purpose all the additional data required should necessarily be collected during the test.

- 5.06.2 Vibration check will also be done as per HIS. Vibration would be checked at thrust bearing locations on horizontal, radial and vertical direction. The acceptance limits would be as per HIS. The instrument used would be IRD 308 or equivalent with velocity pick-up. Vibration limits to be specified as per the speed of the pump.

5.07.00 Material Test Certificate

- 5.07.01 Material of the various pump components shall be tested in accordance with the relevant standards. Test certificates for these shall be furnished for the Owner's approval.
- 5.07.02 Where stage inspection is desired by BHEL/customer all material test certificates shall be correlated and verified with the actual material used for construction before starting fabrication by BHEL/customer's inspector who will stamp the material. In case mill test certificate for the material are not available, the supplier shall carry out physical and chemical tests at his own cost from a testing agency, approved by BHEL/Customer, as per the requirement of specified material standard. The sample for physical and chemical testing shall be drawn up in presence of BHEL/Customer's inspector who shall also witness the testing.

5.08.00 Non Destructive Testing

- (a) UT shall be carried out on shafts of diameter more than 50 mm.
- (b) DP tests shall be carried out on shaft and impeller.
- (c) No weld repair shall be allowed on cast iron.

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5.09.00 Field Testing

- 5.09.01 After installation, the pumps offered shall be operated to prove satisfactory performance as individual equipment as well as a system run. If the performance at site is found not to the requirements then the equipment shall be rectified or replaced by the Vendor, at no extra cost to the Owner. The procedure of the above testing will be mutually agreed between the Owner and the contractor. Noise and vibration tests shall also be repeated at site.
- 5.09.02 Based on observation of the trial operation, if modifications and repairs are necessary, the same shall be carried out by the contractor to the full satisfaction of the engineer and then the performance and guarantee tests to be repeated at site as per relevant clauses of the specification.

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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

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- 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 ½ an hour.
- 3.01.05 The rotating parts of pump drive shall be subjected to static balancing.
- 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.

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**TECHNICAL SPECIFICATION
FOR
VERTICAL CENTRIFUGAL PUMPS**

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1.00.00 GENERAL INFORMATION

1.01.00 The general guidelines as illustrated in the subsequent clauses of this section shall be applicable for vertical pumps to be procured under the scope of this package.

2.00.00 CODES AND STANDARDS

2.01.00 In addition to the requirements spelt out elsewhere in the specification, the equipment to be provided under this section shall specifically conform to the following codes, standards, specifications and regulations, as applicable, including all the latest amendments subsequent to the year of publication as mentioned below.

2.01.01 IS 1710/1989: Vertical Turbine Pumps for Clear, Cold and Fresh Water.

2.01.02 IS 5120/1977: Technical requirements - Rotodynamic special purpose pumps.

2.01.03 IS 5639/1970: Pumps for handling chemical and corrosive liquids.

2.01.04 IS 5659/1970: Pumps for process water.

2.01.05 IS 6536/1972: Pumps handling volatile liquids.

2.01.06 IS 9137/1978: Code for acceptance for centrifugal, mixed flow and axial
Flow pumps - Class 'C'

2.01.07 BS 5316: Acceptance tests for Centrifugal, mixed flow Part-I/1976 And axial flow pumps - Class 'C' Tests (ISO 2548/1973)

2.01.08 BS 5316: Acceptance tests for Centrifugal, mixed flow Part- II/1977 And axial flow pumps - Class 'B' Tests (ISO 3555/1977)

2.01.09 ANSI B 73.2M : Vertical inline centrifugal pumps for chemical process 1984

2.01.10 API 610/1989: Centrifugal pumps general refinery services.

2.01.11 Hydraulic Institute Standards of USA (1983).

2.01.12 PTC 8.2/1965: Power Test Codes - Centrifugal pumps.

3.00.00 Accessories:

All the pumps under this specification shall be complete with following standard/special accessories.

3.01.00 Standard accessories:

- a) Pump motor coupling along with coupling guard
- b) Common base plates for pump and motor.
- c) Lubrication system along with all internal piping, valves, fittings, specialties etc. as required.
- d) Counter flanges for suction/ discharge nozzles along with fixing nuts, bolts and gaskets.
- e) Anchor bolts, nuts, seating steel works, etc. as necessary for mounting the pump-motor unit on Civil foundations.
- f) Suitable vent (with valves)/ lifting/ handling attachments for the pump/ motor/ Accessories.
- g) Suitable drain connections with isolating valves as applicable.

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- h) Set of "Special" Tools & Tackles for Pumps and motors, if any.
- i) Erection and commissioning spares, "on as required" basis.
- j) Bidder shall provide various drawings, data, calculations, test reports/ certificates, Operation and maintenance manuals, As-built drawings, etc. as specified and as necessary.

3.02.00 Services included in Bidder's Scope:

3.02.01 The pumps shall be guaranteed to meet the performance requirements as specified vide datasheet – A and also for trouble free operation after commissioning.

4.00.00 TECHNICAL REQUIREMENTS:

4.01.00 The pumps shall be Electric motor driven.

4.02.00 The Pumps shall conform to HIS

4.03.00 Vertical type pumps with 1500rpm.

4.04.00 Minimum efficiency of vertical pump will be 40%.

4.05.00 No negative tolerance shall be permitted in rated capacity & TDH.

4.06.00 No negative tolerance shall be permitted in efficiency at rated capacity.

4.07.00 The shut off head of pumps shall be at least 115% of pump rated TDH.

4.08.00 The pumps shall be capable of developing the required total head at rated capacity for Continuous operation. The pumps shall operate satisfactorily at any point on the Q-H Characteristic curve over a range of 0% to 130% capacity and shall be suitable for Continuous operation between 30% to 130% capacity.

4.09.00 Selection of the pumps shall be such that the design point shall be met even with negative manufacturing tolerance.

4.10.00 The total head capacity curve shall be continuously rising towards the shut off, the pumps shall preferably be non-overloading type and stable.

4.11.00 The pumps shall be capable of running over the entire range of NPSH conditions required without any noise, vibration or cavitations.

4.12.00 The pumps shall be of stiff shaft design. The minimum internal clearances should be sufficiently more than the max. Static deflection of the shaft. Shaft size selected must take into consideration the critical speed as specified in API-610.

4.13.00 Pumps and motors shall run smooth without undue noise and vibration. The vibration shall be within 75 microns for pump - motor set. The noise level shall be limited to 85 dB at distance of 1.0M.

4.14.00 High reliability of the pumps is an essential requirement and therefore it gets weight age over its efficiency. It is therefore essential that the bidder choose a standard proven model from the range of pumps manufactured.

4.15.00 If water handled by pump is dirty/ not suitable for lubrication/ cooling, the bidder shall provide requisite strainer/ filters, tanks, motorized valves, etc. after the tap off for the required service, the arrangement provided shall be subject to Purchaser's approval.

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5.00.00 OTHER REQUIREMENTS:

5.01.00 The materials of construction for various components specified are the minimum Requirements indicated in datasheet – A section C and materials of construction for other components not specified shall be similarly selected by the bidder for the intended duty.

6.00.00 PAINTING FOR PUMPS:

- a) The surface of SS, Gun metal, brass, bronze and non metallic component shall not be applied with any painting.
- b) The Steel surface to be applied with painting shall be thoroughly cleaned before applying painting by brushing, shop blasting etc. as per the agreed procedure.

For all the steel surfaces inside the (indoor installation) building, a coat of red oxide primes of min. thickness of 50 microns followed up with under coat of Synthetic Enamel paint of min. thickness of 50 microns shall be applied. the top coat shall consist of two coats each of min. thickness of 50 microns of synthetic enamel paint and thus total thickness shall be min. 200 microns.

7.00.00 PERFORMANCE REQUIREMENTS

7.01.00 Pump (s) shall preferably be designed to have the best efficiency at the specified duty point. Further, the pumps (s) shall be suitable for continuous operation at any point within its 'range of operation'.

7.02.00 Under all circumstances, the 'range of operation' of the pump (s) shall exclude any Unstable operating zone of the head-capacity curve.

8.00.00 DESIGN AND CONSTRUCTION

Pumps shall be of vertical shaft, complete with bowl, column pipe, discharge head and base plate with all accessories. General design and constructional features of the pumps shall be as follows:

8.01.00 BOWL ASSEMBLY

8.01.01 This will be either a single, mixed flow or axial flow type with discharge co-axial with shaft. Type of impeller shall be chosen on the basis of the pump specific speed and the characteristics of handling fluid.

8.02.00 IMPELLER SHAFT, LINE SHAFT AND HEAD SHAFT

8.02.01 Shaft size shall be selected on the basis of maximum torque to be applied on the pump shaft. Critical speed of the shaft shall be sufficiently away from the pump operating speed and in no case shall lie between 90% and 110% of the rated speed.

8.02.02 Impeller shaft shall be guided by bearings provided in each bowl or above and below the impeller shaft assembly. The butting faces of the shaft shall be machined square to the assembly and the shaft shall chamfer at the edges.

8.02.03 Line shaft may be single or multiple pieces as required. In case of multiple pieces, line shaft shall be coupled as per the standard practice of the manufacture. For screwed coupling, directions shall permit tightening of the joint during pump operation.

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8.02.04 Replaceable shaft sleeves shall be furnished at applicable location, particularly under stuffing box and at other locations, as considered necessary.

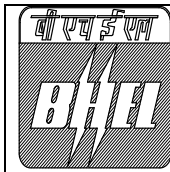
8.03.00 BEARINGS

8.03.01 SHAFT BEARINGS

Adequate number of properly designed bearings shall be provided for smooth and trouble free operation of the pump. Number of bearings shall consider the number of shaft pieces used and the critical speed of the shaft. Bearings shall be either lubricated by external clear water/oil/grease or self-lubricated. In case of external water/oil lubrication, complete lubrication arrangement shall be furnished with the pump.

8.03.02 THRUST BEARING

Thrust bearing of adequate size and capacity shall be provided to take the vertical thrust of the impeller arising out of the pump operation and dead weight of the rotating Components. Life of the thrust bearing shall be guided by the design standard of the pump. Thrust bearing shall be capable of running continuously at maximum load. Thrust bearing shall be either grease or oil lubricated. Lubrication arrangement shall be such that the lubricant does not contaminate the handling fluid. The arrangement shall also be adequate to protect the bearing, while the pump coast down to stop in case of power failure of the station. Pre-lubrication of the thrust bearing, if recommended by the pump manufacturer, shall be taken care of in designing the lubrication system. Cooling of the thrust bearing, if necessary, shall be done by the handling fluid/external Water, depending on the fluid handled. Location of the thrust bearing may be at the pump body or at the driver, or at both depending on the requirement.



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SECTION – II

GENERAL TECHNICAL REQUIREMENTS

SUB-SECTION IIB - GENERAL TECHNICAL REQUIREMENTS (ELECTRICAL)

	TITLE	SPECIFICATION NO.	
		VOLUME	II B
		SECTION D	
		REV NO. 00 DATE	
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MOTOR
DATA SHEET - C

S. No.	Description		Data to be filled by successful bidder
A.	General		
1	Manufacturer & country of origin		
2	Motor type		
3	Type of starting		
4	Name of the equipment driven by motor & Quantity		
5	Maximum Power requirement of driven equipment		
6	Rated speed of Driven Equipment		
7	Design ambient temperature		
B.	Design and Performance Data		
1	Frame size & type designation		
2	Type of duty		
3	Rated Voltage		
4	Permissible variation for		
5	a	Voltage	
6	b	Frequency	
7	c)	Combined voltage & frequency	
8	Rated output at design ambient temp (by resistance method)		
9	Synchronous speed & Rated slip		
10	Minimum permissible starting voltage		
11	Starting time in sec with mechanism coupled		
12	a) At rated voltage		
13	b) At min starting voltage		
14	Locked rotor current as percentage of FLC (including IS tolerance)		
15	Torque		
	a) Starting		
	b) Maximum		
16	Permissible temp rise at rated output over ambient temp & method		
17	Noise level at 1.0 m (dB		
18	Amplitude of vibration		
19	Efficiency & P.F. at rated voltage & frequency		
	a) At 100% load		
	c) At 75% load		

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S. No.	Description	Data to be filled by successful bidder
	c) At starting	
C.	Constructional Features	
1	Method of connection of motor driven equipment	
2	Applicable Standard	
3	DOP of Enclosure	
4	Method of cooling	
5	Class of insulation	
6	Main terminal box	
	a) Type	
	b) Power Cable details (Conductor, size, armour/unarmour)	
	c) Cable Gland & lugs details (Size, type & material)	
	d) Permissible Fault level (kArms & duration in sec)	
7	Space heater details (Voltage & watts)	
8	Flame proof motor details (if applicable)	
	a) Enclosure	
	b) suitability for hazardous area	
	i Zone	O / I / II
	ii Group	IIA / IIB / IIC
9	No. of Stator winding	
10	Winding connection	
11	Kind of rotor winding	
12	Kind of bearings	
13	Direction of rotation when viewed from NDE	
14	Paint Shade & type	
15	Net weight of motor	
16	Outline mounting drawing No (To be enclosed as annexure)	
D.	Characteristic curves/ drawings (To be enclosed for motors of rating $\geq 55\text{KW}$)	
	a) Torque speed characteristic	
	b) Thermal withstand characteristic	
	c) Current vs time	
	d) Speed vs time	

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Explanatory notes for filling up cable list for routing through WinPath, the cable routing program (developed by Corporate R&D) being used in PEM.

1. For the purpose of clarity, it may please be noted that the information given in regard to the cables to be routed through WinPath as per the system elaborated below is called "Cable List", while the term "Cable Schedule" applies to the cable list with routing information added after routing has been carried out.
2. The cable list shall be entered as an MS Excel file in the format as per enclosed template EXT_CAB_SCH_FORMAT.XLS. No blank lines, special characters, header, footer, lines, etc. shall be introduced in the file. No changes shall be made in the title line (first line) of the template.
3. The field properties shall be as under:
 - a. UNITCABLENO: A/N, up to sixteen (16) characters; each cable shall have its own unique, unduplicated cable number. In case this rule is violated, the cable cannot be taken up for routing.
 - b. FROM: A/N, up to sixty (60) characters; the "From" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - c. TO: A/N, up to sixty (60) characters; the "To" end equipment/ device description and location to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - d. PURPOSE: A/N, up to sixty (60) characters; the purpose (i.e. power cable/ indication/ measurement, etc.) to be specified here. Information in excess of 60 characters will be truncated after 60 characters.
 - e. REMARKS: A/N, up to forty (40) characters; Any information pertinent to routing to be specified here (e.g., cable number of the cable redundant to the cable number being entered). Information in excess of 40 characters will be truncated after 40 characters.
 - f. CABLESIZE: A/N, 7 characters exactly as per the codes indicated below shall be specified here. The program cannot route cables described in any other way/ format.
 - g. PATHCABLENO: Field reserved for utilization by the program. User shall not enter any information here.
4. One list shall be prepared for each system/ equipment (i.e., separate and unique cable lists shall be prepared for each system).
5. The cables shall be described as per the scheme listed below:

A	NN	A	NNN
Cable	No. of cores	Cable code	Cable size
Voltage	(e.g. 01,03,3H, 07)	(See C below)	(e.g. 035,185,2.5, 0.5)
Code (see B below)			

(A) **SYSTEM VOLTAGE CODES:**

(ac) A = 11KV, B = 6.6KV, C = 3.3KV, D = 415V, E = 240V, F = 110V
 (dc) G = 220V, H = 110V, J = 48V, K = +24V, L = -24V

(B) **CABLE VOLTAGE CODES:**

A = 11KV (Power cables)

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B = 6.6KV (Power cables)
 C = 3.3KV (Power cables)
 D = 1.1KV (LV & DC system power & control cables)
 E = 0.6KV (0.5 sq. mm. Control cables)

(C) CABLE CODES

PVC Copper

A = Armoured FRLS	B = Armoured Non-FRLS
C = unarmoured FRLS	D = Unarmoured Non-FRLS

PVC Aluminium

E = Armoured FRLS	F = Armoured Non-FRLS
G = unarmoured FRLS	H = Unarmoured Non-FRLS

XLPE Copper

J = Armoured FRLS	K = Armoured Non-FRLS
L = unarmoured FRLS	M = Unarmoured Non-FRLS

XLPE Aluminium

N = Armoured FRLS	P = Armoured Non-FRLS
Q = unarmoured FRLS	R = Unarmoured Non-FRLS

S = FIRE SURVIVAL CABLES
 T = TOUGH RUBBER SHEATH
 U = OVERALL SCREENED
 V = PAIRED OVERALL SCREENED
 W = PAIRED INDIVIDUAL SCREENED
 Y = COMPENSATING CABLES
 I = PRE-FABRICATED CABLES
 Z = JELLY FILLED CABLES

6. Once a cable list has been given to PEM for routing, any subsequent changes required in the cable list (which may be in the form of addition of cables, deletion of cables, change of type or size of cable, etc.) must be informed as specific changes (as a separate file MS Excel of the same format as the original file) to the cable list given earlier if the cable list has been routed and cable schedule generated. The routing status of the cable list shall be got confirmed from PEM by the agency that has prepared the cable list before the changes are intimated. In case PEM confirms that the cable list in question has not been taken up for routing, and the revised cable list is acceptable, the same may be sent. Since cable routing through the program involves adding each cable list to the project cable schedule database, the original cable schedule shall not be furnished to PEM with revisions incorporated within.