The impeller shall be as per the proven design of the manufacturer. It shall be keyed to the shaft and locked in position. The rotor assembly shall be statically and dynamically balanced and designed with critical speed substantially above the operating speed.

3.01.03 **Impeller/Casing Wearing Rings**

Replaceable type wearing rings shall be provided at suitable locations for each pump. The rings shall be so fitted as to prevent turning while the pump is in operation.

3.01.04 **Shaft**

The shaft shall be adequately sized to withstand all stress from rotor weight and hydraulic loads etc. The shaft shall be ground and polished to final dimensions.

3.01.05 **Shaft Sleeves**

Pump shafts shall be protected by renewable type shaft sleeves which shall extend well beyond the pump glands. The sleeves shall be highly polished and shall be securely fastened to the shaft to prevent any loosening.

3.01.06 **Bearings**

Heavy duty bearings, adequately designed for the type of service specified and for long and trouble-free operations, shall be furnished. The design shall be such that the bearing lubricating oil does not contaminate the liquid being pumped.

3.01.07 **Thrust Bearings**

Adequately designed thrust bearings to absorb pump thrust or other unbalanced force, if any, shall be provided.

3.01.08 Lubrication system shall be designed in such a way that in case of total power failure, there will not be any damage while coasting down to stop.

3.01.09 **Stuffing Boxes**

Stuffing boxes of packed ring construction or of mechanical seal type as desired in the Data Sheet - Appendix-II attached with this specification shall be provided. The necessary piping, valves, fitting etc. for the gland sealing connection shall be provided. For mechanical seals, the mating surfaces shall be suitably hard faced to ensure long life.

3.01.10 **Pump Shaft-Motor Shaft Coupling**

The pump shaft and motor shaft shall be connected with a suitably designed flexible coupling of approved design preferably with a spacer to facilitate dismantling of the

pump without disturbing the motor. Necessary coupling guards for the coupling shall also be furnished.

3.01.11 **Base Plate**

A common base plate for mounting the pump and the corresponding driver motor shall be furnished. The base plate shall be of fabricated steel and of rigid construction, properly ribbed as required. Driplip with drain tap suitable for type of service specified shall be furnished.

3.01.12 **Drain, Vent and Priming Connections**

Each pump shall be provided with a casing drain, vent and priming connection at suitable locations.

3.01.13 **Drive Motor and Its Control**

Please refer Electrical Specification enclosed herewith this specification.

3.01.14 **Anchor Bolts, Sleeves, Inserts, Lifting Lugs, Eye Bolt, etc.**

All anchor bolts, foundation plates, sleeves, nuts, inserts etc. to be embedded in concrete for the equipment are to be supplied. The length of the foundation bolts shall be liberally sized to reach below the reinforcement level.

Each equipment shall be provided with suitable lifting lugs, eye bolts etc. to facilitate maintenance.

3.02.00 Consistent with good operating characteristics and high efficiency, each pump shall have a continuously rising head capacity characteristics curve without any zone of instability. Power flow characteristic shall preferably be non-overloading type beyond rated duty point. The characteristic curves of each set of pumps shall match each other for equal sharing in case of parallel operation. The pump motor set shall be designed in such a way that there is no damage due to reverse flow through the pump which may occur due to any mal-operation of the system.

3.03.00 The pumps shall be suitably designed also for smooth and trouble free continuous solo operation in the event of trip out of the remaining pumps running in parallel.

3.04.00 The pumps shall be designed to have best efficiency at the rated duty point. The pumps shall be suitable for continuous operation within a wide range above and below the rated duty point. Such range of operation within which category of pumps can satisfactorily operate on continuous basis, shall be clearly indicated.

3.05.00 Drive motors for each category of pumps shall be suitable for use on 415V ±10%, 3Ø , 50 Hz ±5% and neutral grounded system. Drive motors shall have 15% spare margin over the maximum power requirement of the pump within the range of operation.

4.00.00 TESTING

4.01.00 **Testing and Inspection at Manufacturer's Works**

4.01.01 All tests required shall be conducted to ensure that the equipment furnished shall conform to the requirements of this specification and in compliance with requirements of the applicable codes.

The particulars of the proposed tests and the procedures for the tests shall be submitted for approval before conducting the tests.

4.01.02 The representatives of Purchaser shall be given full access to all tests. Prior to pump performance tests, the manufacturer shall inform the Purchaser allowing adequate time so that if the Purchaser desires, his representatives can witnesses the test.

4.01.03 All materials and casting used for the equipment shall be of tested quality. The test certificates shall be made available to Purchaser.

4.01.04 The pump casing shall be hydraulically tested at 200% of pump rated head or at 150% of shut-off head, whichever is higher. The test pressure shall be maintained for at least half an hour.

4.01.05 The pump rotating parts shall be subjected to static and dynamic balancing tests.

4.01.06 All pumps shall be tested at the shop for capacity, head efficiency and brake horse power and cavitation. The tests are to be done according to the requirement of the "Hydraulic Institute" of USA, ASME Power Test Code PTC-8.2 (latest edition) and Indian Standards as applicable.

4.01.07 The pump accessories e.g. the thrust bearing, the motor pump shaft coupling etc. will be subjected to tests as per Manufacturer's standard.

4.01.08 The combined vibration of pump and motor should be restricted to the limits specified by Hydraulic Institute Standards, USA, when the pump is in operation at any load singly or in parallel.

4.01.09 Tests on motors shall be conducted as per electrical specification enclosed herewith this specification.

4.01.10 The reports and certificates of all the above mentioned tests to ensure satisfactory operation of the system shall be submitted to the Purchaser before despatch.

4.01.11 Cast heat marks are to be provided on castings for casing and impeller.

4.02.00 Tests at Site

After erection at site, pumps under different services shall be operated to prove satisfactory performance as individual equipment as well as a system.

TECHNICAL SPECIFICATION
FOR
VERTICAL CENTRIFUGAL PUMPS

TECHNICAL SPECIFICATION
FOR
VERTICAL CENTRIFUGAL PUMPS

C O N T E N T S

TECHNICAL SPECIFICATION FOR VERTICAL CENTRIFUGAL PUMPS

1.00.00 INTENT OF SPECIFICATION

The specification covers the design, performance, manufacturing, shop testing, erection, testing and commissioning at site, of the vertical centrifugal pumps.

2.00.00 CODES AND STANDARDS

2.01.00 The design, manufacture and performance of the vertical centrifugal pumps shall conform to the latest revisions of the following codes and Indian Standards in addition to other stipulations and standards mentioned elsewhere in the specification :

a) IS-1710 : Vertical turbine pumps for clear, cold, fresh water.

b) IS-5120 : Technical requirement for rotodynamic special purpose pumps.

c) IS-5639 : Pumps handling chemicals and corrosive liquids.

d) IS-5659 : Pumps for process water.

e) Standards of Hydraulic Institute, USA.

2.02.00 The material of construction for the various components of the pumps shall conform to the applicable standards like "American Society of Testing & Materials (ASTM)" and Indian Standards.

3.00.00 DESIGN AND CONSTRUCTION

3.01.00 Pump Type

The pumps shall be vertical wet pit type with open shaft or enclosed shaft construction depending on the type of liquid to be pumped. Material of construction shall be as per the data sheets in Appendix-II. The pump shed shall preferably be limited to 1500 RPM.

3.02.00 Discharge Head Assembly

The pump shall have fabricated discharge head disposed above the ground. The head shall be capable of supporting the pump and motor on the foundation; expansion joint shall be provided immediately at the pump discharge; but no thrust block shall be provided for the unbalanced hydraulic thrust thus developed. The anchor bolts and pump fixing arrangement shall be suitably designed to take up the back thrust due to the expansion joint.

The head shall contain a packed type stuffing box to prevent any leakage.

A water stinger may be fitted to the top shaft to protect the motor from water spray.

3.03.00 Bowl

In addition to housing the impellers properly, the bowls shall provide a smooth path to water passage and shall be hydraulically designed to minimise radial thrust.

3.04.00 Impeller

The impeller shall be closed or open as per standard design of the manufacturer. All rotating parts including the impeller shall be statically and dynamically balanced. The critical speed of all the rotating parts shall be substantially above the design speed.

3.05.00 Pump Shaft and Motor Shaft Coupling

The pump shaft shall be connected to motor shaft by a heavy duty flexible coupling.

3.06.00 Column Pipe and Shaft

The line shaft and the shaft enclosing tube shall be made in convenient sections and shall be joined securely by union couplings. The column pipe shall also be made in sections and shall be joined by flanged coupling. In case of flanged joint gaskets shall be provided at each connection.

For sludge handling, vertical cantilever pump with no submerged bearing shall be provided.

3.07.00 Shaft Sleeves

Replaceable shaft sleeves shall be furnished. The shaft sleeve shall be securely locked to shaft to prevent loosening while in operation.

3.08.00 The necessary supporting frame, base-plates, sole-plates, mounting-plates, etc. as required shall be supplied under this specification, alongwith anchor bolts, foundation bolts, pipe sleeves etc.

3.09.00 Thrust Bearings

Thrust bearing of adequate design shall be furnished for taking the pump weight as well as maximum hydraulic thrust. The bearing may be lubricated by grease or oil. The design should be such that the bearing lubricating oil does not contaminate the liquid being pumped. Cooling of thrust bearing, if necessary, shall be done by liquid tapped from the discharge of the pump itself. The thrust bearing shall be designed on the basis of 20,000 working hours minimum for the load corresponding to the duty point.

3.10.00 Line Shaft and Bowl Bearing

Adequate number of properly designed bearings shall be furnished to prevent undue vibration.

3.11.00 Lubrication system shall be designed in such a way that in case of total power failure, there will not be any damage while coasting down to stop.

3.12.00 Shaft Enclosing Tube

For sludge/turbid/dirty water/chemical services, the pump shaft shall be of enclosed tube construction. For the lubrication of shaft necessary clarified/filtered water required shall be arranged. Necessary piping, valves, fittings, booster pumps etc. as required shall be included in scope.

3.13.00 Suction Bell

The pump shall be complete with adequately dimensioned suction bell to guide and streamline intake fluid.

3.14.00 Adjustment of Impeller

The pump shaft shall have suitable arrangement for vertical adjustment of impeller position from an accessible point.

3.15.00 Pump Characteristics

Head capacity curve should be rising upto the shut-off head condition. Power versus capacity curve shall be non-overloading type beyond rated duty point.

The characteristic curves of each set of pumps shall match each other for equal load sharing in case of parallel operation. The pump shall however, be also designed for smooth and trouble-free continuous solo operation in the event of trip-out of the remaining pumps running in parallel.

3.16.00 The pumps shall be designed for reverse flow through them. The drive motor shall be capable of bringing the pump to its rated speed in the normal direction from the point of maximum possible reverse speed when power to the drive is restored.

3.17.00 The pumps shall be designed to have best efficiency at the rated duty point.

The pumps shall be suitable for continuous operation within a wide range above and below the rated duty point. Such range of operation within which the pumps can satisfactorily operate on continuous basis, shall be clearly indicated.

3.18.00 Drive motors for the pumps shall be suitable for use on 415V ± 10%, 3Ø , 50 Hz, ± 5% and neutral grounded system. Drive motors shall have 15% spare margin over the maximum power requirement of the pump within its range of operation.

4.00.00 TESTING

4.01.00 Testing and Inspection at Manufacturer's works

4.01.01 All tests required shall be conducted 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 Purchaser for approval before conducting the tests.

4.01.02 The representatives of Purchaser shall be given full access to all tests. Prior to pump performance tests, the manufacturer shall inform the Purchaser allowing adequate time so that if the Purchaser so desires, his representative can witness the test.

4.01.03 All materials and casting used for the equipment shall be of tested quality. The test certificates shall be made available to the Purchaser.

4.01.04 The pump casing shall be hydraulically tested at 200% of pump rated head or at 150% of shut-off head, whichever is higher. The test pressure shall be maintained for at least half an hour.

4.01.05 The pump rotating parts shall be subjected to static and dynamic balancing.

4.01.06 All pumps shall be tested at the shop for capacity, head, efficiency, brake horse power and cavitation. The tests are to be done according to the requirements of the Hydraulic Institute of USA, ASME Power Test Code, Indian Standards, as applicable.

4.01.07 The pump accessories e.g. the thrust bearing, the motor pump shaft coupling etc. will be subjected to tests as per manufacturer's standards.

4.01.08 The combined vibration of pump and motor should be restricted within limits specified by Hydraulic Institute Standards, USA when the pump is in operation at any load singly or in parallel.

4.01.09 Tests on motors shall be conducted as per electrical specification enclosed with this specification.

4.01.10 Test reports and certificates of the above mentioned tests to ensure satisfactory operation of the system shall be submitted to the Purchaser before despatch.

4.01.11 Cast heat marks shall be provided on castings for casing and impeller.

4.02.00 Test at Site

After erection at site, pumps under different services shall be operated to prove satisfactory performance as individual equipment as well as a system.

TECHNICAL SPECIFICATION
FOR
POSITIVE DISPLACEMENT PUMPS

TECHNICAL SPECIFICATION
FOR
POSITIVE DISPLACEMENT PUMPS

C O N T E N T S

TECHNICAL SPECIFICATION
FOR
POSITIVE DISPLACEMENT PUMPS

1.00.00 INTENT OF SPECIFICATION

This specification covers the design, performance, manufacturing, shop testing, erection, testing & commissioning at site, of the positive displacement pumps.

2.00.00 GENERAL DESIGN FEATURES

This specification provides guideline for design, manufacturing and testing of positive displacement pumps with variable capacity to inject chemicals, generally used in the treatment of water in metered amounts.

2.01.00 Pumps shall be simplex/duplex type, positive displacement hydraulically operated diaphragm design, driven by squirrel cage induction motor through suitable speed reduction unit.

2.02.00 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 automatically, wherever required, by pneumatic stroke positioner in proportion to a 0.2 - 1.0 Kg/Sq.Cm air signal or manually. For automatic pumps, in addition to the automatic control, manual control facility shall also be provided. Manual control facility shall be of micrometric adjusting type.

2.03.00 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.

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

2.05.00 Crank case shall be constructed of high quality cast iron, which will also house the gear box and guides for cross head.

2.06.00 Material of construction should be as follows :

- Crank case — Cast iron.
- Pump head — Polypropylene.
- Valve and valve housing — Polypropylene.
- Wheel — Cast iron to a 48.

♦ Worm	AISI 4142.
♦ Shafts (worm)	En 19.
♦ Diaphragm	Chemically inert teflon.
♦ Base plate	MS.
♦ Foundation bolts	MS.

2.07.00 Suitable gland seal should be provided to prevent leakage.

2.08.00 Electric drive motor particulars should follow Electrical Specification, enclosed herewith.

3.00.00 TESTING

3.01.00 Testing and Inspection at Manufacturer's Works

3.01.01 The Manufacturer shall conduct all tests required to ensure that the equipment furnished conforms to the requirements of this specification and is in compliance with requirements of the applicable codes.

The particulars of the proposed tests and the procedures for the tests shall be submitted to Purchaser for approval before conducting the tests.

3.01.02 The representatives of Purchaser shall be given full access to all tests prior to pump performance tests. The Manufacturer shall inform the Purchaser allowing adequate time so that if the Purchaser 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 Purchaser.

3.01.04 The pump casing shall be hydraulically tested at 200% of pump operating pressure or 15 Kg/Sq.Cm(g) whichever is higher. The test pressure shall be maintained for at least half 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, repeatative accuracy, power and volumetric efficiency. The tests are to be done according to the requirements of the "Hydraulic Institute" of U.S.A. ASME Power Test Code and Indian Standards or as per API.- 675.

3.01.07 The pump accessories e.g. gear box, speed reduction unit etc. will be subjected to tests as per Manufacturer's standards.

3.01.08 The combined vibration of pump and motor should be restricted within limits specified by Hydraulic Institute Standards, USA, when the pump is in operation singly or in parallel.

3.01.09 Test reports and certificates of all the above mentioned tests to ensure satisfactory operation of the system shall be submitted to the Purchaser before despatch.

3.01.10 Performance test shall be carried out for the setting of pressure relief valve.

3.02.00 Test at Site

After erection at site, pumps under different services shall be operated to prove satisfactory performance as individual equipment as well as a system.

TECHNICAL SPECIFICATIONS
FOR
SCREW PUMPS

CONTENTS

TECHNICAL SPECIFICATIONS FOR SCREW PUMPS

01.00.00 GENERAL

This section covers general requirement of design, construction features. manufacture, inspection and performance testing of screw / gear pump for water, oily water, fuel oil and sludge applications.

2.00.00 CODES AND STANDARDS

The equipment supplied shall comply with the latest applicable Indian Standards listed below. Other national standards are acceptable provided they are established to be equal or superior to the Indian Standards mentioned herewith.

IS : 5120. 1977	Technical requirements of rotodynamic purpose pumps
BS : 599. 1966	Method of testing for pumps
HIS	Hydraulic Institute Standards, USA
API: 676. 1980	Positive Displacement Pumps - Rotary
VDMA 24284. 1970	Positive Displacement Pumps - Code for Acceptance Test
IS: 210.1993	Grey Iron Castings
IS : 2062, 1992	Steel for general structural purposes
ANSI B16.5	Pipe flanges and flanged fittings
ASME Sec II	Engineering Materials

03.00.00 TECHNICAL REQUIREMENTS

03.01.00 Design & Performance Requirements

03.01.01 The pump shall be horizontal, rotary, positive displacement type with gear or screw as rotary element.

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03.01.02 The pump shall be capable of developing the required total head at rated flow under continuous operation. The maximum efficiency of the pump shall be within ± 10% of rated flow.

03.01.03 Pumps of a particular category shall be identical and shall be suitable for parallel operation with equal load sharing. Components of identical pumps shall be Interchangeable.

03.01.04 Pumps shall run smoothly without undue noise and vibration. The noise level at a distance of 1 m from the equipment shall not exceed 85 dBA.

03.01.05 The pumps shall be suitable to handle fluid of characteristics as indicated in technical data sheet.

03.01.06 The pumps shall be suitable to handle the specified fluid for the complete range of operating conditions. The pump capacity shall be selected based on lowest possible viscosity and driving motor power shall be selected based on highest possible viscosity.

03.01.07 Each pump shall be connected to its drive motor directly and shall be mounted on a common base plate. The pump set along with drives shall be designed to permit rapid and economical maintenance.

03.01.08 All pumps shall be provided with suitable mechanical seals of proven design and material.

03.01.09 The supplier shall assume full responsibility in the operation of pump and motor as a unit.

03.02.00 Construction Requirements

03.02.01 Pump Casing

Casing and supports shall be designed to have sufficient strength and rigidity to prevent any adverse effect on internal clearances and to limit change of alignment to 50 micrometers at the coupling

flange caused by the worst combination of pressure, torque or allowable piping stress.

Pump casing shall be provided with a vent connection along with piping, fittings & valves unless pump is self-venting by the arrangement of nozzles. 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.

Jacket for cooling or heating shall be provided, if specified in technical particulars. Passages shall not open into casing joints.

Inlet and outlet connections shall be flanged. Flanges shall be raised face and shall conform to ANSI B 16.5. Counter flanges with necessary bolts. nuts. gasket etc. shall be supplied along with the pump.

03.02.02 Rotating Elements

Rotating parts shall be properly aligned. Rotor and shaft shall be stiff enough to prevent contact between the rotor bodies and the casing. It shall be of material that have wear, corrosion and erosion resistance compatible with the application.

03.02.03 Mechanical Seals

The Pumps shall generally be employed with mechanical seals, which shall be arranged that replacement of seal should be possible with minimum downtime. T sealing faces should be highly lapped surfaces of materials known for their frictional coefficient and resistance to corrosion against the liquid being pumped

The seal end plate or rotating cover and bolting shall be designed to retain the Sl with sufficient rigidity to prevent distortion that might impair seal operation. T stationary seal member shall be positively retained to prevent its rotation. For 1 seals under vacuum service, the seal design must ensure sealing against atmospheric pressure even when the pumps are not operating.

If seal flushing and cooling is provided by the pumped fluid, the pump supplier $hall ensure that sufficient flow reaches the primary seal faces to provide for cooling and maintenance of a stable film at

the seal faces.

03.02.04 Stuffing Box

Stuffing box, if provided, should permit replacement of packing without removing any part other than the gland. Asbestos shall not be used as a packing material.

Stuffing Boxes of packed ring construction type preferably to accommodate five rings of packing (minimum four rings of packing) plus a lantern ring 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. or the gland sealing connection.

03.02.05 Bearing

Heavy duty antifriction bearings, adequately designed for the type of service specified in the technical data sheet and for long, trouble free operation shall be furnished.

The bearings offered shall be capable of taking both the radial and axial thrust coming into play during operation. Antifriction bearings shall be designed for a rated life of either 25000 hours with continuous operation at rated conditions or 16000 hours at maximum axial and radial loads and rated speed.

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 bearing assembly.

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

03.02.06 Pump & Motor shaft Coupling

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.

03.02.07 Base plate

A common base plate for the pump and motor shall be provided. The base plate shall be of fabricated steel (minimum 6 mm thickness) and of rigid construction suitably ribbed and reinforced. Base plate and pump supports shall be 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. The base plate shall be suitability drilled for the anchor bolts. The base plate shall have drip pan and suitable draining arrangement.

03.02.08 Relief Valve

To protect against damage due to accidental closure of discharge valve, each pump shall be provided with a relief valve of adequate capacity,

Relief valve shall be able to handle the pump rated capacity when fully open, at a pressure not more than 10 percent above the set pressure.

03.02.09 Material of Construction

The material of construction of various components shall be as indicated in technical particulars. These are to be considered as minimum requirement and it is the responsibility of supplier to select and offer proper material of construction for the required service,

03.02.10 Assembly and Dismantling

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

03.02.11 Drive Motor

The motor shall be sized to meet the maximum specified operating conditions. including external gear and/or coupling losses. Continuous Motor rating (at 50 ^{0} C ambient) shall be atleast ten percent (10%) above the maximum load demand of the pump in the entire operating range including the run out condition to take care of the system frequency & voltage variation.

The enclosure of motor shall comply various requirements of flame proof construction as per IS-2148 and degree of protection shall be as per IP-55.

Other design and construction features of the drive motor shall be as specified, elsewhere, under Standard Electrical Specifications.

4.00.00 TESTS

Material test certificates from recognized laboratories shall be furnished for review\for various components.

Following are the minimum shop and site tests to be conducted by the supplier:

4.01.00 Shop Tests

4.01.01 Hydrostatic Test

Pressure containing parts, including cooling and heating jackets, shall be test hydrostatically with liquid at a minimum of 1.5 times the maximum allowable working pressure but at not less than 1.38 bar gauge.

Tests shall be maintained for a sufficient period of time to permit complete examination of parts under pressure. The hydrostatic test shall be considered satisfactorily when no leaks are observed for a minimum of 30 minutes.

4.01.02 Mechanical Balancing

All rotating components of the pumps shall be subjected to static and dynamic balancing at shop as per ISO 1940. The dynamic balancing shall be done at or near the operating speed and the supplier shall furnish its acceptance norms for approval before conducting the test.

4.01.03 Non-destructive Testing

Non-destructive testing of the pump components shall be conducted in accordance with relevant standards. Prior to testing, the test procedure and repair procedure shall be submitted for approval. All components subjected to testing shall be identified and only those which are tested successfully shall be used for the manufacture of final product. All test results shall be submitted by the supplier for approval

All cast iron parts shall be tested in accordance with IS - 210. Test bars shall be cast or physical tests from the same ladle of metal as the casting they represent.

Steel forgings used in pump shall be tested for both physical properties and chemical composition. steel forgings shall be ultrasonically tested.

4.01.04 Performance Testing

All pumps shall be performance tested at the Manufacturer's Works as per testing code. The test shall be conducted to determine the following characteristics:

a) Speed
b) Discharge Pressure
c) Suction Pressure
d) Capacity
e) Power

The test shall be conducted preferably with the tested job motor.

Noise and vibration shall be measured during the performance

04.02.02 For pumps operating in parallel, the load sharing should not vary by more than 5%.
testing, for reference purposes.

The pumps showing any abnormal behaviour during the performance testing or the pumps as required shall be stripped down for a thorough examination after the performance test. The performance test report shall be prepared by the supplier and submitted for approval, before despatch of the pumps.

04.02.00 Site Tests

04.02.01 After installation, the pumps supplied shall be operated to prove satisfactory performance as individual equipment as well as a system. The noise and vibration level of the pumps shall be measured and it should be within the design values. For pumps operating in parallel, the load sharing should not vary by more than 5%. If performance at site is found to be unsatisfactory, then the supplier shall rectify or replace the equipment.

04.02.03 Test Procedure Instruments

The test procedures to be followed and instruments to be used for testing shall be subject to the approval. All instruments to be used for stage and performance testing shall be calibrated at reputed third party laboratories.

TECHNICAL SPECIFICATION FOR PRESSURE & STORAGE VESSEL(CONT.)

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 vessel/Mixed bed polisher.
2. Resin Separation and Cation Regeneration vessel.
3. Anion regeneration vessel.
4. 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/make-up Hopper
10. Acid Measuring Tank.

1.01.00 Of these, the items specified from sno 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).

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.

2.02.00 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 and atmospheric tank 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 20 cm or 10% of vessel height above the “Level High”/”Normal Level” for all the tanks. Further, a minimum 100 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.

3.00.00 MATERIAL OF CONSTRUCTION

3.01.00 Please refer DATA SHEET-A.

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 Lungs**

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:

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 minimum ANSI 300 lb class. Flat face flanges shall be used throughout. Nozzle material shall be ASTMA-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)**

This vessel shall be sized to hold a minimum of 5000 liters of 80 deg C demineralised water required for the regeneration of condensate polisher. In sizing this vessel, preheating of the anion resins shall not be considered as a requirement. The cold water feed line shall enter the tank through or near the top head and extend downward to within 15 cm of the tank bottom. Recovery time shall not exceed 4 to 5 hours.

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 or maximum attrition loss whichever is higher.

b) **Material**

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

Lining used may be soft rubber having a shore durometer reading or 4070 on the D scale, or semi-hard rubber having a durometer reading of 4570 on the D 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:

a) Hydrochloric acid, 2 to 8% concentration, at temperature from 10 deg C to 50 deg C.

b) Sodium hydroxide, 1 to 4% concentration, at temperature from 30 deg C to 50 deg C.

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.

d) 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 he following manner.

a) Degrease surface prior to blasting.

b) The surface is to be blasted with steel grit or sharp silica sand to a white and bright metal surface.

c) All traces if grit and dust should be removed with a vacuum cleaner or by brushing. Care must be taken to avoid contaminating the surface.

d) 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 it's 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.

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.
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 dished ends at top & 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. Bidder shall indicate in his drawing the sequence of welding proposed by him which should meet prior approval of the BHEL and customer. 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 BHEL and customer 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 Bidder shall provide these fittings to match with the BHEL and customer'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 conform to minimum 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 (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 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.

TECHNICAL SPECIFICATION FOR

POWER CYCLE PIPING VALVES AND SPECIALTIES

CONTENT

ATTACHMENTS

POWER CYCLE PIPING VALVES AND SPECIALTIES

1.00.00 GENERAL INFORMATION

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

2.00.00 PERFORMANCE REQUIREMENT

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

3.00.00 CODES & STANDARDS

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

3.01.01	ANSI B-31.1	:	Code for Pressure Piping - "Power Piping".
3.01.02	Indian Boiler Regulations	:	(IBR), with latest amendment.
3.01.03	ANSI B-16.5	:	"Steel pipe flanges and flanged fittings".
3.01.04	ANSI B-16.9	:	Wrought steel Butt welding fittings.
3.01.05	ANSI B-16.11	:	"Socket Welding Ends".
3.01.06	ANSI B-16.25	:	"Butt Welding Ends".
3.01.07	ANSI B-16.34	:	"Steel Valves - Flanged and Butt Welding Ends".

3.01.08 Design fabrication, assembly and testing of pipes, fittings shall generally conform to the requirements of ANSI B-31.1. But the portions, which come under the purview of Indian Boiler Regulations (IBR), shall completely comply the requirements of IBR as a minimum.

3.01.09 Any other internationally accepted codes and standards are also acceptable. However, the compliance of ANSI codes and IBR will be considered as

minimum for acceptance of the piping and all appurtenances.

4.00.00 SCOPE OF WORK

4.01.00 Scope of Supply

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

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

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

a) Supply of all power cycle piping including bends, elbows, tees, branches, laterals, crosses, reducing union, couplings, caps, saddles, shoes, flanges, blank flanges, Y-pieces etc. as required for the piping system under the scope of this specification.

b) Matching pipes, matching pieces like reducers/enlargers etc., counter flanges with bolts, nuts, washers, temporary and permanent gaskets, threaded union etc. for all terminals as required.

c) Supply and machining work of flanges, pipe spools and matching pipes to connect flow measuring orifices/nozzles with the main pipe work. The pipe spools shall be supplied along with necessary test certificates of the pipes, after necessary machining to the required bore, for assembly of flow nozzle element. The assembled flow nozzle shall be installed in the piping system. Additional length of pipes equal to length of all fully assembled flow nozzle & orifice plates pipe piece shall be supplied and the same shall also be erected prior to cleaning of the pipes by flushing or steam blowing or chemical cleaning or both. After completion of cleaning of piping the assembled flow nozzles shall be erected replacing the temporary pipe spools.

d) All motorised valves, manually operated isolating and regulating valves, non-return valves, steam traps, relief/safety valves, strainers, pressure reducing orifices, expansion joints and other flexible connections, complete with the counter flanges and matching connecting pieces as required within the terminal points of entire power cycle piping system.

e) Anchors, hangers & supports, vibration dampeners, restraints, shock absorbers etc. as required. Any platform necessary for maintenance and operation of valve and equipment located 1.5m above any permanent floor including access ladders, supporting structures etc.

f) All secondary structural steel members required for pipe supports from building steel structures and from embedded steel including pipe supports in trenches.