

- d) Adequate provision shall be made in each of the pump sumps so as to facilitate insertion of isolation gates as and when required. Gates shall be fabricated of mild steel, shall be of watertight type and shall preferably be of identical size/dimensions to facilitate interchangeability. Sump gates shall generally be accessible by the pump house overhead crane.
- e) The respective pump house shall also accommodate the following equipment/facilities, as applicable.
 - i. All auxiliary equipment related to pump sets such as discharge piping complete with valves and specialties, electric motor drives etc.
 - ii. Ventilation system for the entire pump house.
 - iii. Separate bays for unloading and maintenance.
 - iv. All necessary electrical equipment and accessories as required for this system.
 - v. Overhead Crane complete with all accessories, as specified in Volume-III F, Section-II of this specification.
 - vi. Sump pumps, as specified in Volume-III F, Section-I of this specification.
 - vii. Fixed Screens and accessories located suitably.
 - viii. Necessary toilets and operator's cabins with drinking water facility.
- f) Other general layout criteria as specified in Volume IIA of this specification shall also be adhered to while designing the pump house.

5.14.00 All Horizontal and Vertical Pumps of Plant Water System shall have 10% margin on capacity and 20% margin on Total Dynamic Head.

6.00.00 **DESIGN AND CONSTRUCTION**

6.01.00 **Horizontal Pumps**

6.01.01 Pump Casing

Pump casing shall be provided with adequate number of vents and priming connections with valves unless the pump is made self-venting and priming. Casing drain, as required, shall be provided complete with drain valves.

Pump design must ensure that the nozzles are capable of withstanding external reactions not less than those specified in API-610.

In cases where an expansion joint is located at pump discharge, the pump assembly will be subjected to an additional thrust which will be transmitted to

- the foundation. This additional thrust shall be taken into consideration during pump design.
- 6.01.02 Impeller
- The rotor assembly shall be dynamically balanced and designed with critical speed substantially above the operating speed.
- 6.01.03 Wearing Rings
- Replaceable type wearing rings shall be furnished to prevent damage to impeller and casing.
- 6.01.04 Shaft
- Shaft size shall be selected considering that the critical speed shall be away from the operating speed as recommended in applicable Code/Standard. The critical speed shall also be at least 10% away from runaway speed.
- 6.01.05 Shaft Sleeves
- Renewable type fine finished shaft sleeves shall be provided at the stuffing boxes/mechanical seals. Length of the shaft sleeves must extend beyond the other faces of gland packing or seal end plate so as to distinguish between the leakage past shaft and shaft sleeve and that past the seals/glands.
- Shaft sleeves shall be properly fastened to the shaft to prevent any leakage or loosening. Shaft and shaft sleeve assembly should ensure concentric rotation.
- 6.01.06 Bearings
- Bearings shall be easily accessible without disturbing the pump assembly. A drain plug shall be provided at the bottom of each bearing housing.
- Heavy duty sleeve/ball/roller type bearings shall be provided to take care of the radial loads.
- In case of sleeve type radial bearings, axial thrust shall be absorbed in suitable hydraulic devices and/or thrust bearings.
- Bearings and hydraulic devices (if provided for balancing axial thrust) shall be of adequate design for taking the entire pump load arising from all probable conditions of continuous operation. Life of the bearings shall be guided by the design standard of the pump. Thrust bearing shall be capable of running continuously at maximum load.
- 6.01.07 The bearings shall be oil/grease lubricated. Suitable lubricating arrangement for the bearings shall be furnished with the pump complete with all accessories like pump, filters, pipings, fittings, valves, interlocking and supervising instruments etc. as necessary. The design shall be such that the bearing lubricant does not contaminate the liquid being pumped.

6.01.08 Stuffing Boxes

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

Stuffing boxes shall be sealed/cooled by the fluid being pumped. All necessary pumps, piping, fittings, valves, instruments etc. as required for safe and trouble-free operation of the pumps shall be included in the scope of supply.

6.01.09 Mechanical Seals

Mechanical seals shall be provided if specified in the Annexure attached with this section. The pump supplier shall co-ordinate with the seal maker in establishing the circulation rate for maintaining a stable film at the seal face in the chamber. 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.

6.01.10 Drive Unit

The pumps shall be driven by electric motor directly coupled. A heavy duty flexible coupling along with coupling guard shall be provided between the pump and drive unit. For details regarding specification of drive unit Volume-V of this specification will be referred.

Unless otherwise specified drive unit power rating shall be the maximum of the following requirements.

- a) 15% (for LT motor) or 10% (for HT motor) margin over the pump shaft input power at the rated duty point.
- b) 5% margin over the maximum pump shaft input power required within the "Range of Operation".
- c) Pump shaft input power required considering the overloading of the pump assuming single pump operation in the event of tripping of one or more of the pumps operating in parallel.

6.02.00 **Vertical Pumps**

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

6.02.01 Bowl Assembly

This will be either a single or multi-stage centrifugal, 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 the handling fluid.

Pump(s) shall have provision for adjustment of impellers in vertical direction

7.00.00 **CONTROL & INSTRUMENTATION**

Complete instrumentation and control system including all accessories shall be provided for safe, reliable and trouble-free operation of the plant. For details Bidder shall refer to volume VI, Specification for Controls & Instrumentation.

8.00.00 **INSPECTION AND TESTING**

8.01.00 The Contractor shall carry out the following specific tests and inspections to ensure that the equipment furnished shall conform to the requirements of this section and in accordance with relevant codes and standards. Test certificates for all tests shall be submitted to the Owner for approval.

8.02.00 **Horizontal Pumps**

8.02.01 Material Identification and Testing

- i) All materials used for pump construction shall be of tested quality. Material shall be tested as per the relevant standards. Components on which material test has been done shall be stamped for identification.
- ii) Tests for each pump included under this section shall also include but shall not be limited to the following:
 - The entire surface of the impeller castings shall be subjected to Dye Penetration Test as per ASTM Specification no.: E165-65.
 - Shaft shall be subjected to Dye Penetration and Ultrasonic Tests.
 - Wearing rings shall be subjected to Dye Penetration Test.
 - Verification of material, witnessing of pouring, casting and inspection of finalised fabricated/cast castings.
 - Inspection of finished castings for impeller and verification of materials.
 - Inspection of pump shaft and verification of material.
 - Witnessing of NDT/review of NDT reports.
 - Static balancing test for impeller and dynamic balancing of complete rotating parts as per ISO- 1940.
 - Complete inspection of assembled pump

8.02.02 Hydrostatic Testing

The pump casing and all other applicable pressure parts shall be hydrostatically tested at 150% of the pump shut-off pressure. Pressure shall be maintained for a period of not less than one (1) hour. While arriving at the

above values maximum suction pressure shall be taken into account.

8.02.03 Dynamic Balancing

All rotating components shall be statically and dynamically balanced. Dynamic balancing tests shall be carried out at a speed not less than the rated rpm of the pump. Test procedure and acceptance limits shall be guided by the relevant testing codes and standards.

8.02.04 Performance Test at Shop

i) Each pump shall have to be tested to determine the performance curves of the pumps. These tests are to be conducted in presence of Purchaser's representative as per the requirements of the Standards of Hydraulic Institute of USA (ASME-Power Test Code PTC 8.2/BS EN ISO 9906) or any other equivalent standard but the tolerances on head, discharge and power shall be as specified in HIS, USA. Prior to performance test, the pump supplier shall furnish the procedures and methods of testing to the Purchaser for approval.

ii) Performance tests are to be conducted to cover the entire range of operation of the pumps. These shall be carried out to span 130% of rated capacity upto pump shut-off condition. A minimum of five combinations of head and capacity are to be achieved during testing to establish the performance curves, including the design capacity point, shut-off point and the two extremities of the range of operation as specified in the annexure. After completion of performance test, all pumps shall be stripped down for inspection of internals.

iii) Tests shall be conducted at the rated rpm.

Mechanical run test shall be carried out on all pumps to determine the vibration levels, noise levels etc. This test shall be conducted at site also. However, test value at site shall be used for the acceptance of the equipment.

8.03.00 **Vertical Pumps**

8.03.01 Material Identification and Testing

i) Material identification and testing shall include, but shall not be limited to the following components :

- Bowls and suction bells.
- Impeller and wearing rings.
- Shafts and shaft sleeves.
- Couplings.
- Bearings.
- Column pipes.

- ii) Performance tests are to be conducted to cover the entire range of operation of the pumps. These shall be carried out to span 130% of rated capacity upto pump shut-off condition. A minimum of five (5) combinations of head and capacity are to be achieved during testing to establish the performance curves, including the design capacity point, shut-off point and the two extremities of the range of operation specified. After completion of performance test, all pumps shall be stripped down for inspection of internals.
- iii) Tests shall be conducted at the rated rpm.
- iv) The Bidder shall submit in his proposal the facilities available at his works to conduct performance testing.
- v) Mechanical run test shall be carried out on all pumps to determine the vibration levels, noise levels etc. This test shall be conducted at site also. However, test value at site shall be used for the acceptance of the equipment.
- vi) Reports and test certificates of above tests shall be submitted to the Purchaser for approval.

9.00.00 **DRAWINGS, DATA, CURVES AND INFORMATION**

The Bidder shall submit the following along with his formal proposal besides the different information plate required as indicated elsewhere in this specification

9.01.00 Piping and instrumentation diagram of Plant water system.

9.02.00 General arrangement drawing of Jackwell pump house, raw water transfer pump house, clarified water pump house.

9.03.00 General arrangement of clarified water reservoir.

9.04.00 General Arrangement drawing of service water, potable water tank, DM water storage tank and condensate storage tank.

9.05.00 **Horizontal Pumps**

9.05.01 Drawings

- a) General arrangement and outline drawings showing the principal dimensions, weight and location of the suction and discharge connections of the pumps offered. Details of lubrication and sealing arrangement shall also be included.
- b) Typical cross-section drawing showing various components of the pumps offered, materials of construction etc.

9.05.02 Data and Curves

- a) Determination of pump total dynamic head at rated capacity as per guidelines specified in Section-I of this Volume. Detailed calculations for computing static head and frictional losses shall be furnished by the Bidder.
- b) Anticipated performance curves showing the following characteristics:
 - i. Capacity vs. head
 - ii. Capacity vs. power
 - iii. Capacity vs. efficiency
 - iv. System resistance curves
- c) Speed vs. torque curve of the pump corresponding to recommended mode of pump starting superimposed on speed vs. torque curves of the drive unit corresponding to 80%, 90%, 100% of the rated voltage (applicable only in the cases of pumps with drive motor power rating of 100 KW and above).
- d) Completely filled-in Technical Proposal Particulars enclosed under Volume-IX of this specification.
- e) Details of manufacturing and testing facilities in pump manufacturer's works and illustrative literature regarding the pumps offered.

9.06.00 Vertical Pumps

9.06.01 Drawings/Data

- a) Determination of respective pump total dynamic head and capacity as per guidelines of this specification. Detailed calculations for obtaining static head and frictional losses shall be submitted by the Bidder.
- b) Outline drawings of the pump showing the various dimensions, suction and discharge locations.
- c) Typical cross sectional drawing of the pump to be supplied, showing various components, bearings, seal rings etc. and materials of construction for all items.
- d) Lubrication arrangement drawings for external lubrication.

9.06.02 Anticipated performance curves and test curves for:

- a) Capacity Vs Head.
- b) Capacity Vs. Power & Capacity Vs. Efficiency.
- c) System resistance curves.
- d) Speed Vs. torque requirement of the pump (for pump sets with drive motor rating of 100 KW or more) together the drive motor speed-torque characteristic.