Supplier's scope including supply of all cables, cable tray / trenches, tray support, racks etc. Termination of incoming power cable shall also be done by Supplier.

## 6.0 MISCELLANEOUS DETAILS

**6.1** Supplier shall provide external open / close position indicator for full travel length on the operating winch & cable assembly mounted at the normal place of operation on the platform or ground apart from the position indicator mounted on the damper Shaft. Position Indicators on shaft shall be 305mm long for elevation of 9 meter and 610mm long for elevation greater than 9meter.

**6.2** Limit switches & torque switches (if any) for fully open and fully closed positions and shaft torque limitation, shall be provided as per the electrical area classification.

**6.3** Damper operating wire rope shall be minimum 6mm dia. SS-304 and the other hardware e.g. Thimbles, Turn buckles, clamps etc. shall be galvanized. Damper winch location for stack / off take dampers shall be at heater grade, for all other damper panels shall be located at respective platform locations unless otherwise noted in the job specification / damper datasheet.

**6.4** Calculations for various components comprising the damper system shall be submitted as per Tender specifications. These calculations may be reviewed by EIL and Supplier shall be obliged to revise his design based on comments given by EIL. However, it shall be Supplier's responsibility to guarantee the system and submission of calculations shall not absolve him of this responsibility.

**6.5** The minimum opening requirement of damper if specified in damper datasheet shall only be achieved with an external mechanical stopper.

**6.6** The counterweight if provided in dampers to achieve fail safe condition shall be in the shape of single secured mass at the end of linkage arm with suitable key etc. to provide it's slipping out.

**6.7** Flow direction shall be marked on the damper body.

**6.8** For electrically operated SOB's manual operation with gear box and hand-wheel / pulleys shall also be provided. The hand-wheel / pulley (provided with chain) shall be brought to the nearest platform for ease in accessibility for manual operation. Manual actuation system shall generate sufficient mechanical advantage so that one person (with maximum manual effort of 270 N) can comfortably operate the damper / SOB.

**6.9** Supplier to also indicate straight length requirements upstream / downstream of damper, if any, to ensure smooth functioning of damper.

**6.10** For refractory lined dampers the refractory is to be protected at the ends by providing 3mm thick SS retainer plates provided with expansion slots in leading edges to avoid distortion

**6.11** Bolted / removable type metallic weather protection cover / bonnet shall be provided on all sides of the SOB frame including the blade retraction enclosure, for dust / weather protection of blade and seals. Vent holes (with suitable provisions to prevent water ingress) shall be provided at the top of the weather protection cover, to maintain it at atmospheric pressure.

**6.12** All types of dampers / SOBs shall be provided with mechanical limit stops to limit the blade movement beyond the maximum open / closed position. Blade travel stops shall be designed for twice maximum actuator torque for the selected actuator.

## 7.0 SPARES

7.1 It shall be responsibility of the Supplier to include adequate spares of sealing system, instrumentation, gaskets, bolting etc. required during fabrication, testing, inspection & packing and forwarding.

7.2 In addition to mandatory spares listed in the job specification, Supplier shall furnish list of recommended spares for two year of normal operation. The price for these spares shall be quoted separately, item wise.

## 8.0 PAINTING, PACKING, DESPATCH & PRESERVATION PROCEDURE

8.1 All the exposed carbon steel surface shall be shop painted with at least one coat of heat resistant inorganic zinc silicate paint suitable upto 400°C (total DFT - 65-75 $\mu$). Surface preparation shall be to SA 2½ or equivalent.

8.2 After completion of all testing & inspection, the inside of dampers shall be thoroughly dried by hot air and damper flanges shall be blanked off with suitable covers to avoid entry of foreign material and to avoid damage to damper seals.

8.3 All loose components shall be identified with damper Tag No., Part No., size and name for easy site identification. The damper tag no., P.O. no. and Owner's name and address shall be painted in bold white paint letters written with stencil.

8.4 Packing shall be road worthy (sea worthy, if imported) in wooden crates.

8.5 Supplier shall furnish comprehensive preservation procedure of all the components in a damper in all possible stages & till commissioning.

## 9.0 DEVIATIONS

9.1 No deviation from the requisition / specification / data sheets shall be sought. However, if unavoidable, any deviation from EIL's requirements shall be clearly brought out in a separate 'DEVIATIONS' paragraph in the bid along with reason.

9.2 It will be taken for granted that except for the deviations specifically pointed out in the 'DEVIATIONS' para of offer, all other technical requirements shall be adhered to by Supplier. Any non-compliance / deviation appearing elsewhere in the offer will not be considered.

9.3 Should the deviations sought by Supplier is not acceptable, the Supplier's offer is liable to be rejected.

## 10.0 CONTRADICTIONS

In case of any contradiction between the Tender requirements, specification and data sheets, the matter shall be referred to Owner / EIL at bidding stage itself. Owner / EIL decision shall be binding and without any price implication, if the matter is not resolved at bidding stage.

## 11.0 GUARANTEE

The Supplier shall guarantee the dampers for the design, performance, materials, workmanship and compliance of various technical requirements listed in the requisition. This guarantee shall also include sub-ordered / bought out items forming part of his total supplies. The guarantee period and financial liabilities of the Supplier shall be as per Owner's commercial terms and conditions or general purchase conditions (GPC).

**11.1 Performance**

The Supplier shall guarantee as a minimum following design parameters:

- Leakage efficiency
- Pressure drop across the damper and controllability
- Opening-closing time
- Fail safe / interlock actuation position

**11.2 Material & Fabrication**

The Supplier shall agree to repair / replace damper / components free of cost and with no loss of time if:

- There is a defect in material or workmanship or there is wrong selection of material
- The equipment is found to have damaged components on receipt at site

**11.3** Inspection by inspection agency, approval of Supplier's design / drawings or deviations shall in no way absolve the Supplier or dilute his responsibility towards the guarantees.

## 12.0 INSPECTION AND TESTING

**12.1** All items covered under this requisition are subject to stage wise and final inspection by Client approved Inspection agency. All items procured by the Supplier shall be with their relevant test certificates. Supplier shall provide all the facilities free of cost to the inspector for stage wise as well as final inspection.

**12.2** All dampers (Louvre or Guillotine) having leak tightness $\geq$ 99.5%, shall be subjected to pneumatic leakage testing at shop to establish leakage at design conditions. The test shall measure the leakage across the damper blade. For guillotine dampers with open frame construction, leakage to the atmosphere shall be checked with the blade in closed condition and also with blade in open condition.

**12.3** Supplier shall prepare his Quality Assurance Plan (QAP), defining the stages of inspection, hold points for his own inspection and that of authorized inspector. The QAP shall be discussed with inspector & mutually agreed / approved, before start of job. As a minimum, following inspection and tests to be carried out:

(a) Overall dimensional checks, including checking of critical dimension e.g. shaft dia., blade thickness, expansion gaps, lining thickness etc.

(b) Weld examination by MP/LP test

(c) Functional test for all dampers (Louvre and Guillotine) shall be carried out during testing with their respective actuator. All dampers shall be operated from fully closed to fully open position for minimum 5 cycles.

(d) Actuation time for pneumatic and electrical actuated dampers shall be recorded.

(e) For manual operation, smooth operation by single person operating with ease to be demonstrated.

(f) Leakage testing of dampers according to approved procedure and leakage rates.

(g) Opening and Closing Time of SOB.

**12.4** Dampers shall be dispatched only after the completion of DATA FOLDER

## 13.0 DRAWING AND DOCUMENT SUBMISSION

**13.1** Supplier to note that the following minimum details to be incorporated in GA drawing:

(a) Flow direction

(b) Open / Close indicators

(c) Lining / Anchor / retainer plate details

(d) Material of Construction of major items

(e) Expansion gaps and leakage paths

(f) Top / Bottom to be indicated (for horizontal damper)

(g) Counter weight dimensions & swing clearances

(h) Design details e.g. blade thickness, shaft dia., cylinder size, winch capacity etc.

(i) Clearance required for blade & linkage operation

(j) Weight

(k) Table for damper properties / design conditions

(l) % of the cross-sectional flow area permanently blocked by internals

**13.2** The Supplier shall submit the following data / information at Offer stage:

1. BQC related information, if asked
2. Deviation if any
3. Filled in TQ sheets
4. Vendor information required as per datasheet
5. Preliminary GA drawing
6. List of Erection and Commissioning spares considered by the Supplier (over and above the mandatory spares)
7. List of Recommended spares for two-year normal operations with item wise prices
8. Any other data / information requested anywhere in the specifications

**13.3** **Vendor Data Requirement (VDR):** Following documents as a min. shall be submitted by Supplier after placement of order:

| DESCRIPTION | | AFTER ORDER PLACEMENT | | |
|---|---|---|---|---|
| | | FOR R / I | | AS BUILT IN DATA FOLDER |
| | | Duration from LOI | Purpose | |
| 1. | General Arrangement of Dampers and Control Panel along with MOC, Weight etc. | 8 weeks | R | ✓ |
| 2. | Deviation | - | - | - |
| 3. | All the information required as per specification & data sheets | 4 weeks | R | ✓ |
| 4. | Material Test Report | - | I | |
| 5. | Vendor Drawing / Document Index | 2 weeks | I | |
| 6. | Certificate from Statutory Authorities (Explosion proof etc.) | - | I | |
| 7. | Quality Assurance Plan (QAP) | - | R | |
| 8. | List of Spares Parts | - | R | |
| 9. | Damper Characteristic Curves | 8 weeks | R | |
| 10. | Parts List with Material Spec. | - | I | |
| 11. | Name Plate details | - | I | |
| 12. | Leakage test, Functional test, other test procedures & calculations | - | I | |
| 13. | Test Reports | - | I | |
| 14. | Packing, Dismantling & Erection Instructions. | - | I | |
| 15. | Refractory Lining Anchor details | 8 weeks | R | |
| 16. | Actuator details, motor details for seal fans. | 8 weeks | R | |
| 17. | Control Schemes and writeup, Instrument Data Sheets for Solenoid Valve, Pilot valve, Speed regulator etc. (as applicable) and Catalogues | 8 weeks | R | |
| 18. | Preservation Procedure | - | I | |
| 19. | Operating Manual | - | I | |
| 20. | Any other data requested elsewhere in the requisition / Tender | - | - | - |

**LEGEND:**

R - Document which is required to be reviewed by Owner / EIL

I - Document to be submitted for Owner / EIL Records

**NOTE:**

1. In case paperless submission of documents is applicable, all documents shall be submitted in electronic form as per the procedure / requirements stated in the Purchase Requisition.
2. All drawings & documents shall be submitted in A4 or A3 paper sizes. Documents in higher paper size shall be submitted in exceptional circumstances or as indicated in the MR/Tender.
3. As built documentation shall be submitted in hard copy (Six prints) and soft (two CDs / DVDs) or as per Project philosophy in case defined elsewhere.

# कालिकधौकन यंत्र
# के लिए
# मानक विनिर्देश

# STANDARD SPECIFICATION
# FOR
# SOOTBLOWERS

| Rev. No | Date | Purpose | Prepared by | Checked by | Standards Committee Convenor | Standards Bureau Chairman |
|---|---|---|---|---|---|---|
| | | | | | Approved by | |
| 1 | 07 02 2020 | REVISED AND ISSUED AS STANDARD SPECIFICATION | RP | AP | MK | RKT |
| 0 | 26 03 15 | ISSUED AS STANDARD SPECIFICATION | MK | KJHN | AP | SC |

**Abbreviations:-**

| | | |
|---|---|---|
| AC | : | Alternating Current |
| AISI | : | American Iron and Steel Institute |
| ANSI | : | American National Standards Institute |
| BASEEFA | : | British Approval Service for Electrical Equipment in Flammable Areas |
| BIS | : | Bureau of Indian Standard |
| BOM | : | Bill of Materials |
| BMR | : | Bi-metallic Relay |
| BQC | : | Bidder Qualification Criteria |
| CCOE | : | Chief Controller of Explosives |
| CIMFR | : | Central Institute of Mining and Fuel Research |
| CMRI | : | Central Mining Research Institute |
| DCI | : | Document Control Index |
| DCS | : | Distributed Control System |
| EExd | : | Explosion Proof |
| EIL | : | Engineers India Limited |
| FRP | : | Fibre Reinforced Plastic |
| GA | : | General Arrangement |
| IBR | : | Indian Boiler Regulation |
| I/O | : | Input / Output |
| ITP | : | Inspection and Test Plan |
| MOC | : | Material of Construction |
| MODBUS | : | MODBUS Communication Protocol |
| P&ID | : | Piping and Instrumentation Diagram |
| PESO | : | Petroleum and Explosives Safety Organization |
| PLC | : | Programmable Logic Controller |
| PO | : | Purchase Order |
| PTB | : | Physikalisch-TechnischeBundesanstalt (National Standard Lab of Germany) |
| PTR | : | Proven Track Record |
| QA | : | Quality Assurance |
| RAL | : | RAL Colour Classification System |
| RMS | : | Root Mean Squared |
| RTU | : | Remote Terminal Unit |
| TPIA | : | Third Party Inspection Agency |
| UL | : | Underwriters Laboratories |
| UON | : | Unless Otherwise Noted |
| UPS | : | Uninterrupted Power Supply |
| VDR | : | Vendor Data Requirements |
| WNRF | : | Weld Neck Raised Face |
| Z-PURGING | : | Type Z Purge |

**Fired Equipment Standards Committee**

S/Shri Mandip Kapoor (Convener)
Amit Prakash
Rajesh Patel
Dhiman Deb
Navneet Agarwal
Prasenjit Saha
Deepak Gupta (Projects)
Pankaj Kumar Rai (Construction)

## CONTENTS

## 1.0 GENERAL

1.1 Flue gases carry particles which get deposited on to the tube surfaces which deteriorate the heat transfer ability of the tubes. Therefore, tubes are to be periodically blasted with sufficient energy using soot blowers to remove these deposits. This specification covers the minimum requirements for design & supply of electrically operated long retractable single motor driven soot blowers, which are to be installed in the convection section of process fired heaters and use superheated steam for cleaning.

1.2 This specification shall be read in conjunction with the requisition / job specification.

1.3 The requirements of this specification shall be suitably supplemented by supplier, to ensure that the equipment supplied by him is of proven quality and suitable for the intended purpose.

1.4 The supplier shall be selected based on PTR of similar service and must satisfy the vendor qualification related requirements as per the requisition.

1.5 The soot blower model offered shall be a commercially proven design in comparable services taking into account fuel fired, tube banks arrangement, cleaning medium and other fire box conditions.

## 2.0 SCOPE OF SOOT BLOWER SUPPLIER

2.1 Unless otherwise stated in the requisition, the scope of supply / services of the soot blower supplier shall be as per the requirements mentioned in this specification.

2.2 **Scope of Supply**

a. Soot blowers along with drive

b. Local push button for individual soot blower (start / retract type)

c. Hand crank arrangement for emergency retraction

c. PLC based sequential control system in panel, if applicable

d. Cable / cable glands / lugs

e. Mating flange along with bolts & gaskets, for steam inlet

f. Special tools / tackles (if any) required for erection, commissioning and maintenance

g. Name plate / name tag

h. Lifting device for handling the soot blowers

j. Spares

2.3 **Scope of Services**

a. Design / sizing of soot blower & panel

b. Logic sequence & wiring diagram

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j. Spares

### 2.3 Scope of Services

a. Design / sizing of soot blower & panel

b. Logic sequence & wiring diagram

c. Interface with main plant P&ID

d. IBR certification for the supplied items

e. Preparation, submission and obtaining approval of documents

f. Suitable interface details with Purchaser's equipment sleeve, support steelwork, steam inlet piping & electrical power and cables

g. Inspection & functional test at shop

h. Packing and dispatch

i. Site supervision during installation / pre-commissioning, if required

**2.4 Exclusions**

The following are excluded from soot blower supplier scope of supply / services, however site supervision services may be required:

- Erection / installation work at site
- Supply / installation related to cabling work at site

## 3.0 DESIGN REQUIREMENTS

**3.1** Soot blowers shall be suitable for outdoor installation and operation in specified environment. Any special ambient conditions specified in the requisition, shall also be applicable.

**3.2** The soot blower design & selection shall take into account the fuel fired in the heater / flue gas composition, fire box conditions, cleaning medium availability / design conditions, electric power supply availability, convection tubes arrangement and soot blower location arrangement as per the requisition / job specification.

**3.3** Three phase electric drive to be considered for operating the soot blower.

**3.4** Soot blowers shall be engineered keeping into consideration the actual steam pressure & temperature available as per the requisition / job specification. Individual soot blowers shall be designed to pass a minimum of 4535 kg/hr of superheated steam of the stated design condition at the inlet flange.

**3.5** Wall boxes offered shall be suitable for the negative draught values indicated for the convection box location. Positive pressurization of convection box is normally not expected except in upset conditions which may last only for short durations of maximum 20 seconds. The positive pressure wall box shall be offered only when specifically asked for in the requisition

**3.6** For retractable type soot blowers the lance shall be provided with two nozzles located diametrically opposite.

**3.7** The soot blower cleaning radius should be sufficient to ensure effective cleaning over the entire tube surfaces.

**3.8** Tube sheet supports shall be considered as a limit to horizontal coverage of individual soot blowers.

3.9 Supplier shall design the soot blowers to ensure that there will be no erosion of the tubes / extended tube surfaces on account of the steam jet impingements.

3.10 Supplier shall be responsible for the IBR certification for the supplied items.

3.11 UON in the requisition / job specification, the planned frequency of operation of soot blowers is once in a shift of 8 hours. Supplier has to ensure that the same shall be sufficient for maintaining clean tubes.

## 4.0 MECHANICAL REQUIREMENTS

4.1 Soot Blowers shall be supplied in bolted type mounting with the convection wall sleeve plate to protect refractory at convection box walls. The soot blower sleeve material shall be suitable for the flue gas temperature & composition specified in the Job specification / requisition. SS316 shall be adopted as a minimum.

4.2 Soot Blower lance material shall be suitable for flue gas temperature & composition specified. The minimum metallurgy for lance tube for a retractable type soot blower shall be 1.25Cr-0.5Mo (or AISI 602) and for lance tips minimum SS304 shall be considered.

4.3 Steam inlet & mating flange shall conform to the following details unless specified otherwise in Job Specifications:

Size - 3"NB, 300#
Type - WNRF to ANSI B16.5
Finish - Smooth to 125 RMS
Gasket - SP.WND SS316+GRAFIL+I RING

4.4 A provision for hand crank is required for manual retraction of lance in case of power failure or other malfunction. Minimum one hand crank shall be provided for every soot blower row. Hand crank arrangement shall be located on the same side as the controls / local push buttons.

4.5 Soot blower lance & its travel must be finalized keeping the following into consideration:

4.5.1 At the starting point of steam blowing, the lance nozzle centerline should clear the inside refractory face by a maximum of 50mm, so that maximum blowing length can be provided.

4.5.2 At the end point of travel, a clearance of 50 mm is to be considered between lance tube end and the inside refractory surface.

4.5.3 Maximum Deflection of lance to be limited to 25mm.

4.6 Soot blower enclosure must be sturdy in construction and should provide easy access for maintenance of soot blower components.

4.7 The soot blower body shall be housed in a painted metal body / casing / bonnet for protection against rain & dust.

## 5.0 CONTROL & INTERLOCK REQUIREMENTS

5.1 Each soot blower shall have a local push button station adjacent to soot blower or mounted on soot blower body, start-retract type.

**5.2** PLC based automatic sequential control panel / panels shall be provided for multi-blower / multi-heater installations, as specified in the requisition out of the following possible cases. The panels shall be suitable for mounting in field on grade unless an alternate location is specified in the requisition in which case that shall be followed.

5.2.1 Normally a separate sequential control panel is specified for each heater.

5.2.2 If the number of soot blowers in a heater is less, no sequential control panel may be specified in the requisition.

5.2.3 A common sequential control panel may be specified in the requisition for one or more small heaters which are connected process wise.

**5.3** Field mounted sequential control panel shall be suitable for hazardous area classification and continuous operation at ambient temperature & humidity conditions specified in the requisition.

**5.4** The sequential control panel shall be provided with the following facilities as a minimum, for smooth operation:

5.4.1 A master switch for the automatic soot blowing sequence operation, also switches for operation of individual soot blowers or for bypassing individual soot blowers in the automatic blowing sequence.

5.4.2 Indicating lamps showing the operation of each soot blower.

5.4.3 Automatic control of the soot blower main steam valve.

5.4.4 Alarm indications & identification in case a particular soot blower has not retracted within a stipulated time. In such an eventuality the next blower in line must not start its operation until the stuck up blower is retracted back.

5.4.5 Alarm annunciation for faulty conditions through indicating lamps / alarm annunciator.

5.4.6 Interlock to prevent soot blower operation until piping has reached a suitable temperature, with a lamp to show 'drainage complete'.

5.4.7 Interlock for retraction of soot blower on low steam pressure.

5.4.8 Interlock for retraction of soot blower in case of low steam flow rate availability with a recommended time delay of approx. 45-60 seconds and a timer range of 0-2 mins.

5.4.9 Retraction of soot blower on motor overload condition.

5.4.10 Interlocks with limit switches and local push buttons on / near soot blower motors.

**5.5** Manual bypass provision in panel for bypassing any of the interlocks mentioned in clause 5.4 above. The panel shall be supplied with interlocks indicated in clause 5.4.6, 5.4.7 & 5.4.8 in bypass mode, unless these interlocks are required to be active as per main plant P&ID.

**5.6** The Instrumentation & Control System shall be procured from the soot blower supplier / approved sub supplier / as per Job Specification and shall comply to the following requirements, unless otherwise specified in the requisition:

5.6.1 The soot blower PLC shall be redundant processor, redundant I/Os, redundant power supply and redundant communication all in hot standby configuration realized through hardwired redundancy and shall be installed at field, panel colour shall be RAL 7035.

5.6.2 Configuration laptop with necessary software and connecting cables for soot blower PLC required for configuration & testing of package PLC, shall also be supplied.

5.6.3 Redundant MODBUS –RTU serial link on RS-485 is required from soot blower PLC for signal interfacing with Purchaser's DCS system.

5.6.4 All control instrumentation shall be housed in a local control panel provided with doors and a lock. The panel shall be weatherproof with explosion-proof / flame-proof (FExd) push-buttons, selector switches, lamps etc. It shall be Flame-proof (FExd) or purged enclosure (with Z-purging) for PLC system suitable for hazardous area classification specified elsewhere. Additionally, a FRP / stainless steel canopy or rain-shed shall be provided.

5.6.5 PLC based automatic sequence control panel shall be either free-standing floor mounted type or mounted on a channel / angle frame complete in all respects ready for erection and fixing on foundations. The cabinet internal shall be laid out properly to allow for unhindered maintenance and provide an aesthetic look.

5.6.6 PLC based automatic sequence control panel shall be provided with required entry for the cables with suitable double compression cables glands as per hazardous area classification.

5.6.7 All field inputs and outputs to PLC system shall be provided with three port isolating barriers (for I.S instruments). Relays are required for flame proof digital inputs / outputs as well as for lamps / push buttons. Supply of barriers and relays in PLC panel is included.

5.6.8 For instrumentation purpose, 110 Volts AC, 50 Hz UPS power supply shall be provided by Purchaser only at one point near the sequential control panels. All the other required voltages shall need to be generated.

5.6.9 Supplier shall provide all termination details with proper segregation of cables as per type of signals (signal / alarm / control / power).

## 6.0 ELECTRICAL REQUIREMENTS

**6.1** 415V, 50Hz ± 3% TPN supply will be made available by Purchaser only at one point near the Soot Blower Panel. Isolator, Ammeter, Voltmeter with selector switches & indication lamps shall be provided on the panel for incoming circuits. The size of the incoming cable shall be indicated at the time of drawing approval based on the load furnished by the Supplier.

**6.2** Arrangement for any other required power supply and distribution shall be made by the Supplier. 'ON/OFF' indications (for Phase R, Y & B) shall be provided by Supplier for incoming supply healthy indication and on each soot blower outgoing, showing the operation status of the soot blower. Outgoing feeders shall have switch fuse unit, BMRs, contactors, indication lamps, necessary push buttons etc. 20% spare feeders (with minimum 1 no.) of each type and rating shall be provided in each panel. Switch and contactor shall be selected of suitable switching duty.

**6.3** The soot blower motors shall fulfill the following requirements UON in the requisition:

6.3.1 All the motors shall have minimum enclosure protection Ex-d and shall meet the requirements of IS / IEC-60079-1 and 60079-0.

6.3.2 Cable glands to be supplied with motor shall meet all the requirement of IS / IEC-60079-0.

6.3.3 MV motors (415V) for soot blower system shall conform to relevant specifications and motor data sheets attached in the requisition.

**6.4** All electrical equipment shall be suitable for installation and operation in hazardous areas, as specified in the requisition. Ordinary electrical equipment (even though permitted for use in Div.2 areas as per NEC) shall not be used in Zone-2 areas.

**6.5** All electrical equipment shall conform to relevant BIS/IEC standards in addition to the specifications and standards applicable as per the requisition. The main components such as contactors, switches, push buttons, fuses, indication lamps and all other spark producing devices shall also comply with the relevant BIS/IEC specifications.

**6.6** All electrical equipment for hazardous areas shall be certified by CIMFR (formerly CMRI), PTB, BASEEFA, UL, FM, ATEX or equivalent independent testing agency for the service and the area in which it can be used and shall be approved by PESO/CCoE. All indigenous flameproof equipment (Type Exd) shall be manufactured under BIS license.

**6.7** The cable in supplier scope shall be as per electrical requirements specified elsewhere.

## 7.0 SPARES

### 7.1 Mandatory Spares

As a minimum the following mandatory operational spares shall be supplied along with the soot blowers. Any additional spares, special tools and tackles over & above these specified in Requisition / Job Specification, shall also be supplied.

7.1.1 For soot blowers:

| | | |
|---|---|---|
| Valve assembly | : | 1 no. for each set of 4 (min. 1 no.) |
| Gasket / glands | : | 200% |
| Bearing set for motors | : | 1 no. for each type |
| Terminal bushing for motors | : | 1 set each |

7.1.2 For soot blower related instrumentation:

| | | |
|---|---|---|
| Panel mounted instruments & hardware like : switches, lamps, terminals, MCBs etc. | | 10% (min.1 no. for each type, as installed spares) |
| Instruments, solenoid valves, limit switches, Lamps, push buttons, switches etc. | : | 10% (min. 1 no. for each type, as loose supply) |

7.1.3 For soot blower PLC system:

| | | |
|---|---|---|
| Installed condition | I/O Level | 10 % |
| | Marshalling | 10 % |
| Spare space | I/O Level | 15 % |
| | Marshalling Rack | 15 % |
| Spare supply | Each type of modules including Processor Module | 5% (min. 1 no. each type) |

**7.2** Erection & commissioning spares and recommended spares shall be as per the requirements of the requisition.

**8.0 INSPECTION & TESTING**

**8.1** All items covered under this requisition are subject to stage wise & final inspection by Owner / his authorized Inspector / Owner approved TPIA / IBR approved agency to ensure compliance to specifications. All items shall also be subjected to stage wise internal inspection of the Supplier.

**8.2** Supplier shall provide free access and extend all necessary facilities to the Inspection Authority for stage wise and final inspection.

**8.3** Supplier shall prepare a detailed ITP and seek TPIA and Owner / EIL approval for the same.

**8.4** Supplier shall furnish relevant material test certificates to the Inspection Authority for review. All pressure containing parts and critical components shall be procured with EN10204 Type 3.2 certificates duly inspected by TPIA. Other bought out shall be procured with EN10204 Type 3.1 certificate.

**8.5** Soot blowers shall be subject to tests mentioned below but not limited to these only:

8.5.1 Witness inspection of important components e.g. valves, wall box, lance, limit switches etc.

8.5.2 Indian Boiler Regulation (IBR) inspection and requirements towards the same to be taken care of by the supplier for soot blower inlet valve assembly.

8.5.3 Inspection of materials

8.5.4 PMI of SS, Alloy steel material.

8.5.5 Inspection of quantities

8.5.6 Inspection of dimensions

8.5.7 Power test on motor unit

8.5.8 Functional test on the completed final assembly of the soot blower

**9.0 PAINTING, PACKING & DISPATCH**

**9.1** Painting shall be suitable for outdoor service under general refinery conditions. Painting to supplier's standard is acceptable, UON in the requisition / job specification.

**9.2** Blower identification shall be furnished in a metal tag and fixed to each soot blower clearly and visibly.

**9.3** All spares shall be tagged properly and packed separately in boxes marked SPARES.

**9.4** All openings shall be covered and protected by plugs.

**9.5** Equipment shall be packed according to standard commercial packing acceptable to commercial carriers.

**9.6** Supplier shall furnish comprehensive preservation procedure of the unit in all possible stages till commissioning.

**9.7** The equipment item number, P.O. number and Owner's name and address shall be stenciled in paint in bold white letters.

**9.8** Equipment shall be dispatched only after it has been cleared by Owner's Authorized Inspector.

**9.9** Supplier shall *furnish unpacking, handling and erection procedure* and indicate clearly / boldly the handling marks on the packing boxes.

## 10.0 GUARANTEE

**10.1** The Supplier shall guarantee that the soot blowers designed and supplied will provide satisfactory cleaning of tubes for the given arrangement of tubes, soot blowers, fuel fired and specified frequency of soot blowing.

**10.2** Supplier to guarantee the materials designed & supplied as well as the performance of the soot blower in all respects, failing which vendor to rectify failures at his cost and without delay. This covers a minimum period of 12 months from the date of commissioning or 18 months from the date of shipment whichever is later. In case the period of enforceable Guarantee is covered in the Requisition, same shall be applicable.

## 11.0 DRAWINGS & DOCUMENTS SUBMISSION

**11.1** The Supplier shall submit the following data / information at Offer stage:

a. BQC related information, if asked

b. Duly filled in standard *Technical Questionnaire Sheet*, if applicable

c. Deviations, if any

d. Duly filled soot blower datasheet with complete information

e. Preliminary GA drawing of soot blowers showing approx.weight, overall dimensions, BOM, MOCs etc.

f. P&I Diagram

g. Basic information related to PLC based sequential control panel

h. Any additional hardware envisaged in the steam line or electrical circuit to cover all functions envisaged in control panel (with scope demarcation), if applicable

i. Motor list and filled up motor data sheet

j. Electrical Load Data

k. List of Erection & Commissioning spares recommended by the Supplier with unit rates

l. List of Recommended spares with item wise rates

m. Any other data / information requested anywhere in the specifications

n. Vendor catalogue

o. Special tools and tackles (if any)

## 11.2 Vendor Data Requirement (VDR)

Following documents shall be submitted by Supplier after placement of order:

| | ITEM DESCRIPTION<br>**SOOT BLOWER** | AFTER ORDER PLACEMENT<br>Review Category | AS-BUILT DATA FOLDER |
|---|---|---|---|
| 1. | Supplier DCI<br>(Consolidated list of suppher documents with planned submission schedule) | R | |
| 2. | Soot blower datasheet<br>(Fully engineered with complete data) | R | |
| 3. | GA Drawing of soot blower<br>(with complete details including tag nos , design data, weights, dimensions, BOM / part list, MOCs, interface details, allowable nozzle loads etc ) | R | |
| 4. | Utility requirements | R | |
| 5. | P&ID with scope demarcation & interlock description | R | |
| 6 | Instrumentation Documents:<br>- Sub vendor list for Instruments, accessories, PLC system<br>- Logic Diagrams<br>- General arrangement & Internal arrangement panel drawing<br>- Power supply distribution<br>- Wiring diagram<br>- PLC configuration diagram<br>- BOM for PLC system<br>- MODBUS mapping details<br>- Catalogues for instruments & control systems<br>- Certificates (statutory / inspection / calibration tests) | - R<br>- I<br>- I<br>- I<br>- I<br>- R<br>- I<br>- I<br>- I<br>- I | |
| 7. | Electrical Documents:<br>- Wiring diagram<br>- Motor datasheet<br>- Electrical Load Data | R | |
| 8. | Test procedure for Functional Test at shop | I | |
| 9. | List of Spares | I | |
| 10. | ITP and QA Plan | R | |
| 11. | Manufacturer's Data Report including Inspection records | I | |
| 12. | Unpacking, handling and erection instructions | I | |
| 13. | Installation, Operation, Programming & Maintenance Manual for the soot blowers and control system | I | |
| 14. | Preservation procedure | I | |
| **15.** | **Consolidated Data Folder**<br>**(All documents from Sr. no. 1 to 12; to be also supplied along with the equipment)** | | I |

**LEGEND:**

R Document which is required to be reviewed by EIL
I Document to be submitted for EIL Record

**NOTE:**

All documents shall be submitted in physical / electronic form as per the procedure / requirements stated in the Job specification / Requisition.

## 12.0 VENDOR DATA SHEET

| S. No. | TECHNICAL QUERY | BIDDER'S CONFIRMATION |
|---|---|---|
| 1. | Quoted Model No. | |
| 2. | Stroke length & dead travel | |
| 3. | No. of nozzles per lance (maximum two for long retractable soot blower) | |
| 4. | Lance tube diameter | |
| 5. | Lance tube material and composition | |
| 6. | Lance tip material and composition | |
| 7. | Details of wall box offered | |
| 8. | Clear space requirement for erection / operation / maintenance of soot blowers | |
| 9. | Sleeve size required on furnace wall (Purchaser's supply) | |
| 10. | Weight of soot blower | |
| 11. | Blowing time per cycle | |
| 12. | Blowing angle coverage (degrees) in rotation | |
| 13. | Steam consumption per blower cycle | |
| 14. | Total steam consumption per cycle for all blowers | |
| 15. | Recommended frequency of soot blower operation per day | |
| 16. | Maximum cleaning radius | |
| 17. | Electrical power consumption per blower cycle | |
| 18. | Any other utility consumption envisaged | |
| 19. | Maximum lance deflection (mm) | |

# फैब्रिक टाइप विस्तार जोड़ों के लिये मानक विनिर्देश

# STANDARD SPECIFICATION FOR FABRIC TYPE EXPANSION JOINTS

| Rev. No | Date | Purpose | Prepared by | Checked by | Standards Committee Convenor | Standards Bureau Chairman |
|---|---|---|---|---|---|---|
| | | | | | Approved by | |
| 1 | 30 12 19 | REVISED AND REISSUED AS STANDARD SPECIFICATION | RS | PG | MK | RKT |
| 0 | 20 11 14 | ISSUED AS STANDARD SPECIFICATION | MK | KJHN | AP | SC |

**Abbreviations:**

| | | |
|---|---|---|
| CS | : | Carbon Steel |
| DP | : | Dye Penetration |
| ITP | : | Inspection and Test Plan |
| mmwc | : | Millimeters Water Column |
| MP | : | Magnetic Particle |
| PTFE | : | Poly tetra fluoro ethylene |
| PTR | : | Past Track Record |
| QAP | : | Quality Assurance Plan |
| SRU | : | Sulfur Recovery Unit |
| SS | : | Stainless Steel |
| TPIA | : | Third Party Inspection Agency |
| UV | : | Ultra violet |

**Fired Equipment Standards Committee**

**Convener:** Mandip Kapoor

**Members:** Amit Prakash
Rajesh Patel
Dhiman Deb
Navneet Aggarwal
Prasenjit Saha
Deepak Gupta (Projects)
Pankaj Kumar Rai (Construction)

## CONTENTS

## 1.0 GENERAL

1.1 This specification covers the minimum requirements for design, fabrication, testing and supply of fabric type expansion joints in refinery service used for flue gases, hot air ducts and similar applications.

1.2 The target design life for the expansion joints shall be 15 years and minimum 1000 cycles.

1.3 The requirements of this specification shall be suitably augmented by supplier, to ensure that the items supplied are of proven quality and suitable for the intended purpose & design life.

1.4 The supplier shall be a specialty expansion joint manufacturer who has adequate experience in supply of such items and must satisfy the Vendor Qualification related requirements as per the procurement specification.

1.5 Supplier shall be selected based on proven PTR of similar service (i.e. gas composition, operating temp. operating pressure etc.). Hot air duct application by itself is not considered a sufficient PTR for flue gas duct service or sulfur unit service.

1.6 This specification shall be read in conjunction with the Job Specification.

## 2.0 DESIGN REQUIREMENTS

2.1 The expansion joint shall be suitable for the flue gas composition stated in the Job Specification. For flue gas or other corrosive service dew point check shall also be carried out.

2.2 The expansion joint shall be suitable for the design temperature and design pressure conditions stated in the procurement specification. In case the Job specification specifies the operating conditions, a design margin of 100 °C shall be considered for temperature and 100 mmwc for pressure. As a minimum the following values shall be used:

| Service | Flue Gas | Hot Air |
|---|---|---|
| Mechanical Design Temperature (°C) | 500 | 400 |
| Mechanical Design Pressure (mmwc) | -50 to +50 | +600 |

2.3 The expansion joint should be capable to absorb the axial expansion / lateral expansion / rotation / torsion values as per the Job specification. An additional design margin of 5 mm / 5 degrees shall be considered by the supplier.

2.4 The expansion joint shall be able to sustain the stipulated movements without undue stresses in the connected equipment / duct pieces.

2.5 Suitable metallic liner or baffle shall be provided on the inside to protect the gas seal membrane and insulating layers of the flexible element / Bolster from erosion caused by abrasive particles which may be present in the gas stream.

2.6 The expansion joints shall be able to withstand the frequent alternate expansion and contraction of the connected equipment / duct pieces. 25 cycles (minimum) per year may be considered.

2.7 Additional sheath of fabric shall be provided in the flange area to protect from thermal & mechanical loads.

**2.8** Suitable metallic backup bars shall be provided on the outside at the fabric to flange joints to ensure mechanical strength and good sealing at the joint.

**2.9** Maximum outside dimensions of the expansion joints shall be limited to 200 mm over the outside plate dimensions of connected duct.

**2.10** Pre-compression is permitted for the expansion joints required to only 'open up' to take care of axial expansions.

**2.11** Lateral / angular presetting is permitted with prior consent of the purchaser, for expansion joints required to absorb abnormally high lateral / torsion expansions.

**2.12** For high temperature applications, insulating material / bolster shall be provided for the protection of fabric layer from heat, ingress of solid particles in cavity and support for fabric layer. Insulating material shall be placed in a retaining bag to allow the movement during operation. The bolster shall be pinned or tabbed to metal work. A metallic mesh as a secondary bag over primary retaining bag may be used to protect damage by abrasion.

**2.13** Wherever there is a possibility of the bolt head coming in contact with Fabric, counter sunk type bolting arrangement to be used to avoid damage to the Fabric.

## 3.0 MANUFACTURING REQUIREMENTS

**3.1** The fabric for the expansion joint shall comprise of the following layers as a minimum:

A) Flue Gas Service:

i) Treated texturized fiber glass fabric

ii) Glass felt (Number of glass layers shall be decided by supplier based on the temperature profile)

iii) PTFE coated and both side PTFE foil laminated fiber glass fabric having minimum thickness of 0.95 mm

B) Air Service:

Same as noted in "A)" above. Elastomer coated glass fabric (minimum 0.7 mm thick) with pin hole tested PTFE sheet shall also be acceptable instead of PTFE coated and PTFE laminated glass fabric (minimum 0.95 mm thk).

**3.2** Permeability of the fabric shall be zero (i.e. 100% leak proof). The detailing and manufacture shall not allow gaps or potential leakage paths. The joint of the fabric shall be pressed properly near the flange connection to avoid any gaps, especially at fabric seam joint location.

**3.3** The fabric layers for the expansion joint shall be non-reactive to the flow medium and to each other at any temperature / operating conditions.

**3.4** All metal parts in direct contact with flue gas shall be of minimum SS316 metallurgy.

**3.5** The expansion joints shall be suitable for outdoor operation under refinery environment. Fabric shall be dust resistant, abrasive resistant, UV resistant and suitable for sun & rainy conditions.

**3.6** Minimum 3 mm corrosion allowance shall be considered on CS material.

**3.7** Dimensional tolerances shall be $\pm$ 2 mm over the drawing dimensions.

3.8 Expansion joint metallic parts shall not have sharp edges which could potentially damage the fabric.

3.9 All exposed metallic surface shall be shop painted with at least two coats of primer / finished paint after thorough cleaning of the surface. Supplier's own standard is acceptable, unless otherwise stated in the purchase requisition / purchase specification. No painting is required for stainless steel parts.

## 4.0 SCOPE OF SUPPLIER

4.1 The expansion joints shall be supplied as completely assembled units, shop tested & inspected and ready to be bolted in the duct work.

4.2 For SRU service, expansion joint shall be refractory lined and anchors shall be shop installed. Refractory may be installed at shop / site, as per the requirements of procurement specification.

4.3 The expansion joints shall be suitable for being bolted in duct work through necessary flanges, bolts & gaskets. Standard M16 bolts shall be used for fixing the expansion joint with the ducting system. The scope of supply for mating counter flanges, gaskets, nuts & bolts shall be as per the Job Specification. Expansion joints for SRU or other applications with flue gas under positive pressures, shall be suitable for seal welding after installation & bolting in order to avoid leakage of flue gases.

## 5.0 QUALITY CONTROL, INSPECTION AND TESTING

5.1 Supplier shall submit QAP & ITP for EIL / TPIA approval. In case of TPI, Heater Contractor shall submit QAP / ITP duly approved by Heater Contractor & TPIA to PMC for approval.

5.2 All items are subject to final inspection by Owner / EIL / nominated Inspection authority / approved TPIA. All facilities for this shall be provided by the Supplier.

5.3 Following reports / certificates shall be submitted as a minimum:

a. Material test certificate including Permeability Test.

b. Over all dimensional checks (indicating check of critical dimensions as a min.)

c. Weld examination by MP / DP tests.

## 6.0 PACKING, PRESERVATION & SHIPMENT

6.1 All items shall be marked with item tag number, Owner's name and address. Marking shall be done with stencil in bold white paint letter. Storage in open without protective cover is not permitted.

6.2 The equipment shall be securely packed and anchored in order to prevent shifting and consequent damage during transportation. Packing shall be suitable for rail and road transport. In case of foreign vendors, packing shall be suitable for transportation by sea. Packing shall be suitable to prevent damages from moisture, rain, rust, corrosion etc. during transportation to the site.

6.3 Adequate temporary mechanical stopper plates in bold yellow color shall be provided between the flanges of the expansion joint, which can be removed by the erection contractor after installation of the expansion joint. The stopper plates shall be such that the flange to flange distance / alignment matches the dimension in the expansion joint arrangement drawings and takes care of the pre-compression / presetting requirements.

6.4 Suitable tag with instructions shall be provided to ensure correct installation for items for which pre-compression / presetting is applicable.

6.5 The equipment shall not be dispatched for shipment unless it has been approved by the Authorized Inspector.

## 7.0 GUARANTEE

7.1 All materials shall be new and of fine quality.

7.2 Expansion joint or any part thereof found to be of defective / sub-standard material, improper design, poor workmanship or poor performance, shall be replaced by the supplier at his own cost and without any delay.

## 8.0 DRAWING AND DOCUMENT SUBMISSION

8.1 The following drawing / documents / data are required to be submitted by the Supplier:

a. Vendor Qualification related information, if asked
b. QAP & ITP
c. Arrangement drawings for the expansion joints
d. Final documentation

8.2 Supplier to note that the following minimum details to be incorporated in GA drawing:

a. Flow direction
b. BOM table, MOC of major items
c. Fabric for the layers
d. All important dimensions
e. Other technical details like design data, expansion data etc.
f. Job related information like Client name, Project name, EIL Job no., Item No. etc., which shall be printed in the title block of all the drawings
g. In case pre-compression / presetting is applicable, suitable installation instructions shall be provided on the drawing to ensure correct installation

# मेकैनिकल एजिटेटर का मानक विनिर्देश

# STANDARD SPECIFICATION FOR MECHANICAL AGITATORS

| Rev. No | Date | Purpose | Prepared by | Checked by | Standards Committee Convenor | Standards Bureau Chairman |
|---|---|---|---|---|---|---|
| | | | | | Approved by | |
| 5 | 14.05.2024 | REVISED AND REISSUED AS STD. SPEC. | MKP | TKh | NK | MN |
| 4 | 24.08.2018 | REVISED AND REISSUED AS STD. SPEC. | SA | AT | KJH | RKT |
| 3 | 22.03.2010 | REVISED AND REISSUED AS STD. SPEC. | TK | RKT | AKM | DM/ND |
| 2. | 15.06.2004 | REVISED AND REISSUED AS STD. SPEC. | M.ASHOK | AM | SSA | MG |
| 1 | 04.01.1999 | REVISED AND REISSUED AS STD. SPEC. | | USG | CRMN | A.SONI |
| 0 | 07.04.1986 | ISSUED AS STANDARD SPECIFICATION | A.RAO | RSC | SCG | AK |

**Abbreviations:**

| | | |
|---|---|---|
| AGMA | : | American Gear Manufacturer's Association |
| ASME | : | American Society of Mechanical Engineers |
| ASTM | : | American Society for Testing and Materials |
| BKW | : | Brake Kilowatts |
| BS | : | British Standards |
| dBA | : | Decibels |
| GPC | : | General Purchase Conditions |
| IS | : | Indian Standards |
| KW | : | Kilowatts |
| NB | : | Nominal Bore |
| PTFE | : | Poly Tetra Flouro Ethylene |
| RPM | : | Revolutions Per Minute |

**Static Equipment Standards Committee**

**Convenor:** Mr. Nalin Kumar
**(Co-Convener):** Mr. K. Anjaneyulu

**Members:**
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Mr. Tarun Kumar (Emp. No. A328)
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Mr. Prabhakar Choudhary (SMMS)
Mr. Avdhesh Agrawal (SCM-Inspection)

## CONTENTS

## 1.0 SCOPE

1.1 This specification covers minimum requirements for design, supply, inspection and testing of mechanical agitators, their auxiliaries and accessories.

1.2 No deviation or exception from this specification shall be permitted without the written approval of the purchaser. Intended deviations shall be separately listed by the vendor and supported by reasons for consideration of the Purchaser.

1.3 Compliance with this specification shall not relieve vendor of the responsibility of furnishing equipment and accessories of proper design, materials and workmanship to meet the specified operating conditions.

1.4 This general specification supplements the specific requirements contained in the job specifications, if any, and the equipment data sheets. In the event of any contradiction between the information contained in various attached documents, the following order of precedence shall govern:

i) Data sheets.
ii) Job Specification.
iii) This Specification.
iv) Various reference specifications.

## 2.0 BASIC DESIGN

### 2.1 General

2.1.1 Agitators, gears and auxiliary equipment shall be designed and constructed for operation at continuous full load duty. Units shall be of a proven design for the intended service. The agitator vendor shall be wholly responsible for satisfactory hydraulic, mechanical and overall performance of the equipment and all connected subassemblies. CFD analysis, if required, shall be carried out for the agitator.

2.1.2 Unless otherwise specified elsewhere, the following experience criteria shall be applied for acceptance of the offered agitator model.

i) The vendor shall be an established agitator manufacturer having engineering, manufacturing and testing facilities.

ii) Agitator offered shall be from existing manufacturing range of vendor. (Prototypes are not acceptable).

iii) Proposed agitator shall be identical in model number/ Frame and similar in terms of power rating & mechanical design (e.g. overall shaft length, shaft diameter, operating speed, number/ type of impellers, type of sealing & sealing system etc.) to at least one unit designed, manufactured, tested and supplied from the proposed manufacturing plant and the unit shall have completed 1 year of operation at job site on bid due date. As an alternative, vendor may show to the satisfaction of the purchaser that the equipment offered is comprised of standard subassemblies which individually satisfy the above requirements.

iv) The above acceptance criteria shall also be applicable for bought out auxiliaries like Gearbox, seals, sealing system etc.

v) Vendor shall furnish record of his past experience to justify the proven-ness of the offered equipment.

2.1.3 In cases where the impeller geometry, absorbed power and speeds are specified by the buyer, the Supplier shall review the same and confirm the adequacy for the overall satisfactory performance of the equipment for their specified service conditions. Any deviations or changes required to these Buyer's requirements shall be clearly highlighted by supplier in the technical bid with proper justification.

The supplier shall in all cases satisfy himself that the materials and/or design features indicated by Buyer (including process licensor) are adequate for the design, design duty, test conditions and methods of manufacture and handling to be encountered. In the case of any doubt, the Supplier shall consult Buyer before commencing with work of fabrication.

2.1.4 The agitator shall be designed for mounting and operating in purchaser's vessel/tank whose drawing is annexed with the enquiry specification. The agitator vendor shall, within one month of receipt of order, review and comment on the Purchaser's vessel drawing for number and size of baffles, sparger locations, mounting nozzle details etc.

2.1.5 Agitator shall be designed for complete operational range of vessel liquid level inclusive of full/maximum & minimum liquid level, as specified.

2.1.6 Unless otherwise specified, for small diameter impeller, it shall be possible to remove the complete Agitator assembly without dismantling through the opening provided on the vessel/tank. For large diameter impeller, blades shall be of removable construction for ease of removal. Vendor shall also furnish the headroom required for taking out the agitator as above.

2.1.7 All equipment furnished by vendor shall be suitable for the area classification specified in the data sheets.

2.1.8 The noise level of unit when measured at 1 meter distance shall not exceed 85 dBA. The supplier shall submit noise emission data for the proposed unit post award.

2.1.9 Pressure containing parts and mounting flanges shall be designed, fabricated, tested and inspected in accordance with the ASME codes, unless specified otherwise on the data sheets.

2.1.10 Pressure containing parts of carbon steel shall have a minimum corrosion allowance of 3mm, unless otherwise specified on the data sheets. Carbon steel shaft shall have corrosion allowance of 6 mm on its diameter unless otherwise specified. On other non pressure carbon steel parts a corrosion of 3 mm shall be considered on each surface.

2.1.11 Lifting eye bolts shall be provided for driver, gear box, mounting plate etc. for ease of lifting and shall be located at the centre of gravity of that component.

2.1.12 Vendor shall provide proper dowelling between motor and base plate, gear box and mounting stool/base plate for ease of assembly of the agitator unit. Tapered dowels shall be provided.

2.1.13 Vendor shall provide suitable arrangement for supporting the agitator shaft with impellers during removal of gear box for maintenance and details of such arrangement shall be furnished.

## 2.2 Electric Drives

2.2.1 Unless stated otherwise, the driver shall be in the scope of agitator vendor. The driver shall conform to the corresponding specifications listed in the enquiry document.

2.2.2 Electric motors shall have a minimum power rating in accordance with the following table:

| Agitator BKW at input shaft of gear box (Including Gear &Transmission losses) | Motor rating (% of Agitator Rated BKW) |
|---|---|
| Less than 22 KW | 125% |
| 22 - 55 KW | 115% |
| Higher than 55 KW | 110 % |

The electric motor shall be suitable for the electrical area classification indicated in the electrical specification/data sheets.

## 2.3 Gear Units

2.3.1 In case where speed reduction is required, the vendor shall incorporate helical or worm gear reduction unit. Use of V-belt/Chain drive (antistatic type) is permitted for swivel type side entry agitators. Use of V-belt / Chain drive for any other agitator configuration (i.e. top/bottom entry or fixed type side entry) shall require purchaser's approval, unless otherwise specified in data sheet. Minimum design life of V-belt shall be 25000 hrs.

2.3.2 The gear box rating shall be selected based on minimum gear service factor of 1.5 over the driver's name plate rating. The gear box shall be of heavy-duty type and the bearings shall be capable of withstanding maximum radial cum thrust loading which may occur during startup/ transient & normal operation including initial whirling motion.

2.3.3 The speed reduction unit shall be procured from a reputed gearbox manufacturer and shall conform to DIN/ ISO/ AGMA or equivalent specification.

2.3.4 Where shut off and retracting arrangements are required, the vendor shall provide a gear reduction unit having a hollow output shaft.

2.3.5 The gear reduction unit shall always be provided with an oil drain, a breather and oil level gauge. The lubrication must be designed keeping in view that temperature within bearings should not exceed 85°C.

## 2.4 Couplings

2.4.1 The vendor shall use the following nomenclature.

i) High Speed Coupling

Coupling used between the motor and gear reducer. It shall be of flexible type and shall be provided with a non-sparking guard.

ii) Low Speed Coupling:

Coupling used between the output shaft of the gear reducer or driver, and the agitator shaft. It shall be of the flexible or rigid type with spacer.

iii) Auxiliary coupling:

Coupling provided to sectionalize the agitator shaft inside the tank/vessel.

2.4.2 Flexible couplings shall be selected with a minimum service factor of 2 over the driver nameplate rating and shall be capable of continuous operation at the maximum anticipated misalignment.

2.4.3 Rigid couplings wherever used, shall have tapered bores with key and nut arrangement. All rigid couplings shall be manufactured from cast steel as per IS: 1030 Gr. II or forged steel as per IS : 2004 Cl. 3 or cast iron as per IS : 210 Cl. 30. Rigid couplings in forged steel may be welded to the shaft for atmospheric tanks.

2.4.4 All necessary instructions for assembly of coupling shall be furnished by the Vendor.

## 2.5 Mounting stool & Flanges

2.5.1 Wherever required, the vendor shall provide a mounting stool for the agitator unit. It shall house the shaft coupling, the bearing housing, the seal and the auxiliary coupling as applicable.

2.5.2 The lantern stool shall be designed to provide adequate accessibility for ease of erection and maintenance. The stool shall be either in standard ERW pipe construction as per IS: 1978 or shall be fabricated from

IS :2062 E250 Grade B plate. Plugged holes shall be provided at proper locations to drain the oil which may get collected in the stool due to improper functioning of gear box, oil seal, etc.

2.5.3 Mounting flange dimensions shall be as per ASME B16.5 up to 600 NB, ASME B16.47 Series B for more than 600 NB or as specified in the data sheets. Material of construction shall be as specified in the data sheet of agitator/ vessel/tank.

**2.6 Agitator Shaft**

2.6.1 Unless otherwise specified, the bottom shaft of top mounted agitators shall be one piece. Constant diameter solid/hollow shaft of cantilever design suitable for 20 yrs. of service life shall be furnished. Larger lengths shaft may be divided.

2.6.2 The selection of the shaft diameter shall be done to satisfy the following criteria:

a) Shaft shall be suitable for transmitting full rated (pull out) torque as mentioned in driver's name plate.

b) Shaft shall be suitable for jamming conditions considering that impeller is jammed at a point 0.75R from the centre (R=radius of impeller). Unless otherwise specified a safety factor of 1.5 shall be taken on motor rating to work out pull out torque for calculating the stresses as per maximum shear strain energy theory. The maximum stress thus calculated shall be limited to yield stress of the shaft material at vessel design temperature.

c) Shaft runout shall be limited to a maximum value of 0.05 mm at the face of the stuffing box/seal.

d) Dynamic shaft deflection at the mechanical seal (cartridge) face shall be limited to the value specified by mechanical seal manufacturer or 0.07mm whichever is less.

e) Shaft diameter shall also take into account factors of straightness and runout at shaft end. In the assembled condition, the maximum shaft runout at the free end shall be limited to 1.0 mm per meter (on each side) of overhung length of shaft (measured from nearest bearing/seal face end).

f) There shall be a separation margin of minimum 20% between the critical speed (dry/wet) and any operating speed.

**2.7 Impellers**

2.7.1 Impellers with small diameter shall be of one-piece construction. Impellers with large diameter blades shall be of bolted construction.

2.7.2 Discs and stabilizers may be split to permit removal through manhole openings.

2.7.3 Wherever possible the impellers shall be mounted on the taper bore of the shaft by means of key. Care shall be taken that both tapers match each other. A lock nut with cotter pin shall be provided to safeguard against loosening during operation.

2.7.4 All impellers shall be dynamically balanced for operating speed above 300 rpm.

**2.8 Seals**

2.8.1 The type of seal required shall be as specified in the data sheets.

2.8.2 Seals, when specified shall be of standard manufacturing range and shall be procured from EIL approved makes for Mechanical Seals.

2.8.3 Gland packings, if specified, shall be designed for ease of maintenance and shall not require auxiliary coupling for the same. The design shall incorporate:

a) Gland in two halves.

b) individual packing rings of PTFE or PTFE impregnated asbestos.

c) Spacer ring in two halves between two packing rings.

d) Lantern ring in two halves, if lubrication is required.

Equipment (if any) necessary for lubrication of packing shall be supplied by the vendor and a detailed drawing for the same shall be submitted as per vendor data requirement.

2.8.4 Mechanical seal assemblies shall be of cartridge type and shall be removable without dismantling the agitator drive unit.

Seal cartridges shall be self-venting through circulation return line. Cartridge shall have leak detection ports.

(a) Hydraulically balanced Mechanical Seals shall be used for agitator sealing.

(b) Seal housing & Mechanical Seal shall be designed taking into consideration the vessel design pressure & temperature under static conditions. All parts of seal housing in contact with the process fluid shall be constructed in the same or superior material of vessel.

(c) Inboard seal of all double Mechanical Seals shall have reverse pressure capability.

(d) Pressure double Mechanical Seals shall have barrier fluid inlet adjacent to the inboard seal & outlet adjacent to the above outboard seal.

(e) If dual Mechanical seal is specified, the same shall be provided with modified Plan 53B as per details attached in Annexure-I.

2.8.5 The seal model/type/material code etc. shall be suitable for the specified operating media and shall be as per the seal manufacturer's recommendations. The seal design pressure shall be 1.1 times the vessel design pressure.

2.8.6 The equipment & piping seal for flushing/quenching system, if specified shall be in the agitator vendor's scope of supply.

## 2.9 Bearing Housing and Bearings

2.9.1 The bearing housing shall be designed with a span suitable for the maximum radial cum thrust loadings used for the design of the shaft. The housing shall be either integral with mounting stool or bolted to the mounting stool and be provided with a precision machined step facing to make a corresponding facing on the stool for the purpose of maintaining alignment and interchangeability.

2.9.2 All bearings shall be designed for the maximum radial cum thrust loadings and any shock loadings expected during operation. The bearings shall have a trouble-free operating life of 30,000 hours minimum.

## 2.10 Steady Bearings & Baffles

2.10.1 Unless otherwise agreed upon, the design of the agitator shall not incorporate the use of a steady bearing at the shaft end. However, if the use of such a bearing is imperative, the design shall be such that the bearing is of self aligning type and is product lubricated. Vendor shall highlight the same in proposal.

2.10.2 The steady bearing and its support arrangement for top mounted agitator shall be in the scope of agitator vendor. The vendor shall supply necessary drawings/specifications to purchaser for making arrangement in the vessel/tank for mounting the steady bearing and its support. The pads welded to the equipment shall be supplied by the vessel fabricator.

2.10.3 If antivortex-baffles are required, vendor shall design and furnish the complete details (in terms of dimensions, number, location, orientation) including its supports.

**2.11 Piping Connections**

2.11.1 Threaded and plugged connections for seal flushing, vents and lubrication shall be ½ inch NB minimum size.

2.11.2 Flanged connections shall be used for sizes 1 inch NB and above and shall conform to ASME B 16.5.

**2.12 Special Tools and Tackles**

If required, Vendor shall supply a set of special tools and tackles required for erection, as well as operation & maintenance of the agitator units. A list of such tools shall be submitted along with the offer.

## 3.0 MATERIALS

3.1 Vendor shall indicate the materials of construction for the various parts on the data sheet. However, the vendor shall adhere to the materials as specified by the purchaser in the data sheets or elsewhere in specification and shall quote accordingly. IS/BS/ANSI/ASTM or other international standards shall be used to specify exact material designations.

3.2 Castings used for any part of agitator assembly ordered under these specifications shall be sound and free of shrink or blow holes, scale, blisters and other similar casting defects.

3.3 Unless otherwise specified in the data sheets, material test certificates (chemical analysis and mechanical properties) shall be supplied for impeller, shaft, mounting flange and coupling, after award.

## 4.0 INSPECTION & TESTING

**4.1 General**

4.1.1 Unless otherwise specified all agitator units shall be tested at vendor's shop in accordance with Clause 4.2 to 4.4 of this specification.

4.1.2 The tests to be witnessed by the Purchaser shall be as indicated in the data sheets / approved vendor quality assurance plan.

4.1.3 The vendor shall notify the purchaser not less than 10 days prior to the date of inspection or test.

4.1.4 Acceptance of shop tests shall neither be considered a waiver of requirements to meet field tests under specified operating conditions nor does inspection relieve the manufacturer of his responsibilities in any way whatsoever.

4.1.5 The inspector representing the purchaser shall have entry to the plants including sub-vendor plants where work or testing of the equipment is being performed.

4.1.6 Vendor shall furnish the inspector with all necessary material certificates, shop test data for verifying the vendor's compliance with the specifications on the agitator and all auxiliaries furnished by sub vendors

4.1.7 No surfaces or parts are to be painted until the inspection is completed.

### 4.2 Hydrostatic Test

Each pressure part like stuffing box jacket or seal reservoir of a unpressurized/ pressurized sealing lubrication system, etc., shall be hydrostatically tested with water at a pressure not less than one and a half time the maximum operating pressure. The duration of the test shall be 30 minutes. Criteria of acceptance shall be no leaks.

### 4.3 Mechanical Run Test (in air)

Each agitator unit shall be given a 4 hours mechanical run test in air at vendor's shop. Agitator unit shall be mounted in the same orientation as it will operate in the field. During this test, the record shall be made of:

a) Shaft run out at the free end.

b) Dynamic shaft deflection adjacent to the mechanical seal/packing/vapor seal.

c) Gear box oil temperature and temperature of bearing housing in stool.

The temperature of gear box oil shall not exceed ambient plus 40°C and that of bearing housing shall not exceed room temperature plus 20°C after the temperatures have stabilized.

d) Bearing housing vibration check shall be carried out. The maximum acceptable vibration velocity shall be 6 mm/sec.

e) Noise levels shall be checked and shall be as per clause 2.1.7

f) Agitator shaft RPM and motor RPM.

g) Check of satisfactory operation of shut off and retracting arrangement.

### 4.4 Mechanical Run Test (in water)

If specified in the data sheets, the agitator unit shall be given a load test in water at the vendor's shop. The duration of this test shall be 4 hours unless agreed otherwise between the Purchaser and the vendor. The following parameters shall be recorded during the test:

a) Dynamic shaft deflection adjacent to the mechanical seal/packing/vapor seal.

b) Gear box bearing oil temperature and temperature of bearing housing in stool. The temperature of gear box oil shall not exceed ambient plus 40°C and that of bearing housing shall not exceed room temperature plus 20°C after the temperatures have stabilized.

c) Bearing housing vibrations. Maximum acceptable vibration velocity is 6 mm/sec.

d) Noise levels shall be checked and shall be as per clause. 2.1.7

e) Electrical power input to the motor.

f) Agitator shaft RPM and motor RPM.

g) Check of satisfactory operation of shut off and retracting arrangement.

### 4.5 Acceptance Test at Site (if specified)

After the agitator has been installed at site and is ready for test, vendor shall depute his representative to supervise the site acceptance test. All measurements and record of readings shall be done in accordance with para 4.4 above.

## 5.0 PREPARATION FOR SHIPMENT

5.1 After completion of inspection and tests all exposed machined surfaces and all internal parts shall be thoroughly coated with rust preventive. All exterior parts of the unit, except machined surfaces, shall receive one coat of primer and one coat of synthetic enamel of approved make.

5.2 All untapped openings shall be provided with 4mm thick metal closures with full rubber gaskets and bolted with not less than 4 bolts. Tapped openings not otherwise closed shall be plugged. The end of small piping may be closed with tape.

5.3 The agitator shall be supplied with a name plate containing the following information:

- Manufacturer's Name
- Type and Serial Number of Unit
- Rotational Speed
- Direction of Rotation
- KW Rating
- Tag number of equipment
- P.O. Number

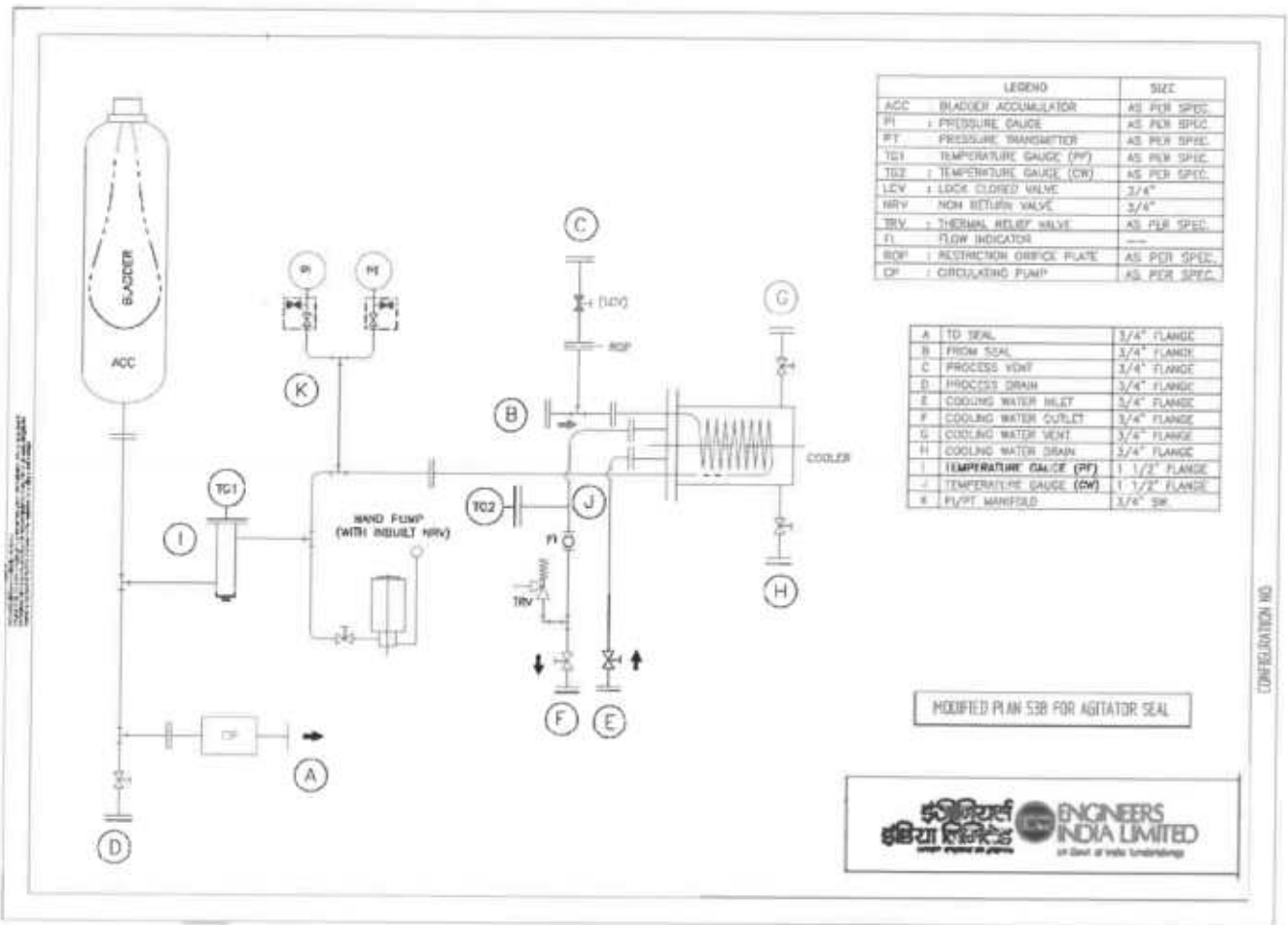
The name plate shall be of stainless steel and relevant information shall be punched onto the same.

5.4 The equipment and spare parts shall be suitably packed, fastened to avoid damage during transit and crated for shipment and outdoor storage for a period of 6 months. Lifting, unpacking and handling instructions shall be securely attached to the exterior of the largest packing in a well marked weather proof container. The upright position, lifting points, gross weight and dimensions shall be clearly marked on each package. Each package shall clearly identify the equipment contained therein.

## 6.0 VENDOR DATA

6.1 The Vendor shall submit the mechanical calculations for EIL review. EIL's review of calculation shall not relieve the Vendor of his responsibility in any manner. The fabrication drawings and other documents shall also be submitted in accordance with the requisition/bid document.

ANNEXURE – I (Modified Plan 53B)




| | LEGEND | SIZE |
|---|---|---|
| ACC | BLADDER ACCUMULATOR | AS PER SPEC. |
| PI | : PRESSURE GAUGE | AS PER SPEC. |
| PT | PRESSURE TRANSMITTER | AS PER SPEC. |
| TG1 | TEMPERATURE GAUGE (PF) | AS PER SPEC. |
| TG2 | : TEMPERATURE GAUGE (CW) | AS PER SPEC. |
| LCV | : LOCK CLOSED VALVE | 3/4" |
| NRV | NON RETURN VALVE | 3/4" |
| TRV | : THERMAL RELIEF VALVE | AS PER SPEC. |
| FI | FLOW INDICATOR | --- |
| ROF | : RESTRICTION ORIFICE PLATE | AS PER SPEC. |
| CP | : CIRCULATING PUMP | AS PER SPEC. |

| | | |
|---|---|---|
| A | TO SEAL | 3/4" FLANGE |
| B | FROM SEAL | 3/4" FLANGE |
| C | PROCESS VENT | 3/4" FLANGE |
| D | PROCESS DRAIN | 3/4" FLANGE |
| E | COOLING WATER INLET | 3/4" FLANGE |
| F | COOLING WATER OUTLET | 3/4" FLANGE |
| G | COOLING WATER VENT | 3/4" FLANGE |
| H | COOLING WATER DRAIN | 3/4" FLANGE |
| I | TEMPERATURE GAUGE (PF) | 1 1/2" FLANGE |
| J | TEMPERATURE GAUGE (CW) | 1 1/2" FLANGE |
| K | PI/PT MANIFOLD | 3/4" SW |

CONFIGURATION NON NEGOTIABLE

# उपकेन्द्रीय पम्पों के लिए मानक विनिर्देश (सामान्य प्रयोजन)

# STANDARD SPECIFICATION FOR CENTRIFUGAL PUMPS (GENERAL PURPOSE)

| Rev. No | Date | Purpose | Prepared by | Checked by | Standards Committee Convenor | Standards Bureau Chairman |
|---|---|---|---|---|---|---|
| | | | | | Approved by | |
| 6 | 02.12.24 | REVISED & ISSUED AS STANDARD SPECIFICATION | AK | JSD/TK | NK | MN |
| 5 | 09.01.20 | REVISED & ISSUED AS STANDARD SPECIFICATION | NGAS | NK | SM | RKT |
| 4 | 06.04.11 | REVISED & ISSUED AS STANDARD SPECIFICATION | SPS | DB | AKN | DM |
| 3 | 13.05.08 | REAFFIRMED & ISSUED AS STANDARD SPECIFICATION | JSD | NK | VKM | VC |
| 2 | 29.08.03 | REVISED & ISSUED AS STANDARD SPECIFICATION | PS | KDS | RK | SKG |

**Abbreviations:**

| | | |
|---|---|---|
| ANSI | : | American National Standards Institute |
| ASME | : | American Society of Mechanical Engineers |
| ASTM | : | American Society for Testing and Materials |
| BIS | : | Bureau of Indian Standards |
| DCI | : | Document Control Index |
| DMW | : | De-Mineralized Water |
| EC | : | Experience Criteria |
| engDMS | : | Engineering Electronic Document Management System |
| ETP | : | Effluent Treatment Plant |
| GA | : | General Arrangement |
| HI | : | Hydraulic Institute |
| IC | : | Internal Combustion |
| ISA | : | Instruments Society of America |
| ISO | : | International Organization for Standardization |
| MAWP | : | Maximum Allowable Working Pressure |
| MCF | : | Minimum Continuous Flow |
| MCR | : | Maximum Continuous Rating |
| MCS | : | Maximum Continuous Speed |
| NPS | : | Nominal Pipe Size |
| NPSH | : | Net Positive Suction Head |
| NPSHA | : | Net Positive Suction Head Available |
| NPSHR | : | Net Positive Suction Head Required |
| OD | : | Outside Diameter |
| P&ID | : | Piping and Instrumentation Diagram |
| PTR | : | Proven Track Record |
| RWTP | : | Raw Water Treatment Plant |
| VDM | : | Vendor Document Management |
| VDR | : | Vendor Data Requirements |

**Rotating Equipment Standards Committee**

**Convenor:** Mr. Nalin Kumar

**Members:**
Mr. Tarun Kumar
Mr. J S Duggal
Mr. Abhay Kumar
Mr. Mahesh Easwaran
Mr. Mahesh Gupta
Mr. Pintu Lal
Mr. Aasheesh K Handa (Projects)

## CONTENTS

## SECTION 1 - GENERAL

### 1.1 SCOPE

i. This specification together with the attendant Data Sheets and other specifications/attachments to inquiry / order defines the minimum requirements for vertical and horizontal centrifugal pumps and their accessories / auxiliaries for general purpose services [i.e. non-process services & utility services such as De-mineralised Water (DMW) plants, Raw Water Treatment Plants (RWTP), Effluent Treatment Plants (ETP), etc.]. Specifically intended are centrifugal pumps for general purpose which are classified as pumps for applications where maximum pressure by all considerations does not exceed 16.0 kg/cm²g, maximum suction pressure does not exceed 5 kg/cm²g, pumping temperature remains within –29°C to 150°C, Specific gravity is not less than 0.7 at the specified operating conditions or when dual pressurised / un-pressurised mechanical seals are not required/specified. Non-metallic pumps are not covered by this specification.

ii. Vendor shall comply with the requirement of this specification and other specifications/attachments to inquiry/order. No deviation or exception shall be permitted without the written approval of the purchaser.

iii Compliance with this specification shall not relieve the vendor of the responsibility of furnishing equipment and accessories/auxiliaries of proper design, materials and workmanship to meet the specified start up and operating conditions.

In case the vendor considers requirement of additional instrumentation, controls, safety devices and any other accessories/auxiliaries essential for safe and satisfactory operation of the equipment, they shall recommend the same along with reasons in a separate section along with their proposal and include the same in their scope of supply.

### 1.2 CONFLICTING REQUIREMENTS

In case of conflict between this specification and the attendant data sheets, job specifications (if any) and other attached specification the following order of precedence shall govern:

1. Process Data Sheet / P&IDs / Process Package
2. Mechanical Data Sheets.
3. Job Specifications/scope of work (if any)
4. This specification
5. Other standards & specifications
6. Other referred codes and standards

The editions of referenced publication that are in effect at the time of inquiry or at a date specified in the inquiry documents shall be applicable.

In case of any ambiguity in the above documents, the vendor/supplier shall seek clarification from the owner/purchaser and the decision of the owner/purchaser shall be final and binding.

### 1.3 DEFINITION OF TERMS

1.3.1 The **Normal operating point** is the point at which usual operation is expected.

1.3.2 The **Rated operating point** is the point at which the vendor certifies that performance is within the tolerances stated in this specification.

1.3.3 **Maximum allowable working pressure (MAWP)** is the maximum continuous pressure for which the manufacturer has designed the equipment (or any part to which the term is referred) when the equipment is operating at the maximum allowable temperature.

1.3.4 **Maximum allowable temperature** is the maximum continuous temperature for which the

manufacturer has designed the equipment (or any part to which the term is referred) when handling the specified liquid at the specified pressure.

1.3.5 **Minimum continuous flow (MCF) stable** is the lowest flow at which the pump can operate continuously without exceeding the noise and vibration limits imposed by this specification.

1.3.6 **Minimum continuous flow (MCF) thermal** is the lowest flow at which the pump can operate without its operation being impaired by the temperature rise of the pumped fluid.

1.3.7 The **Pressure casing** is the composite of all stationary pressure containing parts of the unit, including all nozzles, glands and other attached parts.

1.3.8 Unless otherwise specified, **Supplier / Vendor** shall be a manufacturer of centrifugal pumps (general purpose) having adequate design, engineering, manufacturing, packaging and testing facilities and shall have supplied complete centrifugal pumps (general purpose) package as a single point responsibility vendor. The vendor shall also be the manufacturer of the proposed centrifugal pumps (general purpose).

1.3.9 **Net positive suction head (NPSH)** is the total absolute suction head, in meters of liquid, determined at the suction nozzle and referred to the datum elevation minus the vapour pressure of the liquid in meters absolute. The datum elevation is the shaft centreline for horizontal pumps, the suction nozzle centreline for vertical in-line pumps and the top of foundation for other vertical pumps.

1.3.10 **Net positive suction head available** (NPSHA) is the NPSH in meters of liquid, determined by purchaser for pumping system with the liquid at the rated flow and normal pumping temperature.

1.3.11 **Net positive suction head required** (NPSHR) is the NPSH in meters, determined by vendor while conducting tests with water. NPSHR is measured at the suction flange and corrected to the datum elevation. NPSHR at rated and other capacities is equal to the NPSH that produces a 3 percent head drop (first stage head in multistage pumps) due to cavitation within the pump.

1.3.12 **Minimum Submergence required** is the liquid level with respect to pump suction flange face, in millimetres, determined by the vendor when testing with water for vertical pumps. This is the level required to prevent vortex formation/ingress of air/vapour into the pump suction resulting in loss of flow/head.

1.3.13 **Rated Speed** is the number of revolutions per minute of the pump required to meet the rated operating conditions. (It should be noted that induction motors will operate at a speed that is a function of the load imposed)

1.3.14 **Critical Speed** is the rotative speed corresponding to a lateral natural frequency of a rotor.

1.3.15 **Maximum Continuous Speed (MCS)** is the speed at least equal to 105% of the highest speed required by any of the specified operating conditions.

1.3.16 **Trip Speed** is the speed at which the independent emergency over-speed device operates to shut down a prime mover.

## 1.4 REFERENCED PUBLICATIONS

Unless otherwise specified, the editions of the following standards, codes and specifications that are in effect at the time of issue of the inquiry shall, to the extent specified herein form a part of this specification:

| | |
|---|---|
| **ASME** | **American Society of Mechanical Engineers** |
| B73.1 | Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process. |
| B 16.1 | Cast Iron Pipe flanges and flanged fittings |
| B 16.5 | Pipe flanges and Flange fittings (Steel) [(up to NPS 24)] |
| B 16.47 | Large Diameter Steel Flanges [NPS 26 Through NPS 60] |
| B 16.11 | Forged steel fittings, Socket-welding and Threaded |
| **BIS** | **Bureau of Indian Standards** |
| IS:5120 | Technical Requirements for Rotodynamic Special Purpose Pumps |
| **HI** | The codes, standards, and specifications of the **Hydraulic Institute** (Centrifugal pump section) |
| **ISO** | **International Organisation for Standardisation** |
| ISO:1940 | Mechanical Vibration – Balance Quality requirements of Rigid Rotors Part-1: Determination of Permissible Residual Unbalance Part-2: Balance Errors |
| ISO:5199 | Technical specifications for centrifugal pumps Class II. |

## 1.5 EXPERIENCE CRITERIA

1.5.1 The pump model offered shall be from the existing pump model series and shall be from the regular manufacturing range of the vendor (Prototypes are not acceptable).

The mechanical design as well as the hydraulic performance (including NPSHR) for the complete range of operation of the offered model shall have been established in the shop test. (Details to be furnished, if required).

The offered pump model with identical hydraulics and design shall be field proven (at least ONE unit) with minimum operating experience of one year for similar operating/design conditions, bearing span / column length, pumping liquid and material of construction, supplied in the last Ten (10) years, from the proposed manufacturing plant, as on bid due date.
(Note: Similar operating/design conditions, bearing span / column length would mean approx. 80% or higher)

Multiple references can be furnished to justify the above.

1.5.2 The vendor shall complete the Experience Record Proforma enclosed with the inquiry document to amply prove that the offered pump meets the above criteria by furnishing references of flow, head, pressure & temperature, viscosity, driver rating & speed, number of stages (as applicable), bearing span / column length (as applicable), efficiencies, material of construction, bearing design & lubrication. In addition, manufacturer's catalogue and general reference list for centrifugal pump (general purpose) to be furnished along with the proposal.

# SECTION 2 - BASIC DESIGN

## 2.1 GENERAL

2.1.1 The vendor shall have UNIT RESPONSIBILITY of complete centrifugal pump package & shall be responsible for complete design, engineering, manufacturing, packaging, testing, supply & supervision of erection & commissioning of total package as per specification requirements. Vendor's scope shall include but not limited to the responsibility for execution, coordination of all technical aspects of equipment and its auxiliary systems, their selection & integration into a complete package constituting total order. All

drawings/documents pertaining to the order shall be duly approved by the vendor before onward submission.

2.1.2 Pumps with constant speed drivers shall be capable of at-least 5 percent head increase at rated condition and pump rated speed by replacing with a new impeller or impellers. Offered impeller shall in no case be less than the minimum diameter impeller.

2.1.3 Horizontal pumps of the close-coupled, the two stage overhung, or the single stage double suction overhung, type shall not be furnished.

2.1.4 Unless otherwise specified, Pumps where difference between NPSHA and NPSHR is 0.6 meter or less are not acceptable. The said NPSHR value shall correspond to the maximum value of NPSHR from rated flow down to the recommended minimum continuous stable flow specified by the vendor. However, for pumps having pump rated BKW up to 55 kW, pumps with margin between NPSHA & NPSHR less than or equal to 1 m are not acceptable.
For Pumps with open discharge valve/auto-start condition, the NPSHR at the 120% of Best Efficiency Point (BEP) flow shall not exceed the NPSHA.
Note: Actual datum for NPSHA (i.e. grade level, top of foundation level or any other level as defined in enquiry) shall be referred from the data sheets forming part of enquiry document.

Pumps fitted with inducers for reducing NPSHR are not acceptable.

2.1.5 Pumps shall have stable head/capacity curves (continuous head rise to shut-off). When parallel operation is specified, the head rise to shut-off from rated point shall be at least 10%. Unless otherwise specified, discharge orifice shall not be used to achieve required head rise to shut off, even in the case of parallel operation.

2.1.6 Pumps that handle liquids more viscous than water, shall have their performance corrected with Performance Correction Chart / Performance Correction formulae of Hydraulic Institute Standard. Correction factors as applicable shall be indicated by the manufacturer on the filled-in data sheet.

2.1.7 The best efficiency point for the furnished impeller is preferred between the rated point and the normal point. However the rated point shall be between 70% to 110% of the best efficiency point of the rated impeller except for intermittent duty applications and pump BKW upto 22 KW.

2.1.8 Unless otherwise specified, the maximum permissible sound pressure level of the complete equipment (pump + driver) train shall not exceed 85 dBA measured at 1 meter from pump surface in any direction for the recommended range of operation at site.

2.1.9 The setting depth of vertical submerged pumps shall be worked out to ensure that minimum submergence of the pump is within the boot of vessel / pit.

2.1.10 For vertical pumps, not provided with non-reverse ratchet, vendor shall describe the precaution taken, to prevent damage due to reverse rotation. Vertical pumps shall be provided with their own thrust bearing designed to carry rotor weight and pump generated axial forces and shall not transmit any thrust to the bearings of driver.

2.1.11 Pump-Driver train shall be designed to be suitable for outdoor installation without roof.

2.1.12 Typical cooling plans shall be as per Annexure-A. Piping shall extend upto the edge of base plate. Gate Valve shall be provided in the inlet line. Globe valve along with sight flow glass shall be provided in the outlet line. A thermal relief valve shall also be provided in each isolatable cooling water circuit.

2.1.13 Oil reservoirs and housings that enclose moving lubricated parts (such as bearings, shaft seals, highly polished parts, instruments and control elements) shall be designed to minimise contamination by moisture, dust and other foreign matter during periods of operation & idleness.

2.1.14 Unless otherwise specified, cooling water systems shall be designed for the conditions specified in Table-1. Provision shall be made for complete venting and draining.

**Table-1: Design Conditions for Cooling Water System**

| | | |
|---|---|---|
| Velocity over heat exchanger surface | : | 1.5 - 2.5 m/sec. |
| Maximum Allowable Working Pressure | : | $\geq$ 8.0 kg/cm$^2$g |
| Test Pressure | : | = 1.5 x MAWP |
| Maximum Pressure Drop | : | 0.7 kg/cm$^2$ |
| Maximum Inlet Temperature | : | 33°C |
| Maximum Outlet Temperature | : | 45°C |
| Maximum Temperature Rise | : | 12°C |
| Minimum Temperature Rise | : | 6°C |
| Fouling Factor on Water Side | : | 0.0004 m$^2$ hr °C/kcal |

2.1.15 All equipment shall be designed to permit rapid and economical maintenance. Major parts such as casing components and bearing housings shall be designed (shouldered or doweled) to ensure accurate alignment on reassembly.

2.1.16 Lifting lugs/eye hooks shall be provided for ease of lifting of complete pump as well as the heavy maintenance components of the pump.

2.1.17 Pumps with variable speed drivers shall be capable of operating continuously upto 105 percent of rated speed as well as operating briefly upto driver trip speed.

2.1.18 Casing vents alongwith vent valves, as per manufacturer standards, for all pumps shall be provided. For all horizontal pumps, casing drain with isolation valve and flanged piping terminated at the skid edge shall be provided. Baseplate shall also be provided with flanged drain connection.

## 2.2 PRESSURE CASINGS

2.2.1 MAWP for all pressure containing parts e.g. casing, bowl, discharge head, discharge pipe, column pipe (in case of vertical turbine type pump), stuffing box etc. shall in no case be less than the maximum discharge pressure produced by the pump at shut-off (including tolerances) considering maximum specific gravity, at the maximum suction pressure, for the rated impeller diameter and the maximum continuous speed.

Note: Shut-off pressure for vertical pumps shall be calculated at the delivery flange at the top of mounting plate in the same way bowl head is calculated, since the shut-off head corresponds to the rated impeller, at the Pump casing discharge flange.

MAWP shall also not be less than the specified downstream design pressure.

These pressure-containing parts shall be suitable for hydrostatic test pressure of 1.5 times the MAWP.

MAWP shall also not be less than pressure temperature rating of ASME B16.5 (up to NPS 24) and ASME B16.47 Series B (for above NPS 24) Class 150 flanges for the material used.

Note: In any case, MAWP shall not be less than 16 kg/cm$^2$G for pumps with 150# flanges (i.e. with Carbon Steel or Alloy Steel casing).

2.2.2 Flanged nozzle connections shall be offered for all sizes and all applications (all vertical & horizontal single & two stage pumps shall have suction flanges designed for the same

pressure as discharge flanges). Unless otherwise stated, flanges shall be machined and drilled conforming to ASME B16.5 (up to NPS 24) and ASME B16.47 Series B (for above NPS 24).

2.2.3 Cavities of the Pressure Casing that are not self venting type, shall be equipped with a vent connection of ½" size as a minimum.

2.2.4 Pump Casing shall be provided with low point casing drain with minimum drain size of ¾", piped up to the end of baseplate with block valve & blind flange.

Casing shall be provided with drain connection with nipple, threaded and seal welded and provided with a socket welded gate valve terminated at edge of the base plate. Gate valve shall be of 800# rating with material of construction equal or superior to the pump casing. Unless made self venting casing design, vent connections shall be provided with a nipple, threaded and seal welded and terminated with a gate valve. Pressure gauge connection shall not be provided unless specifically required in the inquiry.

Note: In case threaded/seal welded connections for drain and vent are not possible as per manufacturer's standard design, bolted connections for drain and vent may be provided subject to field proven past supplies.

2.2.5 Radially split casings shall have gaskets (including mechanical seal plate gaskets) externally confined. Radially split casing pumps shall be designed to permit removal of the impeller(s), shaft, bearings without disassembling the suction or discharge piping.

2.2.6 In the event that nozzle sizes of 32 mm (1¼ inch), 65 mm (2½ inch), 90 mm (3½ inch), 125 mm (5 inch), 175 mm (7 inch) and 225 mm (9 inch) are offered, forged companion flanges (weld neck type), with raised face (RF) along with gaskets & fasteners shall be supplied with the pumps. The metallurgy of the companion flanges shall be same as casing metallurgy or superior.

2.2.7 Vendor shall furnish the permissible external forces and moments that can be withstood by suction and discharge nozzles of pump constructed of steel, alloy steel and cast iron material. While computing the permissible external forces and moments, vendor shall take into account the following as a minimum:

a) Effect of operating temperature.
b) Size of the pump i.e. discharge nozzle size.
c) Design of base plate.
d) Shaft displacement at the coupling on the installed pump to a maximum of 127 microns (0.005 inch) in any direction when subjected to the forces and moments as allowed / recommended by vendor, simultaneously to the pump through each nozzle.
e) The maximum allowable forces and moments on the pump nozzles shall be as per Table B.3 of ISO: 5199-2002. Any one Component of force or moment on any nozzle shall be 1.4 times of value as per Table B.3 of ISO:5199-2002. While being simultaneously subjected to maximum allowable forces and moments (as above) through each nozzle, the lateral displacement of the shaft end of the pump shall not exceed the limits as per Table B.4 of ISO-5199:2002.

## 2.3 IMPELLER, SHAFT & SHAFT SLEEVES

2.3.1 Impellers shall be single piece castings. Fabricated impellers are not acceptable.

2.3.2 Shaft shall be provided with sleeves under the packing/seal and shall be locked to the shaft. The material of sleeve shall be 12 percent chrome steel (hardened). Where the size of pump makes the use of shaft sleeve impracticable, the shaft shall be constructed of 12 percent chrome steel (hardened). For vertical pumps, shaft material shall be 12 percent chrome steel.

2.3.3 Impellers shall be secured to the pump shaft and shall be retained against circumferential moment by keying. Overhung impellers shall be secured to the shaft by a cap screw or cap nut that does not expose shaft threads. Impellers shall be positively locked by mechanical locking method.

2.3.4 Impellers shall have solid hubs.

2.3.5 Shaft shall be of ample size to transmit the maximum torque required under any specified operating condition including 105% speed for variable speed drive.

## 2.4 WEAR RINGS

2.4.1 Unless otherwise specified, renewable wear ring shall be furnished at least on the casings. Mating wear surfaces of hardenable materials shall have a difference in Brinell hardness number of at least 50. Integral impeller wear surfaces shall have higher hardness than that of the casing wear rings, when only casing wear rings are provided.

2.4.2 Renewable wear rings shall be held in place by a press fit with locking pins or threaded dowels or by flanged and screwed methods. Tack welding is not acceptable.

2.4.3 Vendor shall also furnish in the proposal the maximum permissible running clearance, which in no case shall be less than twice the minimum diametrical running clearances as specified below:

**Table 2: Minimum Running Clearances**

| Diameter of Rotating Member at Clearance (mm) | Minimum Diametrical Clearance (mm) |
|---|---|
| < 50 | 0.25 |
| 50 – 64.99 | 0.28 |
| 65 – 79.99 | 0.30 |
| 80 – 89.99 | 0.33 |
| 90 – 99.99 | 0.35 |
| 100 – 114.99 | 0.38 |
| 115 – 124.99 | 0.40 |
| 125 – 149.99 | 0.43 |

For diameters greater than 149.99 mm, the minimum diametrical clearance shall be 0.43 mm plus 0.025 mm for each additional 25 mm.

Note: While selecting the running clearances, galling tendency of the offered wear rings shall be taken into consideration.

## 2.5 MECHANICAL SEAL

2.5.1 The mechanical seal shall be of a make, duly approved by the purchaser.

2.5.2 Only balanced type mechanical seal shall be furnished.

2.5.3 Seal manufacturers specific recommendation shall be obtained and submitted along with the proposal.

2.5.4 In case vendor has any reservation to the flushing plans and/or seal material selection, the vendor shall submit alternate proposal supported by seal manufacturer's recommendation.

2.5.5 All auxiliaries for flushing of mechanical seal shall be in vendor's scope of supply. For details of seal flushing plans, refer Annexure-A.

2.5.6 Jackets shall be provided on pump seal chamber, in case the pumping temperature is above

120°C or with dead ended seal arrangement.

2.5.7 Requirement of the throat bushing shall be decided by the vendor to suit the operating conditions.

2.5.8 In case, the pump is to be supplied with packings, the stuffing box shall have minimum five packing rings plus lantern ring. Packing ring size shall be 3/8" or larger.

## 2.6 BEARINGS & BEARING HOUSINGS

2.6.1 Antifriction bearings shall be of standard type and shall meet minimum L-10 rating life of either 25000 hours with continuous operation at rated conditions or 16000 hours at maximum axial and radial loads and rated speed.

2.6.2 The rise in bearing grease/oil temperature with continuous running of the pump shall be within the allowable limits which shall not exceed 30°C for grease and 39°C for oil lubricated bearings above ambient temperature. Cooling arrangements shall be provided if required. Bearings shall be equipped with constant level oilers, vent breather & drain point for oil lubricated arrangements.

2.6.3 Jacketed bearing housing shall be provided for pumping temperatures of 160°C and above. Cooling coils are not acceptable.

2.6.4 Sleeve bearing pumps shall be arranged so as to permit measurement of shaft vibration adjacent to at-least one bearing.

2.6.5 For self lubricated vertical pumps, the guide bushing shall be suitable for dry running start-up. For vertical pumps handling liquid containing solids, external lubrication arrangement for line-shaft bearings may be provided.

2.6.6 **Vibrations**

2.6.6.11 The un-filtered vibration for all anti-friction bearing pumps, measured on the bearing housing during the shop test at rated speed and capacity ±10% shall not exceed a velocity of 7.6 mm/sec (0.3 inch/sec) peak nor exceed a displacement of 63.5 micrometer (2.5 mils) peak-to-peak (including shaft run-out). The filtered vibration at running speed frequency, blade-passing frequency or frequencies etc. shall not exceed a velocity of 5.1 mm/sec (0.2 inch/sec) peak.

2.6.6.22 The un-filtered vibration for all sleeve bearing pumps, measured on the bearing housing during the shop test at rated speed and capacity ±10% shall not exceed a velocity of 10.2 mm/sec (0.4 inch/sec) peak nor exceed a displacement of 63.5 micrometer (2.5 mils) peak-to-peak (including shaft run-out). The filtered vibration at running speed frequency, blade-passing frequency or frequencies etc. shall not exceed a velocity of 7.6 mm/sec (0.3 inch/sec) peak.

2.6.6.33 The vibration limits specified vide clause. 2.6.6.1 and 2.6.6.2 above shall be applied for pumps only. The vibration limits for the drivers shall be as per their respective applicable standards. Where respective applicable standards do not specify such limits for the associated drivers, the driver manufacturer's recommendation shall be applied for acceptance of the driver. Such acceptable limits shall be indicated by the vendor in their proposal.

## 2.7 MATERIALS

2.7.1 The material of construction of pump parts shall be in accordance with pump data sheet.

Vendor shall furnish the equivalent material as per ASTM.

2.7.2 Unless otherwise specified in the data sheet, material test certificates (chemical and mechanical properties) shall be supplied for impeller, shaft, shaft sleeve, wearing rings and casings.

2.7.3 The repair of pressure castings by peening, plugging, impregnating or by the use of plastic or cement compound is prohibited. The Inspector's prior approval shall be obtained for the repair of castings. When authorised, repair shall be carried out in accordance with applicable ASTM Specification. Weld repair of pressure containing parts of Cast Iron construction is not permitted.

2.7.4 As a minimum, the components of the pumps shall be subjected to following tests and the test certificates furnished to the Purchaser accordingly:

a) Shaft, Impeller, Pressure Casing: Chemical Analysis and Tensile Test
b) Wearing rings, bushing and sleeve: Chemical Analysis and hardness.

Material Compliance Certificate can also be considered for wearing rings, bushing and sleeve

2.7.5 For Carbon Steel construction pumps, in caustic services, the pressure containing components as well as any welding performed on these, shall be stress relieved.

## 2.8 DYNAMICS

2.8.1 Actual critical speed shall not encroach upon the specified operating speed range. The separation margin of encroachment from all lateral modes shall be at least 20% over the maximum continuous speed for rigid rotors. This condition shall be satisfied for the entire range from the design running clearances upto the maximum permissible clearance.

2.8.2 The limits of vibration as specified in 2.6.6 shall also be applicable for the maximum clearances as specified in 2.4.3.

2.8.3 Torsional analysis shall be performed when the driver is IC engine or the drive is through a gear box. Torsional modes of the complete unit shall be at least 10% below any operating speed or at least 10% above trip speed.

# SECTION 3 - ACCESSORIES

## 3.1 DRIVER

3.1.1 Electric motor drivers shall have a maximum continuous rating (MCR) (i.e. service factor equal to 1) not lower than the following unless higher rating is dictated by the Note 1 and/or Note 2.

| **Pump Rated BKW *** | | **Motor MCR** |
|---|---|---|
| Less than 22 kW | : | To suit maximum BKW indicated on pump data sheet or 125% of rated pump BKW, whichever is higher. |
| 22 kW - 55 kW | : | 115% of rated pump BKW. |
| Higher than 55 kW | : | 110% of rated pump BKW. |

Note: * including all mechanical & transmission losses & with 0% +ve tolerance.

Note :

1. The motor nameplate rating for pumps under parallel operation or for pumps with auto-start operation, shall not be less than the max. BKW indicated on pump data sheet (Power at End of the curve for the rated impeller) or shall have the specified margin as per this clause whichever is greater. The pump motors shall also be suitable

for start-up under open discharge valve condition.

2. The motor nameplate rating for applications where the specific gravity of pumped fluid is less than 1.0 shall either be 100% of the BKW of pump at minimum continuous stable flow with clean cold water of sp. gravity 1.0 or shall have the specified margin as per this clause, whichever is greater.

3.1.2 Steam Turbine rating shall be at-least 110% of rated pump BKW (unless higher rating is dictated by Note 1 and/or Note 2 above) at the rated speed with coincident minimum inlet & maximum exhaust steam conditions.

## 3.2 COUPLING & GUARDS

3.2.1 Coupling shall be of forged steel and of non lubricated, laminated disc type, with stainless steel/monel laminations. A spacer coupling (127mm minimum normal length) shall be used unless otherwise specified. The spacer length shall permit the removal of coupling, bearings, seal and/or rotor as applicable without disturbing the driver or the suction and discharge piping. It shall be the responsibility of the pump Vendor to obtain Purchaser's approval for the selected coupling, its make and rating.

3.2.2 Coupling shall be dynamically balanced in accordance with grade 2.5 as per ISO 1940 and a certificate to this effect shall be furnished.

3.2.3 Whether or not pump vendor is required to mount the driver the vendor shall still deliver the fully machined coupling assembly alongwith the pump. The driver shaft dimensions and tolerances shall be furnished by the Purchaser to the pump vendor.

3.2.4 Removable coupling guard shall be provided which shall be fabricated from non-sparking material, and shall be open at the bottom to permit manual shaft rotation. The guard shall be sufficiently rigid to withstand deflections as a result of bodily contact of nominally 100 kgs. Coupling guard shall have a hinge to open and Inspection window to see the healthiness of the coupling shims.

3.2.5 Coupling service factor shall not be less than 1.5 over driver rating. However, while selecting the coupling, it shall be ensured by pump vendor that the allowable shaft stresses of the pump train are not exceeded under any circumstances including any offset condition or conditions of maximum torque. For pump trains having gear-box, the coupling service factor shall not exceed the gear-box service factor.

## 3.3 BASEPLATE

3.3.1 Baseplate shall extend under the pump, gear box and motor/turbine driver and shall be fully machined for mounting the above equipment. All other projections of the equipment supplied shall fall within the maximum perimeter of the baseplate. Baseplate shall be steel fabricated and shall have sufficient rigidity to avoid vibration and distortion. Baseplate shall be so designed as to facilitate proper grouting (Vent holes where required shall be provided). Baseplate shall be cleaned (sand blasted) inside and outside and coated with suitable anticorrosion paint.

Drain Pan Type Baseplate surrounding the entire baseplate to be provided. Baseplate to be provided with minimum 2" flanged drain connection.

3.3.2 The length shall be atleast equal to the overall length of the pump and drive-train assembly.

3.3.3 Unless otherwise specified, base plate for all sizes of pump shall be grouted. Type of grout material and technical details shall be furnished by vendor in his proposal.

3.3.4 For driver trains over 18.5 kW, alignment positioning screws shall be provided for each drive element to facilitate longitudinal and transverse horizontal adjustments. The lugs holding these positioning screws shall be attached to the baseplate so that they do not interfere with the installation or removal of the drive element.

Vertical leveling screws, spaced for stability shall be provided on the outside perimeter of the baseplate. These shall be numerous enough to carry the weight of the baseplate, pump, gear-box (if any) and driver without excessive deflection.

3.3.5 Pumps in corrosive service shall have provision to collect and drain the leakage from mechanical seal or packing, through drip pan of metallurgy equivalent or superior to pump casing. Leakages from drip pan shall be piped to baseplate with a flanged connection for onwards disposal by purchaser. Where the design prohibits the provision of drip pan, the material of bearing bracket shall be suitable for the corrosive service.

3.3.6 The baseplate shall be provided with lifting lugs for at-least a four point lift. Lifting the baseplate complete with all equipment mounted shall not permanently distort or otherwise damage the baseplate or machinery mounted on it.

3.3.7 **Mounting Plates for Vertical Pumps**
Unless otherwise specified, mounting plate for vertical pumps shall be having a minimum thickness of 48 mm and is to be made from IS:2062/IS:2002 plate material or can be of the same material as that of vessel / tank. Mounting plate shall be supplied with gaskets (as applicable) & fasteners.

Alignment positioning screws shall be provided for all motors.

3.4 **PIPING & APPURTENANCES**

3.4.1 Cooling water, lube oil and auxiliary process piping including all accessories such as gauges, valves, shall be furnished by the manufacturer fully assembled and installed on horizontal pumps and where practical on vertical pumps. All piping & appurtenances shall be located within the confines of baseplate.

3.4.2 Vendor shall provide gate valve at C.W. inlet line and Globe valve at the return line. Gate valve shall conform to API 602 with ASTM A105 body as CS + 13% Cr steel trim. Globe valve shall conform to BS5532 800# SW ASTM A105 Body and CS+13% Cr steel.

3.4.3 Unless otherwise specified, Carbon Steel piping conforming to A106 Gr.B Sch 80 shall be provided for cooling water. Socket welded/flanged connections shall be employed. Connections to pump pedestal, stuffing box jacket or bearing housing jacket shall be screwed.

3.4.4 Sight flow indicator shall be provided in each cooling water outlet line. Sight flow indicator shall have ball or flag for easy verification of water flowing through pipes. Thermal relief valve (in each isolatable cooling water circuit) shall be provided upstream of globe valve on the cooling water outlet line.

3.4.5 Temperature indicator at the outlet of each mechanical seal flushing fluid cooler shall be provided. As specified in the inquiry/order, instruments associated with seal flushing plans e.g. pressure gauges, pressure transmitters, level gauges, level transmitters, flow indicator etc. shall be provided. The switches shall be suitable for the specified area classification, supply voltage and contact rating.

3.4.6 Restriction orifice of diameter not less than 3.2 mm in diameter shall be furnished when required.

3.4.7 Unless otherwise specified, material for mechanical seal flushing fluid cooler shall be as per the following:

Tube or Coil : Type 316 stainless steel or Monel.
Shell : Carbon Steel

Cooling medium shall be re-circulating cooling water which shall be on the shell side.

3.4.8 In case where operating condition warrants use of orifice and flushing fluid cooler in flushing plan for mechanical seal, flushing fluid cooler shall be installed upstream of orifice.

## SECTION 4 - INSPECTION AND TESTS

### 4.1 GENERAL

4.1.1 Unless otherwise specified, all pumps shall be inspected and all tests shall be witnessed by the Purchaser or by the Purchaser's authorised representative.

4.1.2 Purchaser's or their authorised representative shall have access to the plant including sub vendors plants where work on or testing of equipment is being performed.

4.1.3 No surfaces of parts of pumps are to be painted until the inspection is completed.

4.1.4 Vendor shall give to the purchaser at-least 15 days notice prior to commencement of testing. Vendor shall carry out all running tests and mechanical checks and satisfy himself prior to purchaser's arrival for inspection and shall maintain desired log of tests.

4.1.5 Acceptance of shop test shall not constitute a waiver of requirement to supply equipment as per specification and/or to meet field test under operating condition, nor does inspection relieve the manufacturer of his responsibility in any way whatsoever.

4.1.6 Pump shall be unitised, along with job driver at pump manufacturer's works.

4.1.7 **Inspection & Testing requirements:**

A. Pump-Centrifugal Horizontal (GPP)

| Sno. | Inspection & Tests | Scope of Inspection (Note-1) | |
|---|---|---|---|
| 1 | Shop Test / Inspection | R | |
| 2 | Material Certificates | R | |
| 3 | Hydrostatic test | R | |
| 4 | Performance Test / Sound level Test | Upto 55 kW | R |
| | | 55 kW to 160 kW | W (1 per tag) |
| | | More than 160 kW | W (all tags) |
| 5 | NPSH Test as required (as per specification) | Upto 55 kW | NR (Note-2) |
| | | 55 kW to 160 kW | W (1 per tag) |
| | | More than 160 kW | W (all tags) |
| 6 | Dismantle Inspection & Re-assembly after test | W (Note-3) | |
| 7 | Unitization / Check of direction of rotation of pump | R (but not required for PMC jobs; to be governed by contractor's quality plan) | |
| 8 | Visual, dimension and skid completeness check | W (Conventional jobs)<br>R (PMC jobs) | |

B. Pump-Centrifugal Vertical (GPP)

| Sno. | Inspection & Tests | Scope of Inspection (Note-1) |
|---|---|---|
| 1 | Shop Test / Inspection | R |
| 2 | Material Certificates | R |
| 3 | Hydrostatic test | R |
| 4 | Performance Test / Sound level Test | W |
| 5 | Minimum Submergence Test (for Vertical pumps) | W |
| 6 | Dismantle Inspection & Re-assembly after test | W (Note-3) |
| 7 | Unitization / Check of direction of rotation of pump | O (but not required for PMC jobs; to be governed by contractor's quality plan) |
| 8 | Visual, dimension and skid completeness check | W (Conventional jobs)<br>R (PMC jobs) |

Legends:

R: Required: Reviewing of manufacturer's shop test reports shall be considered as adequate.

O: Observed: Purchaser shall be notified but work may proceed after scheduled date.

W: Witnessed: A HOLD shall be applied and work shall not proceed without approval.

NR: Not Required.

Notes:

1. The inspection & test requirements specified are applicable for each pump unless otherwise specified.
2. For pumps up to 55 kW, during evaluation of bids, no pumps with margin between NPSHA & NPSHR less than or equal to 1m shall be accepted.
3. Dismantle Inspection of pump after performance test shall be applicable only in case of abnormality in mechanical behaviour (such as excessive noise & vibration, bearing temperature rise etc.) during performance test.

4.2 **TESTS**

Following tests shall be performed, as a minimum. The basic reference standard shall be the latest edition of HI or IS:5120.

4.2.1 **Hydrostatic Test**

4.2.1.1 Pressure casings including column pipe and discharge head (if any) shall be hydrostatically tested with water at ambient temperature at 1½ times the maximum allowable working pressure specified in the data sheet.

4.2.1.2 Jackets for bearing, stuffing box, coolers, etc, shall be tested at 1½ times the maximum allowable jacket working pressure.

4.2.1.3 Hydrostatic test shall be maintained for a minimum period of 30 minutes.

4.2.2 **Performance Test**

4.2.2.1 Unless specifically agreed upon, each pump shall be tested within ±3% of the rated speed specified in the data sheet with calibrated motors, atleast for four hours. During the four hour run test, complete data including pressure, capacity, power, vibration levels, bearing temperatures and noise levels (for records only) shall be recorded and guaranteed parameters verified.

4.2.2.2 The pump shall be tested with water at ambient temperature.

4.2.2.3 The tolerance of the guaranteed parameters shall be as follows:

| | | |
|---|---|---|
| Rated head | : | Zero negative tolerance. |
| Shut-off head | : | Zero negative tolerance.<br>Positive tolerance permitted as long as the downstream design pressure is not exceeded. Negative tolerance permitted so long as the curve is continuously rising to shutoff without any drooping and minimum 110% head rise to shutoff shall be available for pumps in parallel operation.<br>Note: As a guideline, shut-off head is generally 120% of rated head for horizontal pumps and 140% for vertical pumps. |
| Min. Submergence required (for vertical pump) / NPSH(R) | : | Zero Positive Tolerance. |
| Rated BKW | : | Zero positive tolerance (However pumps may be accepted upto 104 percent of Guaranteed BKW subject to Penalties as defined elsewhere) |

As a minimum, data at Shut-off (no vibration data required), minimum continuous stable flow, midway between minimum and rated flow, rated flow and maximum allowable flow (as a minimum, 120% of best efficiency flow), shall be measured and recorded during tests. All the instruments used for conducting the tests shall be calibrated before tests and calibration certificates furnished from a recognised testing institution to the Inspector.

4.2.2.4 Engine driven horizontal and vertical pumps shall be subjected to a 4 hour complete unit string test at the pump vendor's works during which mechanical performance of the train shall be verified, in terms of vibration, bearing/oil temperature, engine parameters and controls. If there are multiple units of Engine driven pumps, then only one unit shall be subjected to complete unit string test at pump vendor's works. Any modification due fault noticed in the tested unit shall also be carried out in the other units.

4.2.2.5 During the performance test, rise in temperature of bearing oil shall be measured and results recorded on the test log. Values shall not exceed those given in 2.6.2.

4.2.2.6 During the performance test, the equipment shall be checked for its sound level, values shall not exceed those given in 2.1.8.

4.2.3 **NPSH Test / Min. Submergence Test**

Unless otherwise specified, NPSH test (for pumps beyond 55 kW) shall be carried out where difference between NPSH available and NPSH required is 1 meter or less at the Rated point.

In case of vertical pumps, all pumps shall be subjected to minimum submergence test. Testing for NPSH is not required for Vertical pumps.

Test points shall be similar to those of Performance test.

4.2.4 **Vibration Measurement**

During performance test vibration shall be measured on the bearing housing for the capacity range from pump MCF to 110% of rated capacity.
For checking the vibration, flat surface shall be provided on bearing housing by pump manufacturer, as per manufacturer's standards. The vibrations shall be within the limits as specified in clause no. 2.6.6.

4.2.5 **Dismantling Inspection**

Dismantle inspection of pump after performance test shall be applicable only in case of

abnormality in mechanical behaviour (such as excessive noise and vibration, bearing temperature rise etc.) during performance test.

If it is necessary to dismantle a pump after the performance test for the sole purpose of machining impellers to meet the tolerances for differential head, no re-test will be required unless the reduction in diameter exceeds 5 percent of the original diameter. The diameter of the impeller at the time of shop test, as well as the final diameter of the impeller, shall be recorded on a certified shop test curve that shows the operating characteristics after the diameter of the impeller has been reduced.

If it is necessary to dismantle a pump for some other correction, such as improvement of power, NPSH, or mechanical operation, the initial test will not be acceptable, and the final performance test shall be run after the correction is made.

4.2.6 **Final Inspection**

After the performance/dismantle test the pump and the job driver shall be unitised on the job base plate, aligned and coupled to make a complete unit. The pump will then be checked for visual inspection to confirm compliance to the GA drawings, nozzle dimension and facing, elevations, anchor bolts position, direction of rotation etc.

4.2.7 Prior to start of tests, vendor shall furnish the following:

1. Certificate of calibration of driver, which should be recalibrated after a period of every three years.
2. Certificate of calibration of measuring instruments, which should be recalibrated after a period of every one year. Magnetic flowmeters shall be recalibrated once in two years. Pressure gauges shall be calibrated prior to start of test and after completion of test.
3. Record of all running test and mechanical checks (including test curves and data) completed prior to purchaser's inspection.

4.2.8 Unless otherwise specified in the data sheet, the following tests shall also be performed on each pumps:

1. Dynamic balancing of impellers for Overhung pumps (Observed).
2. Other tests (if any) as specified elsewhere.

## 4.3 PREPARATION FOR SHIPMENT

4.3.1 The equipment shall be suitably prepared for shipment after all tests & inspections have been completed and equipment has been released by the purchaser. All exposed mechanical surfaces and all internal parts shall be thoroughly coated with a rust preventive. All exterior parts of the unit except machined surfaces shall receive one prime coat and one coat of vendor's standard enamel.

4.3.2 All flanges, nozzles shall be blanked off. All untapped openings shall be provided with substantial wood or metal closure. The ends of small piping may be sealed with tape.

4.3.3 The pump shall be supplied with a nameplate containing the following information:

- Purchaser's Item No.
- Manufacturer's Name
- Type and Serial No
- Rated capacity in m3/hr.
- Differential head at rated capacity in m.
- Casing hydrostatic test pressure in kg/cm².
- Speed in rpm.

The nameplate shall be of stainless steel and relevant information shall be punched into the same.

4.3.4 All auxiliary, dismantled and packed separately shall be properly marked with the Item No. for which it is intended by means of metal tag.

4.3.5 The pump shall be suitably packed, fastened to avoid damage during transit and crated for shipment and storage for a period of 12 months. Lifting, unpacking and handling instructions shall be securely attached to the exterior of the largest packing in a well marked weather proof container. The upright position of lifting points, gross weights and dimensions be clearly marked on each package. Each package shall clearly identify the equipment contained therein. If any extra precaution is to be taken by the Purchaser for storage beyond 12 months the same shall be explicitly indicated in the operation and maintenance manuals.

## SECTION 5 - VENDOR'S DATA

5.1 **PROPOSALS**

The vendor's proposals shall as a minimum include the following:

a) All data sheets, drawings and documents listed under "PRINTS WITH QUOTE" in the enclosed Vendor Data Requirement Form.
b) Vendor's confirmation/comments on post-order Vendor Data Requirements (Type of Documents, no. of prints and date needed) indicated in Vendor Data Requirement forms data sheets and specs.
c) List of recommended commissioning spares included in the offer.
d) List of mandatory spares (where specified by the purchaser) included in the offer.
e) List of Vendor's standard Spare Parts for Two Years Normal Operation
   This list shall be made separately for each items including auxiliaries and drivers in the form of a table & shall show :
   i) Part name, description and number.
   ii) Quantity installed in one unit.
   iii) Quantity recommended per unit for 2 years normal operation.
   iv) Quantity recommended for number of units of an item as specified in the inquiry.
   v) Quantity recommended as insurance for the number of units of an item specified in the inquiry.
f) An itemised list of special tools included in the offer.
g) Any start-up, shutdown or operating restrictions required to protect the integrity of the equipment.
h) Any limitations of vendor's test-facility to carryout the specified tests.
i) A specific statement that the scope of supply, the offered equipment/systems and all its components are in strict accordance with the data sheets, job specifications, this specifications and all other attachments, except for specific deviations as listed in the proposal.

5.2 **CONTRACT DATA**

5.2.1 **General**

5.2.1.1 Drawings and data as required after purchase order has been specified in Vendor Data Requirement forms. Vendor to note that the drawing/document descriptions/titles as given in the Vendor Data Requirement are generic in nature. It is possible that against one drawing/document specified there are several drawings to be furnished by the vendor or vice versa.
Vendor shall complete & forward a document "DOCUMENT CONTROL INDEX" to the purchaser (Destination & contact person as per order).
This document shall list out in consolidated form all drawings and documents required by purchaser (As specified in Data Sheets, Specifications and Vendor Data Requirement

forms enclosed with the order).
Against each drawing/document vendor shall indicate the vendor's drawing numbers, titles, Rev. No., category (whether for information or approval) and schedule of submission.
This shall be the first document to be submitted by vendor within two weeks of order. **No drawing shall be taken up for review till the DCI for inquiry/order is finalized by vendor**. If specified, drawing review may be through VDM in soft as per the details provided elsewhere in the inquiry document.

5.2.1.2 Drawings and data shall have a title block (in addition to vendor's standard title block) which shall as a minimum contain the following contract information:

i) Purchaser's and Consultant's Corporate Name
ii) Project Name.
iii) Client / Customer's Name.
iv) Equipment Name and Item No.
v) Purchase Order No.
vi) Purchase Requisition No.

Title Block on drawings shall be placed on the lower right hand corner.

5.2.1.3 All vendor data/drawings/documents shall be in English Language and in Metric Systems.

5.2.1.4 Data specified in the VDR forms is the minimum requirements of Purchaser. Any additional document/data required or requested by Purchaser for engineering or construction shall also be made available by the vendor.

5.2.1.5 Whether or not specified the vendor shall furnish the following, before shipment:

- As built running clearances and when applicable; thrust bearing, radial bearing and seal running clearances.
- A supplementary list of spare parts other than those included in his original proposal. The supplementary list shall include recommended spare parts, cross-sectional or assembly type drawings, parts numbers, materials, prices and delivery period. The vendor shall forward this supplementary list to the purchaser promptly after receipt of the reviewed drawings and in time to permit order and delivery of parts before field start-up.
- A parts list for all equipment supplied. The list shall include pattern, stock, or production drawing numbers and materials of construction. The list shall completely identify each part so that the purchaser may determine the interchangeability of the parts with other equipment furnished by the same manufacturer. Standard purchased items shall be identified by the original manufacturer's name and part number.
- At least 8 weeks before shipment, the vendor shall submit his preservation, packaging and shipping procedures to the purchaser's for his information.

5.2.2 **Co-ordination Meeting**

When specified, a co-ordination meeting shall be held at Purchaser's office, preferably within 4 weeks of order.
An agenda shall be prepared for this meeting and would include the following points related to technical aspects.

a. Any clarifications required by the vendor on purchaser's order.
b. Vendor Data Index & Schedule,
c. Vendor Data Review/approval modalities.
d. Sub-vendor lists proposed by vendor.
e. Utility requirements.
f. Preliminary General Arrangement & layout drawings & purchaser's interface drawings.

5.2.3 **Drawings**

5.2.3.1 The number of prints and/or reproducible required and the times within which these are to be submitted by vendor are specified in Purchaser's inquiry/order.

5.2.3.2 The purchaser's review of the vendor's drawings shall not constitute permission to deviate from any requirements in the purchase order/specifications unless specifically agreed upon in writing. After the drawings have been reviewed, the vendor shall furnish certified copies in the quantity specified. All drawings must be clearly legible and shall be folded to 216 mm x 279 mm (8½" x 11") size.

5.2.3.3 Drawings/documents with following titles shall contain as a minimum the following information:

a) **General Arrangement Drawing**

A general arrangement drawing shall indicate:

i) Outline dimensions (minimum three views) (All principal dimensions).
ii) Allowable forces and moments on suction and discharge nozzles.
iii) Location (in all three planes), size, type, rating and identification of all purchaser's interface connections including those of vents, drains lubricating oil, sealing fluid, cooling water, steam & Electrical/Instrumentation.
iv) Direction of rotation viewing from the driving end.
v) Weight of each assembly/component.
vi) The weight & location of center of gravity of the heaviest assembly/components that must be handled for erection.
vii) Identification and weight, dimensions of the heaviest assembly / subassembly / component required to be handled for maintenance.
viii) Maintenance clearances and dismantling clearances.
ix) Speeds of Driven Equipment and driver and driver rating. Location of driver terminal box (in case of Electric Driver)
x) Layout of auxiliary equipment and operating platform.
xi) Make, Type and Size of couplings and the location of guards and their coverage.
xii) A list of reference drawings if any.
xiii) A list of any special weather-protection and climatic features.
xiv) Line diagram of sealing piping indicating direction of flow of fluid by arrow and inlet and outlet.

b) **Foundation Drawing**

A foundation drawing shall indicate complete information required for foundation design by purchaser including the following :

i) Foundation bolt sizes & pipe sleeve details and pocket sizes & locations.
ii) Grouting thickness and other necessary technical details.
iii) Static weight of each independently grouted item and location of center of gravity of each item in all three planes.
iv) Weight distribution for each bolt/subsole-plate location and total static weight.
v) Dynamic loads, if any, caused due to various items grouted independently. (The cause of generation of such loads shall also be indicated).
vi) The direction and magnitude of unbalance forces and moments (with their phase angles) generated by the out of balance of the rotating / moving parts of the machine at the relevant operating conditions. [These loads and their locations are to be given in all three planes. These shall be utilised for computing the amplitudes of vibration of the foundation].
vii) $GD^2$ value of each item resolved to driver speed.
viii) Maximum permissible amplitude of vibration on the foundation at the base level. (The location of the points on the foundation base where such amplitudes are not to be exceeded shall be given in all three planes). The reference of relevant code, if any, shall also be indicated.

ix) Total mass of rotating parts.
x) Total mass of reciprocating parts (in case of engine driven units).
xi) Suggested dynamic factor and ratio of weight of foundation to weight of machine.
xii) Short circuit loads caused in motor drivers.
xiii) Operating speed of the machine and the driver.
xiv) Scope of Supply of the Foundation Bolts (unless otherwise specified, by vendor).
xv) Maximum permissible magnitude of the unbalance forces and moments generated by the out of balance of the rotating / moving parts of the machine as allowed by the relevant codes, if any. (The reference of such code, if any, shall also be indicated).
xvi) Recommended separation margin (if any), between the machine operating speeds and the natural frequencies of the machine foundation system along with the basis of such recommended separation margins.
[Note: Unless otherwise indicated by vendor, the dynamic forces as given in e) & I) above are considered as additional static loads for designing the foundations statically. Such dynamic forces are not unbalance forces and therefore, these shall not be utilised for computing the amplitudes of vibration.]

c) **Heat Exchanger Drawings**
Heat exchanger drawing and data shall include heat and mass balance data, details of provisions for separating and withdrawing the condensate, construction details, cross sections & general arrangement drawings of heat exchangers, vendors recommendations regarding provision for support and piping expansion.

5.2.3.4 **Cross-sectional Drawing**(with Bill of Materials)
The vendor shall supply cross-sectional or assembly type drawings for all equipment furnished showing all parts, design assembly and running clearances, and balancing data required for erection and maintenance. Each part shall be numbered which shall correspond to the part number on the bill of materials. The bill of materials shall include the part no., name of component, materials quantity installed per unit & sizes where applicable (say for bolts, nuts, rings, gaskets etc.). All boughtout items shall also be indicated with make and brief specifications.
A separate cross-sectional drawing showing installation and setting dimensions for the seals shall be furnished.

5.2.4 **Performance Characteristic Curves**

5.2.4.1 The vendor shall provide complete performance curves to encompass the map of operations, with any limitations indicated thereon.

5.2.4.2 All curves submitted prior to final performance testing shall be marked "PREDICTED". Any set of curves resulting from a test shall be marked "TESTED".

5.2.4.3 Certified test curves and data shall be submitted within 15 days after testing and shall include head, power recalculated to the proper specific gravity and efficiency plotted against capacity. If applicable, viscosity corrections shall be indicated. If NPSHR test is specified, the water NPSHR curve (drawn upto minimum continuous flow) shall also be included. The curve sheet shall include the maximum and minimum diameters of the impeller design supplied, the eye area of the first stage impeller, the identification number of the impeller or impellers and the pump serial number.

5.2.5 **Data Sheet**

5.2.5.1 The Vendor shall provide completely filled in data sheets, first for "as purchased" and then

for "as built". This shall be done by the vendor correcting and filling out the data sheets and submitting copies to the purchaser.

5.2.6 **Technical Data Manual/Mechanical Catalogues**

5.2.6.1 Technical Data Manual/Mechanical Catalogue is a compilation of "as built" drawings and data, manufacturing and test records, installation, operating and maintenance instructions.

5.2.6.2 Not later than two weeks after successful completion of all specified tests, the vendor shall furnish the required number of Technical Data Manual/Mechanical Catalogues for the equipment, any auxiliaries and instruments that the vendor is providing. The Technical Data Manual/Mechanical Catalogue shall include the following documents as a minimum:

i) All drawings and data as listed in the vendor data index & schedule. (For drawings, where purchaser's approval is required, the final certified drawings shall be attached.)

Sections shall be organised in a manner that data & drawings related to one subject is grouped together such as Mechanical, Electrical, Instrumentation etc.

ii) All manufacturing, inspection and test data and records.

iii) Installation and Instruction Manual

The vendor shall provide sufficient written instructions, including a cross-reference list of all drawings, to enable the purchaser to correctly install the equipment and prepare the equipment for start-up. It shall include any special information required for proper installation that is not on the drawings, special alignment or grouting procedures, utility specifications (including quantity) and all installation data. It shall also contain the following information:

(a) Instructions for erecting, piping, aligning (including the expected thermally induced shaft centerline shift between normal site ambient temperature position and that at normal equipment operating temperature).

(b) A description of rigging procedures, including the lifting of the assembled equipment, and methods of disassembly, repair, adjustment, inspection and reassembly of the equipment and auxiliaries.

(c) Pre-commissioning/commissioning/functional test procedures and acceptance criterion.

iv) **Operation and Maintenance Manual**

This manual shall provide sufficient written instructions and data to enable purchaser to correctly operate and maintain the equipment ordered. It shall include a section to cover special instructions for operation at extreme environmental and/or extreme operating conditions. The following shall be included in this manual:

(a) Instructions covering start-up, normal shutdown, emergency shutdown, operating limits and routine operational procedures.

(b) A description of equipment construction features and the functioning of component parts or systems (such as control, lubrication, sealing systems etc.).

(c) Outline and sectional drawings, schematics and illustrative sketches in sufficient details to identify all parts and clearly show the operation of all equipment and components and the methods of inspection and repair. Standardised sectional drawings are acceptable only if they represent the actual construction of the equipment.

(d) The following maintenance information:

i. Maximum and minimum bearing, labyrinth and seal clearances including any other clearance between moving and stationary parts of the equipment affecting proper running and maintenance of the equipment.

ii. Instructions for measuring and adjusting cold clearances, shaft runout,

concentricity etc.

iii. Rotor float allowance.

iv. Interference fits on parts that are required to be removed or replaced for maintenance of normally consumable spares.

v. Balancing data with permissible unbalance.

vi. Lubricating schedules indicating recommended grades of oil, their properties, replacement period etc.

vii. Normal maintenance procedure.

viii. Preventive maintenance schedules and criterion for replacement of parts.

ix. Trouble - shooting procedures.

(e) The following reassembly information:

i. Bolting sequence and torque values for all bolts affecting equipment performance/integrity/safety.

ii. Reassembly sequences together with required inspection checks.

iii. Adjustment procedures to achieve required positions, clearances, float and so forth.

iv. Detailed procedures for pre-operational checks, including settings and adjustments.

v. Seals and coupling installation procedures.

vi. Parts list indicating cross-sectional drawings of various assemblies and sub-assemblies, part numbers, materials of construction (ASTM) etc.to facilitate identification of parts and for procurement of spares.

v) Following information shall also be included in the Technical Data Manual/Mechanical Catalogue:

a) Storage instructions for storing and preserving the equipment (including driver and all the auxiliary units) at the plant site before installation of the same.

b) Instructions for preserving the equipment after it has been installed. This is particularly required in cases where a long time gap is expected between equipment installation and commissioning.

5.2.6.3 Technical Data Manual/Mechanical Catalogue shall be in Hard board folder(s) of size 265 mm x 315 mm (10½" x 12½") and shall not be more than 90 mm thickness; it may be of several volumes and each volume shall have a volume number, index of volumes & index of contents of that particular volume.

5.2.6.4 Title sheet (Top sheet) of each volume of Technical Data Manual/Mechanical Catalogue shall contain the contract information as defined under 5.2.1.2 besides the volume number.

5.2.6.5 In case order contains more than one item, separate dedicated technical data manuals / mechanical catalogues shall be submitted for each item.

5.2.6.6 All post order documents shall be submitted / approved through EIL VDM portal.

5.2.6.7 Final documentation shall be submitted in hard copy and soft (CDs/ DVDs) in addition to submission through EIL VDM portal. The number of prints and/or reproducible required to be submitted by vendor are specified in Purchaser's inquiry/order.

## ANNEXURE – A

**Seal Flushing Plans for Primary Seals**

| | | |
|---|---|---|
| Plan 01 | : | Integral (Internal) re-circulation from pump discharge to seal. |
| Plan 02 | : | Dead ended seal box with no circulation of flush fluid. Water cooled box jacket and throat bushing required unless otherwise specified. Plugged connections for possible future use of circulation of flush fluid to be provided. |
| Plan 11 | : | Recirculation from pump discharge case through orifice to seal. |
| Plan 12 | : | Recirculation from pump discharge case through strainer and orifice to seal. |
| Plan 13 | : | Recirculation from seal chamber through orifice to pump suction. |
| Plan 21 | : | Recirculation from pump discharge case through orifice and cooler to seal. Temperature Indicator is to be provided. |
| Plan 22 | : | Recirculation from pump discharge case through strainer, orifice and cooler to seal. Temperature Indicator is to be provided. |
| Plan 23 | : | Recirculation from seal with pumping ring through cooler and back to seal. Temperature Indicator is to be provided. |
| Plan 31 | : | Recirculation from pump discharge case through cyclone separator delivering clean fluid to seal and fluid with solids back to pump suction. |
| Plan 32 | : | Injection to seal from external source of clean fluid. The fluid characteristics shall be indicated in the inquiry/order. The desired pressure (in $kg/cm^2g$) & consumption (in $m^3/hr$) to be indicated by vendor. |
| Plan 41 | : | Recirculation from pump case through cyclone separator delivering clean fluid through cooler to seal and fluid with solids back to pump suction. |

**Seal Flushing Plans for Throttle Bushing, Auxiliary Seal Device**

| | | |
|---|---|---|
| Plan 61 | : | Tapped connections for owner's use. |
| Plan 62 | : | External fluid quench (steam, water etc.). |

**Cooling Water Piping Plans**

| | | |
|---|---|---|
| Plan A | : | Cooling to bearing housing. |
| Plan B | : | Cooling to bearing housing with parallel flow to seal plate. |
| Plan C | : | Cooling to stuffing box jacket. |
| Plan D | : | Cooling to stuffing box jacket with parallel flow to seal plate. |
| Plan E | : | Cooling to stuffing box jacket & bearing housing in series. |
| Plan F | : | Cooling to stuffing box jacket & bearing housing in series with parallel flow to seal plate. |
| Plan G | : | Cooling to pedestals, stuffing box jacket & bearing housing in series. |
| Plan H | : | Cooling to pedestals, stuffing box jacket & bearing housing in series with parallel flow to seal plate. |
| Plan J | : | Cooling to stuffing box jacket with parallel flow to cooler. |
| Plan K | : | Cooling to stuffing box jacket & bearing housing in series with parallel flow to cooler. |
| Plan L | : | Cooling to pedestals, stuffing box jacket & bearing housing in series with parallel flow to cooler. |

# उपकेन्द्रीय पम्प के लिए मानक विनिर्देश (जल सेवा)

# STANDARD SPECIFICATION FOR CENTRIFUGAL PUMPS (WATER SERVICE)

| Rev. No | Date | Purpose | Prepared by | Checked by | Standards Committee Convenor | Standards Bureau Chairman |
|---|---|---|---|---|---|---|
| | | | | | Approved by | |
| 6 | 02/12/24 | REVISED & ISSUED AS STANDARD SPECIFICATION | MK | JSD/TK | NK | MN |
| 5 | 09/01/20 | REVISED & ISSUED AS STANDARD SPECIFICATION | BBS | JSD | SM | RKT |
| 4 | 06/04/11 | REVISED & ISSUED AS STANDARD SPECIFICATION | SPS | DB | AKN | DM |
| 3 | 20/03/08 | REVISED & ISSUED AS STANDARD SPECIFICATION | NK | AKN | VKM | VC |
| 2 | 04/09/02 | REVISED & ISSUED AS STANDARD SPECIFICATION | NK | KDS | VJN | GRR |

**Abbreviations:**

| | | |
|---|---|---|
| ANSI | : | American National Standards Institute |
| ASTM | : | American Society for Testing and Materials |
| BIS | : | Bureau of Indian Standards |
| CG | : | Centre of Gravity |
| DCI | : | Document Control Index |
| EC | : | Experience Criteria |
| engDMS | : | Engineering Electronic Document Management System |
| GA | : | General Arrangement |
| IC | : | Internal Combustion |
| ISA | : | Instruments Society of America |
| MAWP | : | Maximum Allowable Working Pressure |
| MCF | : | Minimum Continuous Flow |
| MCR | : | Maximum Continuous Rating |
| MCS | : | Maximum Continuous Speed |
| NFPA | : | National Fire Protection Association |
| NPSH | : | Net Positive Suction Head |
| NPSHA | : | Net Positive Suction Head Available |
| NPSHR | : | Net Positive Suction Head Required |
| OD | : | Outside Diameter |
| P&ID | : | Piping and Instrumentation Diagram |
| PTR | : | Proven Track Record |
| VDM | : | Vendor Document Management |
| VDR | : | Vendor Data Requirements |

**Rotating Equipment Standards Committee**

**Convenor:** Mr. Nalin Kumar

**Members:**
Mr. Tarun Kumar
Mr. J S Duggal
Mr. Abhay Kumar
Mr. Mahesh Easwaran
Mr. Mahesh Gupta
Mr. Pintu Lal
Mr. Aasheesh K Handa (Projects)

## CONTENTS

## SECTION 1 - GENERAL

### 1.1 SCOPE

i. This specification together with the attendant Data Sheets and other specifications/attachments to inquiry/order defines the minimum requirements for vertical and horizontal centrifugal pumps and their accessories/auxiliaries for use in clean, cold water service. Water injection pump, boiler feed water pumps and pumps for sea water services are not covered by this specification.

ii. Vendor shall comply with the requirement of this specification and other specifications/attachments to inquiry/order. No deviation or exception shall be permitted without the written approval of the purchaser.

iii. Compliance with this specification shall not relieve the vendor of the responsibility of furnishing equipment and accessories/auxiliaries of proper design, materials and workmanship to meet the specified start up and operating conditions.

In case the vendor considers requirement of additional instrumentation, controls, safety devices and any other accessories/auxiliaries essential for safe and satisfactory operation of the equipment, they shall recommend the same along with reasons in a separate section along with their proposal and include the same in their scope of supply.

### 1.2 CONFLICTING REQUIREMENTS

In case of conflict between this specification and the attendant data sheets, job specifications (if any) and other attached specification the following order of precedence shall govern:

1. Process Data Sheet / P&IDs / Process Package
2. Mechanical Data Sheets.
3. Job Specifications / Scope of Work (if any)
4. This specification
5. Other standards & specifications
6. Other referred codes and standards

The editions of referenced publication that are in effect at the time of inquiry or at a date specified in the inquiry documents shall be applicable.

In case of any ambiguity in the above documents, the vendor/supplier shall seek clarification from the owner/purchaser and the decision of the owner/purchaser shall be final and binding.

### 1.3 DEFINITION OF TERMS

1.3.1 The **Normal operating point** is the point at which usual operation is expected.

1.3.2 The **Rated operating point** is the point at which the vendor certifies that performance is within the tolerances stated in this specification.

1.3.3 **Maximum allowable working pressure (MAWP)** is the maximum continuous pressure for which the manufacturer has designed the equipment (or any part to which the term is referred) when the equipment is operating at the maximum allowable temperature.

1.3.4 **Maximum allowable temperature** is the maximum continuous temperature for which the manufacturer has designed the equipment (or any part to which the term is referred) when handling the specified liquid at the specified pressure.

1.3.5 **Minimum continuous stable flow** is the lowest flow at which the pump can operate continuously without exceeding the noise and vibration limits imposed by this specification.

1.3.6 The **Pressure casing** is the composite of all stationary pressure containing parts of the unit, including all nozzles, glands and other attached parts.

1.3.7 Unless otherwise specified, **Supplier / Vendor** shall be a manufacturer of centrifugal pumps (water service) having adequate design, engineering, manufacturing, packaging and testing facilities and shall have supplied complete centrifugal pumps (water service) package as a single point responsibility vendor. The vendor shall also be the manufacturer of the proposed centrifugal pumps (water service).

1.3.8 **Net positive suction head** (NPSH) is the total absolute suction head, in meters of liquid, determined at the suction nozzle and referred to the datum elevation minus the vapour pressure of the liquid in meters absolute. The datum elevation is the shaft centreline for horizontal pumps, the suction nozzle centreline for vertical in-line pumps and the top of foundation for other vertical pumps.

1.3.9 **Net positive suction head available** (NPSHA) is the NPSH in meters of liquid, determined by purchaser for pumping system with the liquid at the rated flow and normal pumping temperature.

1.3.10 **Net positive suction head required** (NPSHR) is the NPSH in meters, determined by vendor testing with water. NPSHR is measured at the suction flange and corrected to the datum elevation. NPSHR at rated and other capacities is equal to the NPSH that produces a 3 percent head drop (first stage head in multistage pumps) due to cavitation within the pump.

1.3.11 **Minimum Submergence required** is the liquid level with respect to pump suction flange face, in millimeters, determined by the vendor when testing with water for vertical pumps. This is the level required to prevent vortex formation/ingress of air/vapour into the pump suction resulting in loss of flow/head.

## 1.4 EXPERIENCE CRITERIA

1.4.1 The pump model offered shall be from the existing pump model series and shall be from the regular manufacturing range of the vendor (Prototypes are not acceptable).

The mechanical design as well as the hydraulic performance (including NPSHR) for the complete range of operation of the offered model shall have been established in the shop test. (Details to be furnished, if required).

The offered pump model with identical hydraulics and design shall be field proven (at least ONE unit) with minimum operating experience of one year for similar operating/design conditions, bearing span/column length, pumping liquid and material of construction supplied in the last Ten (10) years, from the proposed manufacturing plant, as on bid due date.
(Note: Similar operating/design conditions, bearing span/column length would mean approx. 80% or higher)

Multiple references can be furnished to justify the above.

1.4.2 The vendor shall complete the Experience Record Proforma enclosed with the inquiry document to amply prove that the offered pump meets the above criteria by furnishing references of flow, head, pressure & temperature, driver rating & speed, number of stages, bearing span / column length (as applicable), efficiencies, material of construction, bearing

design & lubrication. In addition, manufacturer's catalogue and general reference list for centrifugal pump (water service) to be furnished along with the proposal.

## SECTION 2 - BASIC DESIGN

### 2.1 GENERAL

2.1.1 The vendor shall have UNIT RESPONSIBILITY of complete centrifugal pump package & shall be responsible for complete design, engineering, manufacturing, packaging, testing, supply & supervision of erection & commissioning of total package as per specification requirements. Vendor's scope shall include but not limited to the responsibility for execution, coordination of all technical aspects of equipment and its auxiliary systems, their selection & integration into a complete package constituting total order. All drawings/documents pertaining to the order shall be duly approved by the vendor before onward submission.

2.1.2 Pumps with constant speed drivers shall be capable of at-least 5 percent head increase at rated condition and pump rated speed by replacing with a new impeller or impellers. Offered impeller shall in no case be less than the minimum diameter impeller.

2.1.3 Horizontal pumps of the close-coupled, the two stage overhung, or the single stage double suction overhung, type shall not be furnished.

2.1.4 Unless otherwise specified, Pumps where difference between NPSHA and NPSHR is 0.6 meter or less are not acceptable. The said NPSHR value shall correspond to the maximum value of NPSHR from rated flow down to the recommended minimum continuous stable flow specified by the vendor. However, for pumps having pump rated BKW up to 55 kW, pumps with margin between NPSHA & NPSHR less than or equal to 1 m are not acceptable.
For Pumps with open discharge valve/auto-start condition, the NPSHR at the 120% of Best Efficiency Point (BEP) flow shall not exceed the NPSHA.
Note: Actual datum for NPSHA (i.e. grade level, top of foundation level or any other level as defined in enquiry) shall be referred from the data sheets forming part of enquiry document.

Pumps fitted with inducers for reducing NPSHR are not acceptable.

2.1.5 Pumps shall have stable head/capacity curves (continuous head rise to shut-off). When parallel operation is specified, head rise shall be at least 10 percent of the head at the rated capacity. The shut off head shall not be more than 120 percent of the rated head in horizontal pumps and 140 percent in the case of vertical turbine pumps. In no case shutoff pressure shall exceed downstream design pressure. Unless otherwise specified, discharge orifice shall not be used to achieve required head rise to shut off, even in the case of parallel operation.

2.1.6 The best efficiency point for the furnished impeller is preferred between the rated point and the normal point. However the rated point shall be between 70 to 110 percent of the best efficiency point of the rated impeller except for intermittent duty applications and for pumps having rated BKW upto 22 kW.

2.1.7 Unless otherwise specified, the maximum permissible sound pressure level of the complete equipment (pump + driver) train shall not exceed 85 dBA measured at 1 meter from pump surface in any direction for the recommended range of operation at site.

2.1.8 For vertical pumps, not provided with non-reverse ratchet, vendor shall describe the precaution taken, to prevent damage due to reverse rotation.
Vertical pumps shall be provided with their own thrust bearing designed to carry rotor

weight and pump generated axial forces and shall not transmit any thrust to the bearings of driver.

2.1.9 Pump-Driver train shall be designed to be suitable for outdoor installation without a roof.

2.1.10 Lifting lugs/eye hooks shall be provided for ease of lifting of complete pump as well as the heavy maintenance components of the pump (e.g. Top half casing cover of axially split pump).

2.1.11 The guaranteed parameters shall be demonstrated during shop test without any coating on impellers or casings.

LCWP (Horizontal/vertical) shall be internally coated after pump performance test to improve the pump efficiency to the extent possible. One pump per tag will be performance tested (testing procedure similar to pump tested without coating) after coating to witness the actual improvement in efficiency.

2.1.12 Pumps with variable speed drivers shall be capable of operating continuously upto 105 percent of rated speed as well as operating briefly upto driver trip speed.

2.1.13 Casing vents alongwith vent valves, as per manufacturer standards, for all pumps shall be provided. For all horizontal pumps, casing drain with isolation valve and flanged piping terminated at the skid edge shall be provided. Baseplate shall also be provided with flanged drain connection.

2.1.14 Horizontal between bearing pumps, pumps with rated flow above 500 m3/hr (horizontal) and pumps with rated flow above 100 m3/hr (vertical) shall be considered as Large Capacity Water Service (LCWS).

## 2.2 PRESSURE CASING DESIGN

2.2.1 Maximum allowable working pressure (MAWP) for all pressure containing parts e.g. casing, bowl, discharge head, discharge pipe, column pipe (in case of vertical turbine type pump), stuffing box etc. shall in no case be less than the maximum discharge pressure produced by the pump at shut-off (including tolerances), at the maximum suction pressure, for the rated impeller diameter and the maximum continuous speed.
Note: Shut-off pressure for vertical pumps shall be calculated at the delivery flange at the top of mounting plate in the same way bowl head is calculated, since the shut-off head corresponds to the rated impeller, at the Pump casing discharge flange.

MAWP shall also not be less than the specified downstream design pressure.

These pressure containing parts shall be suitable for hydrostatic test pressure of 1.5 times the MAWP.

Note: MAWP shall not be less than 10 kg/cm²g for pumps with 125# flanges (i.e. with Cast Iron casing) & 16 kg/cm²g for pumps with 150# flanges (i.e. with Carbon Steel or Alloy Steel casing).

2.2.2 Pumps shall have suction and discharge flanges designed for same rating. Unless otherwise stated, flanges shall be machined and drilled conforming to ASME B16.5 (up to NPS 24) and ASME B16.47 Series B (for above NPS 24).

2.2.3 Pumps shall be provided with Flanged nozzles.

2.2.4 Unless otherwise specified, all pumps shall be supplied with companion flanges with rating conforming to applicable specification of ASME B16.5 (up to NPS 24) and ASME B16.47 Series B (for above NPS 24), drilled and faced in accordance with pump suction

and discharge flanges alongwith gaskets and fasteners.

For pumps with casing material as cast iron (CI), the companion flanges shall be of slip-on (SO) type [for flange sizes 50 mm (2 inches) & above] or socket welded (SW) type [for flanges of size 15 mm (0.5 inches) to 40 mm (1.5 inches)] with flat face (FF) & of carbon steel material. The gasket shall be of full face type.

For pumps with casing material other than cast iron, the companion flanges for pump suction and discharge connections shall be of weld neck (WN) type with raised face (RF) & of the material compatible with piping material.

## 2.3 IMPELLER, SHAFTS AND SHAFT SLEEVES

2.3.1 Impellers shall be cast as one piece.

2.3.2 Shaft shall be provided with sleeves under the packing/seal and shall be locked to the shaft. The material of sleeve shall be 12 percent chrome steel (hardened). Where the size of pump makes the use of shaft sleeve impracticable, the shaft shall be constructed of 12 percent chrome steel (hardened). For vertical pumps, shaft material shall be 12 percent chrome steel.

## 2.4 WEAR RINGS

Unless otherwise specified, renewable wear ring shall be furnished at least on the casings. Mating wear surfaces of hardenable materials shall have a difference in Brinell hardness number of at least 50. Integral impeller wear surfaces shall have higher hardness than that of the casing wear rings, when only casing wear rings are provided.

## 2.5 DYNAMICS

The following vibration limits shall be applied at rated speed and at flow of ±10 percent of rated flow.

2.5.1 **Horizontal Pumps**

Unfiltered vibration velocity (peak) for horizontal pumps upto 3000 rpm with antifriction bearing or sleeve bearings when measured at the bearing housing in horizontal or vertical direction shall not exceed 4.0 mm/sec (0.16 inch/sec).

Bearing housings shall be suitable to permit measurement of vibration.

2.5.2 **Vertical Pumps**

Unfiltered vibration velocity (peak) for vertical pumps with antifriction and or sleeve bearings when measured at the top bearing housing of pump or top bearing housing of motor or mounting flange for measuring points upto 3 meters above the mounting base shall not exceed the following limit:

| | | |
|---|---|---|
| Pumps greater than 1500 rpm | = | 7.0 mm/sec (0.28 inch/sec) |
| Pumps upto & including 1500 rpm | = | 5.1 mm/sec (0.2 inch/sec) |

2.5.3 The vibration limits (peak) specified vide clause. 2.5.1 and 2.5.2 above shall be applied for pumps only. The vibration limits for the drivers shall be as per their respective applicable standards. Where respective applicable standards do not specify such limits for the associated drivers, the driver manufacturer's recommendation shall be applied for acceptance of the driver. Such acceptable limits shall be indicated by the vendor in their proposal.

## 2.6 MECHANICAL SEAL/PACKING

2.6.1 Unless otherwise specified, the pump shall be supplied with packings. Stuffing box shall

have minimum five packing rings plus lantern ring. Packing ring size shall be 3/8" or larger.

2.6.2 The mechanical seal shall be of a make, duly approved by the purchaser.

2.6.3 Seal manufacturers specific recommendation shall be obtained and submitted alongwith the proposal.

2.6.4 All auxiliaries for flushing of mechanical seal shall be in vendor's scope of supply.

2.6.5 Large Capacity Water Service (LCWS) Pumps shall be provided with Non-API, balanced & horizontal split mechanical seals.

## 2.7 BEARINGS

2.7.1 Antifriction bearings shall be of standard type and shall meet minimum L-10 rating life of either 25000 hours with continuous operation at rated conditions or 16000 hours at maximum axial and radial loads and rated speed.

2.7.2 The rise in bearing grease/oil temperature with continuous running of the pump shall be within the allowable limits which shall not exceed 30°C for grease and 39°C for oil lubricated bearings above ambient. Cooling arrangements shall be provided if required. Bearings shall be equipped with constant level oilers, vent breather & drain point for oil lubricated arrangements.

2.7.3 Unless otherwise specified, for vertical pumps with open shaft, the intermediate bearings / bushings shall be suitable for operation without any lubrication during start / shut-down or during normal operation (i.e. bearing bush material shall be of self lubricating type). Details of line shaft bearings shall be furnished with the proposal.

2.7.4 Unless otherwise specified, for vertical pumps, thrust from the pump shall not be transferred to the electric motor.

## 2.8 MATERIALS

2.8.1 The material of construction of parts shall be as specified. Vendor shall furnish the equivalent material as per ASTM.

For impellers in cast iron or bronze construction, the tip speed shall be limited to 40 meters/sec. Unless otherwise specified, for tip speeds exceeding 40 meters/sec, the material of impellers shall be stainless steel.

2.8.2 Unless otherwise specified in the data sheet, material test certificates (chemical and mechanical properties) shall be supplied for impeller, shaft, shaft sleeve, wearing rings and casings.

2.8.3 The repair of pressure castings by peening, plugging, impregnating or by the use of plastic or cement compound is prohibited. The Inspector's prior approval shall be obtained for the repair of castings. When authorised, repair shall be carried out in accordance with applicable ASTM Specification. Weld repair of pressure containing parts of Cast Iron construction is not permitted.

## 2.9 PUMPS FOR FIRE WATER APPLICATION

Pumps for Fire Water Application shall also meet the following additional requirements:

2.9.1 Unless otherwise specified, Pumps shall meet the requirements of NFPA (National Fire

Protection Association). Technical requirements specified in the data sheet are also to be met. The vendor shall also be responsible for obtaining the necessary approvals as specified in inquiry.

2.9.2 Pumps shall be direct-coupled except in the case of engine-driven vertical turbine pumps wherein gear drives through universal joint and cardan shaft shall be used. Belt driven pumps are not acceptable.

2.9.3 Parts of pumps like impeller, shaft sleeve, wearing ring etc. shall be of non-corrosive metal preferably brass or bronze unless the quality of water dictates the use of special metals/alloys which shall be insisted upon.

2.9.4 Pumps shall be capable of discharging not less than 150 percent of rated capacity at a head not less than 65 percent of the rated head.

2.9.5 Difference between NPSHA and NPSHR at 150 percent of the duty point shall not be less than 0.6 meters.

2.9.6 The electrical motor shall be of continuous rating type and the rating shall be 110 percent of the power at rated point or equal to maximum BKW rated impeller whichever is higher.

2.9.7 For Diesel engine drivers, the net continuous site power available after considering the deration due to site condition and power losses, due to other parasitic loads and engine driven auxiliaries shall be higher of the following two values:

(a) 20 percent in excess of the BKW required to drive the pump at rated condition.
(b) Maximum BKW rated impeller as indicated by the manufacturer in the pump data sheets.

## SECTION 3 - ACCESSORIES

### 3.1 DRIVERS

3.1.1 Electric motor drivers shall have a maximum continuous rating (MCR) (i.e. service factor equal to 1) not lower than the following unless higher rating is dictated by the Note 1.

| **Pump Rated BKW *** | | **Motor MCR (% of Pump Rated BKW)** |
|---|---|---|
| Less than 22 kW | : | To suit maximum BKW indicated on pump data sheet or 125% of rated pump BKW, whichever is higher. |
| 22 kW - 55 kW | : | 115% of rated pump BKW. |
| Higher than 55 kW | : | 110% of rated pump BKW. |

Remark: * including all mechanical & transmission losses & with 0% +ve tolerance.

Note :

1. The motor nameplate rating for pumps under parallel operation shall not be less than the max. BKW indicated on pump data sheet (the power at End of the curve for the rated impeller) or shall have the specified margin as per this clause whichever is greater. The pump motors shall also be suitable for start-up under open discharge valve condition.

### 3.2 GEARS

The type of gears shall be as specified in the inquiry document.

Unless otherwise specified, gear box shall be selected with a minimum of AGMA service factor of 1.75 over the driver rating.

Wherever right angle gear box are required the same shall be supplied non-reversible

ratchet and shall allow for vertical adjustment of the impeller. Further the gearbox shall be suitable for absorbing the maximum thrust under any case of operation.

## 3.3 COUPLING & GUARDS

3.3.1 Unless otherwise specified, connection between pump and driver shall be made by a flexible metallic coupling.

A spacer (127 mm minimum normal length), shall be used to permit the removal of coupling, bearings, seal and/or rotor as applicable without disturbing the driver, the suction and discharge piping, or the casing top cover, for all horizontal pumps.

It shall be the responsibility of the pump vendor to obtain purchaser's approval for the selected coupling, its make and rating.

3.3.2 Whether or not pump vendor is required to supply the driver, he shall still deliver the fully machined coupling assembly alongwith the pump. The driver shaft dimensions and tolerances shall be furnished by the Purchaser to the pump vendor.

3.3.3 Removable coupling guard shall be provided which shall be fabricated from non-sparking material, and shall be open at the bottom to permit manual shaft rotation. The guard shall be sufficiently rigid to withstand deflections as a result of bodily contact of nominally 100 kgs. Coupling guard shall have a hinge to open and Inspection window to see the healthiness of the coupling shims.

3.3.4 Coupling service factor shall not be less than 1.5 over driver rating. However, while selecting the coupling, it shall be ensured by pump vendor that the allowable shaft stresses of the pump train are not exceeded under any circumstances including any offset condition or conditions of maximum torque. For pump trains having gear-box, the coupling service factor shall not exceed the gear-box service factor.

## 3.4 BASEPLATE

### 3.4.1 Baseplates for Horizontal Pumps

3.4.1.1 Baseplate shall extend under the pump, gear box and motor/turbine driver and shall be fully machined for mounting the above equipment. All other projections of the equipment supplied shall fall within the maximum perimeter of the baseplate. Baseplate shall be steel fabricated and shall have sufficient rigidity to avoid vibration and distortion. Baseplate shall be so designed as to facilitate proper grouting (Vent holes where required shall be provided).Type of grout material and technical details shall be furnished by vendor in his proposal. Baseplate shall be cleaned (sand blasted) inside and outside and coated with suitable anticorrosion paint.

Drain Pan Type Baseplate surrounding the entire baseplate to be provided. Baseplate to be provided with minimum 2" flanged drain connection.

3.4.1.2 The baseplate shall be provided with lifting lugs for at-least a four point lift. Lifting the baseplate complete with all equipment mounted shall not permanently distort or otherwise damage the baseplate or machinery mounted on it.

3.4.1.3 For driver trains over 75 kW, alignment positioning screws shall be provided for each drive element to facilitate longitudinal and transverse horizontal adjustments. The lugs holding these positioning screws shall be attached to the baseplate so that they do not interfere with the installation or removal of the drive element.

3.4.1.4 Vertical leveling screws, spaced for stability shall be provided on the outside perimeter of

the baseplate. These shall be numerous enough to carry the weight of the baseplate, pump, gear-box (if any) and driver without excessive deflection.

3.4.2 **Baseplate / Mounting Plate for Vertical Pumps**

3.4.2.1 Vertical pumps shall have the manufacturer's standard mounting arrangement.

3.4.2.2 Alignment positioning screws shall be provided for 18.5 kW and above and as per manufacturer's standard practice for lower ratings.

3.4.2.3 Unless otherwise specified, mounting plate for vertical pumps shall be having a minimum thickness of 48 mm and is to be made from IS:2062/IS:2002 plate material or can be of the same material as that of vessel / tank. Mounting plate shall be supplied with gaskets (as applicable) & fasteners.

3.4.2.4 Alignment positioning screws shall be provided for all motors.

**3.5 STRAINERS**

Unless otherwise specified, all vertical pumps shall be provided with suction strainers of SS-316 material.

## SECTION 4 - INSPECTION, TESTING AND PREPARATION FOR SHIPMENT

**4.1 GENERAL**

4.1.1 Unless otherwise specified, all pumps shall be inspected and all tests shall be witnessed by the Purchaser or by the Purchaser's authorised representative.

4.1.2 Purchaser's or their authorised representative shall have access to the plant including sub vendors plants where work on or testing of equipment is being performed.

4.1.3 No surfaces of parts of pumps are to be painted until the inspection is completed.

4.1.4 Vendor shall give to the purchaser at-least 15 days notice prior to commencement of testing. Vendor shall carry out all running tests and mechanical checks and satisfy himself prior to purchaser's arrival for inspection and shall maintain desired log of tests.

4.1.5 Acceptance of shop test shall not constitute a waiver of requirement to supply equipment as per specification and/or to meet field test under operating condition, nor does inspection relieve the manufacturer of his responsibility in any way whatsoever.

**4.2 TESTS**

As a minimum following tests shall be performed. The basic reference standard shall be the latest edition of Hydraulic Institute Standard or IS:5120.

4.2.1 **Hydrostatic Test**

4.2.1.1 Pressure casings including column pipe and discharge head shall be hydrostatically tested with water at ambient temperature at 1½ times the maximum allowable working pressure specified in the data sheet.

4.2.1.2 Jackets for bearing, stuffing box, coolers, etc, shall be tested at 1½ times the maximum allowable jacket working pressure.

4.2.1.3 Hydrostatic test shall be maintained for a minimum period of 30 minutes. Shop test certificate is required.

4.2.2 **Performance Test**

4.2.2.1 Unless otherwise specified, performance test for Horizontal Pumps for General Water Service (GWS) shall be carried out as per the following:

| | |
|---|---|
| Pumps with drivers upto 55 kW | Non witnessed. Only review of manufacturer's shop test reports are required. |
| Pumps with drivers from 55 kW to 160 kW | One pump per tag/Item no. to be witnessed |
| Pumps with drivers above 160 kW | All pump units in an item to be witnessed |

However in case of vertical pumps and for pumps for Large Capacity Water Service (LCWS), all pumps in a tag needs to undergo witnessed performance test.

4.2.2.2 Unless specifically agreed upon, pump shall be tested at the rated speed specified in the data sheet with calibrated motors, at least for four hours. During the four hour run test, complete data including pressure, capacity, power, vibration levels, bearing temperatures and noise levels shall be recorded and guaranteed parameters verified.

Prior to start of test, manufacturer shall furnish the certificate of latest calibration / re-calibration of driver and measuring instruments. Unless electrical or mechanical failure occurs, driver used for shop testing need not be recalibrated and original calibration certificate shall remain valid. Duration of recalibration for all measuring instruments shall be as per the recommendations of HI Standards and/or relevant standards of the country of origin of the pump manufacturer.

4.2.2.3 The pump shall be tested with water at ambient temperature. Suitable rust inhibitor shall be added in the water used during any internal testing / performance testing of the pumps, to prevent rusting of pump internals.

4.2.2.4 The performance test for the pumps shall be in accordance with Indian Standard IS:5120 latest edition and the tolerance of the guaranteed parameters shall be as follows:

| | | |
|---|---|---|
| Rated head | : | Zero negative tolerance. |
| Shut-off head | : | Positive tolerance permitted as long as it does not exceed downstream design pressure. Negative tolerance permitted so long as the curve is continuously rising to shutoff without any drooping and minimum 110% head rise to shutoff shall be available for pumps in parallel operation. |
| Min. Submergence required (for vertical pumps)/ NPSH(R) | : | Zero Positive Tolerance. |
| Rated BKW | : | Zero positive tolerance (However pumps may be accepted upto 104 percent of Guaranteed BKW subject to Penalties as defined elsewhere) |

As a minimum, data at Shut-off (no vibration data required), minimum continuous stable flow, midway between minimum and rated flow, rated flow and maximum allowable flow (as a minimum, 120% of best efficiency flow), shall be measured and recorded during tests. All the instruments used for conducting the tests shall be calibrated before tests and calibration certificates furnished from a recognised testing institution to the Inspector.

4.2.2.5 For fire water application all engine driven horizontal and vertical pumps shall be subjected to a 4 hour complete unit string test at the pump vendor's works during which mechanical performance of the train shall be verified, in terms of vibration, bearing/oil temperature, engine parameters and controls.

In case multiple units are ordered, only one number of diesel engine and gear box unit (if used) may be brought to the pump vendor shop for complete unit (string) test for the fire water pump unit. For the remaining pumps, complete unit (string) need not be done. However, any modification required to be done on the first unit shall be uniformly done on the remaining units also for proper unitization of the same at site.

4.2.3 **NPSH Test / Min. Submergence Test**

Unless otherwise specified, NPSH test for Horizontal Pumps for General Water Services (GWS) shall be carried out as per following:

| | |
|---|---|
| For pumps with driver rating upto 55 kW | Not Applicable |
| For Pumps with driver rating between 55 kW to 160 KW | One pump tag/item to be witnessed |
| For Pump with driver rating above 160 KW | All pump units to undergo witness test |

Additionally, in case of vertical pumps, all pumps in tag needs to undergo minimum submergence test Testing for NPSH is not required for Vertical pumps.

Also for all pumps in LCWS, all pumps in a tag needs to undergo NPSH test if required as per specification.

Unless otherwise specified NPSH test shall be carried out where difference between NPSH available and NPSH required is 1 meter or less at the rated point, for pumps beyond 55 kW.

Test points shall be similar to those of Performance test.

4.2.4 **Vibration Measurement**

During performance test vibration shall be measured on the bearing housing for the capacity range from pump MCF to 110% of rated capacity. For checking the vibration, flat surface shall be provided on bearing housing by pump manufacturer. The vibrations shall be within the limits as specified in clause no. 2.5.

4.2.5 **Dismantling Inspection**

Dismantle inspection of pump after performance test shall be applicable only in case of abnormality in mechanical behaviour (such as excessive noise and vibration, bearing temperature rise etc.) during performance test.

If it is necessary to dismantle a pump after the performance test for the sole purpose of machining impellers to meet the tolerances for differential head, no re-test will be required unless the reduction in diameter exceeds 5 percent of the original diameter. The diameter of the impeller at the time of shop test, as well as the final diameter of the impeller, shall be recorded on a certified shop test curve that shows the operating characteristics after the diameter of the impeller has been reduced.

If it is necessary to dismantle a pump for some other correction, such as improvement of power, NPSH or mechanical operation, the initial test will not be acceptable and final performance test shall be run, after the correction is made.

4.2.6 **Final Inspection**

After the performance/dismantle test the pump and the job driver shall be unitised on the

job base plate, aligned and coupled to make a complete unit except for engine driven vertical pumps. The pump will then be checked for visual inspection to confirm compliance to the GA drawings, nozzle dimension, elevations, anchor bold position, direction of rotation etc.

4.2.7 Prior to start of tests, vendor shall furnish the following:

1. Certificate of calibration of driver, which should be recalibrated after a period of every three years.
2. Certificate of calibration of measuring instruments, which should be recalibrated after a period of every one year. Magnetic flowmeters shall be recalibrated once in two years. Pressure gauges shall be calibrated prior to start of test and after completion of test.
3. Record of all running test and mechanical checks (including test curves and data) completed prior to purchaser's inspection.

## 4.3 PREPARATION FOR SHIPMENT

4.3.1 After all tests are completed and after inspection is made, all exposed mechanical surfaces and all internal parts shall be thoroughly coated with a rust preventive. All exterior parts of the unit except machined surfaces shall receive one prime coat and one coat of vendor's standard enamel.

4.3.2 All flanges, nozzles shall be blanked off. All untapped openings shall be provided with substantial wood or metal closure. The ends of small piping may be sealed with tape.

4.3.3 The pump shall be supplied with a nameplate containing the following information:

- Purchaser's Item No.
- Manufacturer's Name
- Type and Serial No
- Rated capacity in m3/hr.
- Differential head at rated capacity in m.
- Casing hydrostatic test pressure in kg/cm².
- Speed in rpm.

The nameplate shall be of stainless steel and relevant information shall be punched into the same.

4.3.4 All auxiliary, dismantled and packed separately shall be properly marked with the Item No. for which it is intended by means of metal tag.

4.3.5 Pump with auxiliary shall be suitably packed, fastened to avoid damage during transit and crated for shipment and storage for a period of 12 months. Lifting, unpacking and handling instructions shall be securely attached to the exterior of the largest packing in a well marked weather proof container. The upright position of lifting points, gross weights and dimensions be clearly marked on each package. Each package shall clearly identify the equipment contained therein. If any extra precaution is to be taken by the Purchaser for storage beyond 12 months the same shall be explicitly indicated in the operation and maintenance manuals.

# SECTION 5 - VENDOR'S DATA

## 5.1 PROPOSALS

The vendor's proposals shall as a minimum include the following:

a) All data sheets, drawings and documents listed under "PRINTS WITH QUOTE" in the enclosed Vendor Data Requirement Form.
b) Vendor's confirmation/comments on post-order Vendor Data Requirements (Type of

Documents, no. of prints and date needed) indicated in Vendor Data Requirement forms data sheets and specs.

c) List of recommended commissioning spares included in the offer.
d) List of mandatory spares (where specified by the purchaser) included in the offer.
e) List of Vendor's standard Spare Parts for Two Years Normal Operation
This list shall be made separately for each items including auxiliaries and drivers in the form of a table & shall show :
   i) Part name, description and number.
   ii) Quantity installed in one unit.
   iii) Quantity recommended per unit for 2 years normal operation.
   iv) Quantity recommended for number of units of an item as specified in the inquiry.
   v) Quantity recommended as insurance for the number of units of an item specified in the inquiry.
f) An itemised list of special tools included in the offer.
g) Any start-up, shutdown or operating restrictions required to protect the integrity of the equipment.
h) Any limitations of vendor's test-facility to carryout the specified tests.
i) A specific statement that the scope of supply, the offered equipment/systems and all its components are in strict accordance with the data sheets, job specifications, this specifications and all other attachments, except for specific deviations as listed in the proposal.

## 5.2 CONTRACT DATA

### 5.2.1 General

5.2.1.1 Drawings and data as required after purchase order has been specified in Vendor Data Requirement. Vendor to note that the drawing/document descriptions/titles as given in the Vendor Data Requirement are generic in nature. It is possible that against one drawing/document specified there are several drawings to be furnished by the vendor or vice versa.
Vendor shall complete & forward a document "DOCUMENT CONTROL INDEX (DCI)" to the purchaser (Destination & contact person as per order).

This document shall list out in consolidated form all drawings and documents required by purchaser (As specified in Data Sheets, Specifications and Vendor Data Requirement forms enclosed with the order).

Against each drawing/document vendor shall indicate the vendor's drawing numbers, titles, Rev. No., category (whether for information or approval) and schedule of submission.

This shall be the first document to be submitted by vendor within two weeks of order. **No drawing shall be taken up for review till the DCI for inquiry/order is finalized by vendor**. If specified, drawing review may be through VDM in soft as per the details provided elsewhere in the inquiry document.

5.2.1.2 All transmittal letters (covers), drawings and data shall have a title block (in addition to vendor's standard title block) which shall as a minimum contain the following contract information:
i) Purchaser's and Consultant's Corporate Name
ii) Project Name.
iii) Client / Customer's Name.
iv) Equipment Name and Item No.
v) Purchase Order No.
vi) Purchase Requisition No.
Title Block on drawings shall be placed on the lower right hand corner.

5.2.1.3 All vendor data/drawings/documents shall be in English Language and in Metric Systems.

5.2.1.4 Data specified in the VDR is the minimum requirements of Purchaser. Any additional document/data required or requested by Purchaser for engineering or construction shall also be made available by the vendor.

5.2.1.5 Whether or not specified the vendor shall furnish the following, before shipment:

- As built running clearances and when applicable; thrust bearing, radial bearing and seal running clearances.
- A supplementary list of spare parts other than those included in his original proposal. The supplementary list shall include recommended spare parts, cross-sectional or assembly type drawings, parts numbers, materials, prices and delivery period. The vendor shall forward this supplementary list to the purchaser promptly after receipt of the reviewed drawings and in time to permit order and delivery of parts before field start-up.
- A parts list for all equipment supplied. The list shall include pattern, stock, or production drawing numbers and materials of construction. The list shall completely identify each part so that the purchaser may determine the interchangeability of the parts with other equipment furnished by the same manufacturer. Standard purchased items shall be identified by the original manufacturer's name and part number.
- At least 8 weeks before shipment, the vendor shall submit his preservation, packaging and shipping procedures to the purchaser's for his review.

5.2.2 **Co-ordination Meeting**

When specified, a co-ordination meeting shall be held at Purchaser's office, preferably within 4 weeks of order.
An agenda shall be prepared for this meeting and would include the following points related to technical aspects.

a. Any clarifications required by the vendor on purchaser's order.
b. Vendor Data Index & Schedule.
c. Vendor Data Review/approval modalities.
d. Sub-vendor lists proposed by vendor.
e. Utility requirements.
f. Preliminary General Arrangement & layout drawings & purchaser's interface drawings.

5.2.3 **Drawings**

5.2.3.1 The number of prints and/or reproducible required and the times within which these are to be submitted by vendor are specified in Purchaser's inquiry/order.

5.2.3.2 The purchaser's review of the vendor's drawings shall not constitute permission to deviate from any requirements in the purchase order/specifications unless specifically agreed upon in writing. After the drawings have been reviewed, the vendor shall furnish certified copies in the quantity specified. All drawings must be clearly legible and shall be folded to 216 mm x 279 mm (8½" x 11") size.

5.2.3.3 Drawings/documents with following titles shall contain as a minimum the following information:

a) **General Arrangement Drawing**

A general arrangement drawing shall indicate:

i) Outline dimensions (minimum three views) (All principal dimensions).
ii) Allowable forces and moments on suction and discharge nozzles.
iii) Location (in all three planes), size, type, rating and identification of all purchaser's interface connections including those of vents, drains lubricating oil, sealing fluid, cooling water, steam & Electrical/Instrumentation.
iv) Direction of rotation viewing from the driving end.
v) Weight of each assembly/component.
vi) The weight & location of center of gravity of the heaviest

assembly/components that must be handled for erection.

vii) Identification and weight, dimensions of the heaviest assembly / subassembly / component required to be handled for maintenance.

viii) Maintenance clearances and dismantling clearances.

ix) Speeds of Driven Equipment and driver and driver rating. Location of driver terminal box (in case of Electric Driver)

x) Layout of auxiliary equipment and operating platform.

xi) Make, Type and Size of couplings and the location of guards and their coverage.

xii) A list of reference drawings if any.

xiii) A list of any special weather-protection and climatic features.

b) **Foundation Drawings**

A foundation drawing shall indicate complete information required for foundation design by purchase including the following:

i) Foundation bolt sizes, pipe sleeve details, pocket sizes and locations and also distance between the first/ nearest anchor bolt and pump suction and discharge nozzle centrelines.

ii) Grouting thickness and other necessary technical details.

iii) Static weight of each skid/independently grouted item and location of center of gravity of each of such skid/items in all three planes.

iv) Weight distribution for each bolt/subsole plate location and total static weight.

v) Dynamic loading caused due to various items grouted independently.

vi) The direction and magnitude of unbalance forces and moments generated by each such item at the worst operating condition and short circuit moments of motor drivers at the C.G. of the pump-motor baseplate.

vii) $GD^2$ value of each item resolved to driver speed.

viii) Maximum permissible amplitude of vibration on the foundation at base level.

ix) Total mass of rotating parts.

x) Total mass of reciprocating parts.

xi) Suggested dynamic factor and ratio of foundation weight to weight of skid/equipment as per vendor experience.

c) **Layout Drawing** (For multi-skid packages)

This drawing shall include atleast the following:

i) Layout of all skid/equipment and their auxiliaries, vessels, control panels, exchangers etc. Vendor shall furnish an optimised layout (considering the space allocated, site wind conditions, area classification, the type of equipment located in the vicinity etc.) indicating elevation and dimension of skids/equipment.

ii) Minimum spacing required between the various skids/equipment and between the skids and the walls/columns/roof for an easy accessibility and maintenance.

iii) Layout for water piping, trenches for water piping, cable tray/trenches layout.

iv) Piping arrangement and piping support arrangement/location for piping in vendor's scope.

v) Layout for auxiliary equipment and operating platform details.

vi) Specification for crane/mono rail (including suggested mono rail layout) recommended for maintenance and height of the lifting hook from the centerline of equipment.

d) **Field Alignment Diagram**

The diagram shall indicate the relative displacement to be kept between the centrelines of various equipments at the time of installation, so that under normal running conditions the equipments get fully aligned. This relative displacement should be decided on the basis of centerline temperature rise data of driver, gear box/transmission system, driven equipment.

e) **Heat Exchanger Drawings**
Heat exchanger drawing and data shall include heat and mass balance data, details of provisions for separating and withdrawing the condensate, construction details, cross sections & general arrangement drawings of heat exchangers, vendors recommendations regarding provision for support and piping expansion.

5.2.3.4 **P&I Diagrams** (with Bill of Materials)
Vendor shall supply P&I Diagrams along with Bill of Materials of each system in the vendor's scope of supply or specified in the order. P&I Diagram shall indicate the system details, location of various auxiliaries, instruments, controls and safety devices as required. Line sizes, piping class, valve sizes and class shall be clearly marked on the P&ID. Vendor's scope and purchaser's scope shall be clearly demarcated. Each item shall be identified by an item No./item tag no., which shall correspond to the item no. shown on the bill of materials. The bill of materials shall include items number, normal value, set value, range, quantity per unit, make and other specifications as applicable.
Legends adopted shall be indicated either at the bottom of drawing or on a separate drawing. The legends shall be as per ISA.

5.2.3.5 **Cross-sectional Drawing** (with Bill of Materials)
The vendor shall supply cross-sectional or assembly type drawings for all equipment furnished showing all parts, design assembly and running clearances, and balancing data required for erection and maintenance. Each part shall be numbered which shall correspond to the part number on the bill of materials. The bill of materials shall include the part no., name of component, materials quantity installed per unit & sizes where applicable (say for bolts, nuts, rings, gaskets etc.). All boughtout items shall also be indicated with make and brief specifications.
A separate cross-sectional drawing showing installation and setting dimensions for the seals shall be furnished.

5.2.4 **Performance Characteristic Curves**

5.2.4.1 The vendor shall provide complete performance curves to encompass the map of operations, with any limitations indicated thereon.

5.2.4.2 All curves submitted prior to final performance testing shall be marked "PREDICTED". Any set of curves resulting from a test shall be marked "TESTED".

5.2.4.3 Certified test curves and data shall be submitted within 15 days after testing and shall include head, power recalculated to the proper specific gravity and efficiency plotted against capacity. If applicable, viscosity corrections shall be indicated. If NPSHR test is specified, the water NPSHR curve (drawn upto minimum continuous flow) shall also be included. The curve sheet shall include the maximum and minimum diameters of the impeller design supplied, the eye area of the first stage impeller, the identification number of the impeller or impellers and the pump serial number.

5.2.5 **Data Sheet**

5.2.5.1 The Vendor shall provide completely filled in data sheets, first for "as purchased" and then for "as built". This shall be done by the vendor correcting and filling out the data sheets and submitting copies to the purchaser.

5.2.6 **Technical Data Manual/Mechanical Catalogues**

5.2.6.1 Technical Data Manual/Mechanical Catalogue is a compilation of "as built" drawings and data, manufacturing and test records, installation, operating and maintenance instructions.

5.2.6.2 Not later than two weeks after successful completion of all specified tests, the vendor shall

furnish the required number of Technical Data Manual/Mechanical Catalogues for the equipment, any auxiliaries and instruments that the vendor is providing. The Technical Data Manual/Mechanical Catalogue shall include the following documents as a minimum:

i) All drawings and data as listed in the vendor data index & schedule. (For drawings, where purchaser's approval is required, the final certified drawings shall be attached.) Sections shall be organised in a manner that data & drawings related to one subject is grouped together such as Mechanical, Electrical, Instrumentation etc.

ii) All manufacturing, inspection and test data and records.

iii) Installation and Instruction Manual

The vendor shall provide sufficient written instructions, including a cross-reference list of all drawings, to enable the purchaser to correctly install the equipment and prepare the equipment for start-up. It shall include any special information required for proper installation that is not on the drawings, special alignment or grouting procedures, utility specifications (including quantity) and all installation data. It shall also contain the following information:

(a) Instructions for erecting, piping, aligning (including the expected thermally induced shaft centerline shift between normal site ambient temperature position and that at normal equipment operating temperature).

(b) A description of rigging procedures, including the lifting of the assembled equipment, and methods of disassembly, repair, adjustment, inspection and reassembly of the equipment and auxiliaries.

(c) Pre-commissioning/commissioning/functional test procedures and acceptance criterion.

iv) Operation and Maintenance Manual

This manual shall provide sufficient written instructions and data to enable purchaser to correctly operate and maintain the equipment ordered. It shall include a section to cover special instructions for operation at extreme environmental and/or extreme operating conditions. The following shall be included in this manual:

(a) Instructions covering start-up, normal shutdown, emergency shutdown, operating limits and routine operational procedures.

(b) A description of equipment construction features and the functioning of component parts or systems (such as control, lubrication, sealing systems etc.).

(c) Outline and sectional drawings, schematics and illustrative sketches in sufficient details to identify all parts and clearly show the operation of all equipment and components and the methods of inspection and repair. Standardised sectional drawings are acceptable only if they represent the actual construction of the equipment.

(d) The following maintenance information:

i. Maximum and minimum bearing, labyrinth and seal clearances including any other clearance between moving and stationary parts of the equipment affecting proper running and maintenance of the equipment.

ii. Instructions for measuring and adjusting cold clearances, shaft runout, concentricity etc.

iii. Rotor float allowance.

iv. Interference fits on parts that are required to be removed or replaced for maintenance of normally consumable spares.

v. Balancing data with permissible tolerances.

vi. Lubricating schedules indicating recommended grades of oil, their properties, replacement period etc.

vii. Normal maintenance procedure.

viii. Preventive maintenance schedules and criterion for replacement of parts.

ix. Trouble - shooting procedures.

(e) The following reassembly information:

i. Bolting sequence and torque values for all bolts affecting equipment

performance/integrity/safety.

ii. Reassembly sequences together with required inspection checks.

iii. Adjustment procedures to achieve required positions, clearances, float and so forth.

iv. Detailed procedures for pre-operational checks, including settings and adjustments.

v. Seals and coupling installation procedures.

vi. Parts list indicating cross-sectional drawings of various assemblies and sub-assemblies, part numbers, materials of construction (ASTM) etc.to facilitate identification of parts and for procurement of spares.

v) Following information shall also be included in the Technical Data Manual/Mechanical Catalogue:

a) Storage instructions for storing and preserving the equipment (including driver and all the auxiliary units) at the plant site before installation of the same.

b) Instructions for preserving the equipment after it has been installed. This is particularly required in cases where a long time gap is expected between equipment installation and commissioning.

c) Field performance test procedures and acceptance criterion.

5.2.6.3 Technical Data Manual/Mechanical Catalogue shall be in Hard board folder(s) of size 265 mm x 315 mm (10½" x 12½") and shall not be more than 90 mm thickness; it may be of several volumes and each volume shall have a volume number, index of volumes & index of contents of that particular volume.

5.2.6.4 Title sheet (Top sheet) of each volume of Technical Data Manual/Mechanical Catalogue shall contain the contract information as defined under 5.2.1.2 besides the volume number.

5.2.6.5 In case order contains more than one item, separate dedicated mechanical catalogues shall be submitted for each item.

5.2.6.6 Final documentation shall be submitted in hard copy and soft (CDs/ DVDs) in addition to submission through EIL VDM portal. The number of prints and/or reproducible required to be submitted by vendor are specified in Purchaser's inquiry/order.

5.2.6.7 All post order documents shall be submitted / approved through EIL VDM portal.

# उपकेन्द्रीय पम्पों के लिए मानक विनिर्देश
# विशिष्ठ प्रयोजन प्रक्रिया पम्प
## [एपीआई-६१०,१२वें संस्करण पर आधारित]

# STANDARD SPECIFICATION FOR CENTRIFUGAL PUMPS
## (SPECIAL PURPOSE PROCESS SERVICE)
## [BASED ON API-610, 12TH EDITION]

| Rev. No | Date | Purpose | Prepared by | Checked by | Standards Committee Convenor | Standards Bureau Chairman |
|---|---|---|---|---|---|---|
| | | | | | Approved by | |
| 0 | 31.07.2023 | Issued as Standard Specification | HM | MG/TK | NK | SM |

**Abbreviations:**

| | | |
|---|---|---|
| API | : | American Petroleum Institute |
| ARV | : | Automatic Recirculation Valve |
| ASME | : | The American Society of Mechanical Engineers |
| BDD | : | Bid due date/Tender due date |
| BEP | : | Best Efficiency Point |
| BLO | : | Balance Leak off |
| DCI | : | Document Control Index |
| EC | : | Experience Criteria |
| eDMS | : | Electronic Document Management System |
| FFT | : | Fast Fourier Transform |
| HPRT | : | Hydraulic Power Recovery Turbine |
| ISA | : | Instrumentation Society of America |
| ISBL | : | Inside Battery Limits |
| MAWP | : | Maximum Allowable Working Pressure |
| MCF | : | Minimum Continuous Flow |
| MCR | : | Maximum Continuous Rating |
| MCS | : | Maximum Continuous Speed |
| MKS | : | Meter, Kilogram, Seconds |
| MMS | : | Machine Monitoring System |
| MOP | : | Main Oil Pump |
| MRT | : | Mechanical Run Test |
| NPSH | : | Net Positive Suction Head |
| NPSHA | : | Net Positive Suction Head Available |
| NPSHR | : | Net Positive Suction Head Required |
| NPSH3 | : | Net Positive Suction Head 3% |
| OSBL | : | Outside Battery Limits |
| P&ID | : | Piping and Instrumentation Diagram |
| PTC | : | Power Test Codes |
| PTR | : | Proven Track Record |
| VDM | : | Vendor Document Management System |
| VDR | : | Vendor Data Requirements |
| VMS | : | Vibration Monitoring System |

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## 1 Scope

i. This specification together with the attendant Data Sheets and other specifications/attachments to inquiry / order defines the minimum requirements for vertical and horizontal centrifugal pumps including pumps running in reverse direction as hydraulic power recovery turbines and their accessories / auxiliaries for use in the petroleum, petrochemical and natural gas industries.

ii. Vendor shall comply with the requirement of this specification and other specifications/attachments to inquiry/order. No deviation or exception shall be permitted without the written approval of the purchaser.

iii. Compliance with this Specification shall not relieve the vendor of the responsibility of furnishing equipment and accessories /auxiliaries of proper design, materials and workmanship to meet the specified start up and operating conditions.

In case the vendor considers requirement of additional instrumentation, controls, safety devices and any other accessories/auxiliaries essential for safe and satisfactory operation of the equipment, they shall recommend the same along with reasons in a separate section along with his proposal and include the same in their scope of supply.

## 1A Amendments / Supplements to API Standard 610

1A.1 Except as modified herein, the centrifugal pumps shall be designed, manufactured, tested and supplied strictly in accordance with the **API Standard 610 - Centrifugal Pumps for Petroleum, Petrochemical and Natural gas industries, Twelfth Edition, January 2021**.

1A.2 Except for new paragraphs, the number and title of the paragraphs in this specification correspond to the respective sections and paragraphs of the above standard. Paragraphs not addressed in this specification shall be strictly in accordance to **API Standard 610, Twelfth Edition, January 2021** requirements.

The word in parenthesis following the number or title of a paragraph indicates the following:

| | | |
|---|---|---|
| (Addition) | : | An addition to a part, section or paragraph referred to. |
| (Modification) | : | An amplification or rewording has been made to a part of the corresponding section or paragraph but not a substitution replacing the entire section or paragraph. |
| (Substitution) | : | A substitution has been made for the corresponding section or paragraph of the standard in its totality. |
| (New) | : | A new section or paragraph having no corresponding section or paragraph in the Standard. |
| (Delete) | : | The paragraph is deleted. |

## 1B Experience Criteria

1B.1 The pump model offered shall be from the existing pump model series and shall be from the regular manufacturing range of the vendor (Prototypes are not acceptable).

The mechanical design as well as the hydraulic performance (including NPSHR/NPSH3) for the complete range of operation of the offered model shall have been established in the shop test. (Details to be furnished, if required).

The offered pump model with identical hydraulics and design shall be field proven (at least ONE unit) with minimum operating experience of one year for similar operating/design conditions & driver rating (at rated pump speed), rotor dynamics, mechanical design, pumping liquid and material of construction, supplied in the last Ten (10) years, from the

proposed manufacturing plant, as on BDD.
(Note: Similar operating/design conditions& driver rating would mean approx. 80% or higher; Pumping liquid and material of construction would mean references in the same model series, are also acceptable.)

1B.2 The vendor shall complete the Experience Record Proforma enclosed with the inquiry document to amply prove that the offered pump model meets the above criteria by furnishing details of similar operating/design conditions {flow, head, operating/design pressures & temperatures, viscosity, speeds, efficiencies, driver rating, no. of stages, bearing span/column length etc.}, Rotor Dynamics {Impeller Arrangement, No. of Impellers, Bearing Span, Speeds etc.}, Mechanical Design {Bearing Type & Lubrication, MAWP etc.}, pumping liquid & material of construction etc. as applicable in the format.

Past Test Curves shall also be submitted (when requested) to justify the quoted efficiencies. Multiple references may be furnished to justify the above.
In addition, manufacturer's catalogue and general reference list for "Centrifugal Pumps-Special Purpose Process Service" shall also be furnished along with the proposal.

**1 Scope**

Paragraph 1 of **API Standard 610 - Centrifugal Pumps for Petroleum, Petrochemical and Natural gas industries, Twelfth Edition, January 2021** stands modified as per para 1, para 1A and para 1B above.

**3 Terms and Definitions**

**3.1.21 Maximum Allowable Working Pressure** (Addition)

MAWP shall not be less than maximum discharge pressure calculated as per 3.1.23 below and must satisfy the pressure and temperature parameters consistent with the discharge flange rating upto 600#.
For higher pressure rating pumps (900# and above), MAWP shall not be less than downstream design conditions as a minimum.

**3.1.23 Maximum Discharge Pressure** (Modification)

- Replace 'relative density' by 'maximum specified relative density at any specified operating condition' (including start-up/commissioning with water, if specified).
- Highest Pressure shall include all test tolerances for shut off head.

**3.1.64 Supplier / Vendor** (Substitution)

Unless otherwise specified, **Supplier / Vendor** shall be the manufacturer of centrifugal pumps (special purpose), as per API 610, having adequate design, engineering, manufacturing, packaging and testing facilities and shall have supplied similar centrifugal pumps (special purpose) package as a single point responsibility vendor. The vendor shall also be the manufacturer of the proposed centrifugal pumps (special purpose).

**4 General**

**4.1 Unit Responsibility** (Substitution)

Vendor shall have UNIT RESPONSIBILITY of complete centrifugal pump package & shall be responsible for complete design, engineering, manufacturing, packaging, testing, supply & supervision of erection & commissioning of total package as per specification requirements. Vendor's scope shall include but not limited to the responsibility for execution, coordination of all technical aspects of equipment and its auxiliary systems, their selection & integration into a complete package constituting total order. All drawings/documents, including sub vendor's drawings, pertaining to the order shall be duly reviewed &approved by the vendor before onward submission.

4.2.2 Unless otherwise specified OH1, OH4, OH5, BB4, VS3, VS5 & VS7 type pumps are not acceptable.

## 5 Requirements

**5.1 Units** (Modification)
Unless otherwise specified, MKS system of units shall be used.

**5.3 Hierarchy of Requirements** (Substitution)
In case of conflict between this specification and the attendant data sheets, job specifications (if any) and other attached specification the following order of precedence shall govern:

1. Process Data Sheet / P&IDs / Process Package
2. Mechanical Data Sheets.
3. Job Specifications/scope of work (if any)
4. This specification
5. Other standards & specifications
6. Other referred codes and standards

The editions of referenced publication that are in effect at the time of inquiry or at a date specified in the inquiry documents shall be applicable.

In case of any ambiguity in the above documents, the vendor/supplier shall seek clarification from the owner/purchaser and the decision of the owner/purchaser shall be final and binding.

## 6 Basic Design

### 6.1 General

6.1.4 (Addition)
Unless otherwise specified, pump minimum continuous flow (MCF) shall be less than or equal to process normal flow for cases wherein addition of MCF to process flow is not specified in process data sheet. Pumps having MCF greater than Process Normal Flow are not acceptable.

6.1.5 (Modification)
The words "different hydraulic design, variable speed capability" stands deleted.

6.1.9 (Addition)
Unless otherwise specified, pumps where difference between NPSHA and NPSHR/NPSH3 from quoted minimum flow to rated flow is less than 0.6 meter are not acceptable. The said NPSHR/NPSH3 value shall correspond to the maximum value of NPSHR/NPSH3 from rated flow down to the recommended minimum continuous stable flow specified by the vendor. Additionally, in case of parallel operation and/or auto start against open discharge valve condition, NPSHR/NPSH3 upto 120% of best efficiency point shall not exceed specified NPSHA.

Pumps (except for OH6 type pumps) fitted with inducers/coke crusher for reducing NPSHR/NPSH3 is not acceptable.
Note: Actual datum for NPSHA (i.e. grade level, top of foundation level or any other level as defined in enquiry) shall be referred from the data sheets forming part of enquiry document.

6.1.14 (Substitution)
Unless otherwise specified, discharge orifice shall not be used to achieve required head rise to shut off, even in case of parallel operation.

For discharge nozzle size less than 2-inch, reduced bore design, if used, shall be clearly highlighted in the proposal (pump datasheet/performance curve) and may be considered with prior experience of hydraulics.

6.1.15 (Substitution)
Pumps shall have stable head/flow-rate curves (continuous head rise from rated to shutoff) for all applications (except for pumps permitted as per Cl. 8.3.3.4.2 of API 610 wherein continuous head rise from rated to MCF is required).

If parallel operation is specified, the head rise from rated point to shutoff shall be at least 10%.

For all other pumps, minimum 5% head rise from rated to shut-off shall be provided in order to ensure stable pump operation.

6.1.16 (Substitution)
Pumps shall have preferred operating region of 70% to 120% of best efficiency flow-rate of the pump as furnished. Rated flow shall be within 70% to 110% of best efficiency flow-rate of the rated impeller except for low flow pumps ($\leq$ 20 m3/hr) or pump rated BKW upto 15 kW. The "end of the curve flow" is defined as 120% of the BEP flow. Vendor shall indicate "Preferred Operating Range" and "Allowable Operating Range" on the characteristic curve.

6.1.19 (Substitution)
The NOTE at end of Cl. 6.1.19 is substituted with the following clause:
Unless otherwise specified, the maximum permissible sound pressure level of the complete equipment (pump + driver) train including all ancillaries & auxiliaries shall not exceed 85 dBA measured at 1 meter from equipment surface in any direction for the recommended range of operation at site.

6.1.22 (Modification)
Unless otherwise specified, vendor shall offer their standard cooling plan (as per API Annex B) guaranteeing safe and satisfactory operation of the pump package.

The need for cooling shall be determined by the vendor, and the method shall be agreed upon by the purchaser. However water cooling shall be provided to bearing housing for all pumps with fluid temperature greater than 250°C operating in ISBL areas.

6.1.27 (Modification)
Unless otherwise specified, water cooling systems (jackets, heat exchangers and so forth) shall be designed for the following conditions on the water side:

| | | |
|---|---|---|
| Velocity over heat exchanger surface | : | 1.5 - 2.5 m/sec. |
| Maximum Allowable Working Pressure (MAWP) | : | $\geq$ 8.0 kg/cm$^2$g |
| Test Pressure | : | = 1.5 x MAWP |
| Maximum Pressure Drop | : | 0.7 kg/cm$^2$ |
| Maximum Inlet Temperature | : | 33°C |
| Maximum Outlet Temperature | : | 45°C |
| Maximum Temperature Rise | : | 12°C |
| Minimum Temperature Rise | : | 6°C |
| Fouling Factor on Water Side | : | 0.0004 m$^2$ hr°C/kcal |
| Shell Side Corrosion allowance (not for tubes) | : | 3.2 mm |

Note: TSV set pressure (in CW isolatable circuits) shall not exceed the design pressure of purchaser's CW header.

6.1.36 (Addition)
Unless otherwise specified, equipment shall be designed to be suitable for outdoor installation without a roof.

6.1.42 (New)
For balancing axial thrust in multi-stage pumps, only the following arrangements shall be used:
- Opposed arrangements of impellers.
- A balancing piston

6.1.43 (New)
Unless otherwise specified, for rated flows exceeding 1000 $m^3$/hr or with differential head above 200 m, only "Between Bearing Type" pump shall be supplied. For offsites/OSBL, pumps falling in this range shall be selected with Side Suction/Top Discharge or Side Suction/Side Discharge nozzle orientation.

6.1.44 (New)
Unless otherwise specified, electric motor driven pumps shall be directly driven.

6.1.45 (New)
Single and two-stage pumps operating at temperatures less than 150°C and multi-stage pumps operating at temperatures less than 120°C shall be suitable for instantaneous start-up from ambient to full operating temperature without any warm-up.
For operating temperatures higher than the above, unless otherwise specified, the pump vendor shall provide casing warm-up arrangement with suitable hardware (i.e. flanged piping, valves, orifice & fittings as applicable) within pump skid battery limits.
Warm up flow shall be added to the rated flow for pump/driver sizing and selection and the same shall be reflected on data sheet and performance curves. Flanged warm-up connection shall be provided at the skid edge for the further interfacing by purchaser.
Casing warm up schematic shall be provided by pump vendor.
As part of the operating manual, an appropriate start-up procedure shall be provided by pump vendor.
Required sensing/monitoring equipment (i.e. skin thermo-couples, temperature transmitters etc.) to ensure that the pump, including seal(s), does not incur damage due to rapid heat up, shall be supplied by pump vendor.

**6.2 Pump Types** (Modification)
Unless otherwise specified, pump types as listed in Table 3 shall not be offered.

**6.3 Pressure Casings**

6.3.1 (Substitution)
The maximum discharge pressure shall be the maximum suction pressure plus the maximum differential pressure including all test tolerances, the pump is able to develop, when operating with the furnished impeller at the rated speed (MCS for pumps equipped with variable speed drivers) and specified maximum relative density at any specified operating condition' (including start-up/commissioning with water at normal suction pressure, if specified).

6.3.3 (Modification)
The 'NOTE' stands modified as under:
Vendor to note that the criteria specified in a) above shall also be used for design of purchaser's associated piping system.

6.3.6 (Modification)
MAWP shall be calculated as per 3.1.21 defined in this specification.

6.3.8 (Modification)
Unless otherwise specified, regions of VS6, OH6, BB3 & BB5 that are subjected only to suction pressure shall be designed for the same MAWP as that of discharge section.

6.3.13 (Modification)
The second line "Gaskets other than spiral-wound may be proposed and furnished, if proven suitable for service and approved by the purchaser" stands deleted.

6.3.14 (Modification)
The words "except as allowed in 9.2.1.2" stand deleted.

**6.4 Nozzles and pressure casing connections**

6.4.3 **Auxiliary connections**

6.4.3.1 (Addition)
All drain and vent connections shall be terminated at the skid edge along with instructions that the same are to be further connected to either an open drain or a closed drain.

6.4.3.11 (New)
For horizontal multistage pumps, In case, Balance-leak-off (BLO) line is connected to suction source (piping / vessel) of the pump, the balance line shall be provided with pressure gauge, orifice & pressure relief valve upto vendors battery limit. Vendor shall ensure that BLO flow has already been considered in pump & driver sizing and the rated capacity is available from pump discharge. Screwed connections are not allowed. Balance leak off line shall be designed for the pump casing MAWP.

**6.5 External Nozzle Forces and Moments**

6.5.1 (Modification):
The pump's pressure casing and their base-plates shall be suitable to withstand twice the forces and moments in Table 5 applied simultaneously to the pump through each nozzle, plus internal pressure, without distortion that would impair operation of the pump or seal.
Note:
1. Vendor to note that the above criteria shall be used for design of purchaser's associated piping system.
2. Annex F of API 610 may be utilised for pumps with Automatic Recirculation Valve (ARV) mounted on the pump discharge nozzle.

**6.7 Wear Rings and Running Clearances**

6.7.3 (Modification)
Tack welding shall not be employed for fitting of the metallic wear rings.

6.7.4 (Addition)
In order to ensure close clearances between impeller wear ring and casing wear ring and to achieve improved efficiency, following Non-Metallic wear rings shall be used for all clean applications within the design temperature limitations as per Table H-3:
a) Polyether Ether Ketone (PEEK) Continuous –Carbon-Fibre wound
b) PFA/CF Carbon-fiber Filled 20% mass fraction random X-Y oriented carbon-fibre
Offered Non-metallic wear ring material shall be field proven and certified compatible with the specified process liquid. A letter from the wear ring material manufacturer shall be furnished in the bid certifying compatibility of offered wear ring material with the process liquid and operating and design conditions.

6.7.5d) (New)
The maximum permissible running clearances shall not be less than twice the new running clearances.
Note: While selecting the running clearances, galling tendency of the offered wear rings shall be taken into consideration.

**6.8 Mechanical Shaft Seals**

6.8.1 (Addition)
For the applicable flushing plans, the vendor shall also include in his scope of supply, all items shown as optional items in Annex-G of API 682 4th edition (Standard Flush Plan and auxiliary Hardware) along with other additional specified/ required items, if any.

**6.9 Dynamics**

6.9.2 TORSIONAL ANALYSIS

6.9.2.9 (Modification)
Replace the words 'If specified' by 'If torsional analysis is performed'.

**6.10 Bearings and Bearing Housings**

6.10.2 BEARING HOUSINGS

6.10.2.9 (Modification)
Bearing housings shall be equipped with suitable replaceable noncontact type bearing isolators where shaft passes through the housing.

6.10.2.13 (Substitution)
All multistage pumps without forced feed lubrication system and driver rating >=160 Kw shall be provided with accelerometer based transducers in X&Y directions.

6.10.2.14 (Substitution)
A flat surface at least 25 mm in diameter shall be supplied for the location of magnetic based vibration measuring equipment, whether or not vibration measuring equipment is included in the vendor's scope of supply. Pumps shall also have provision for mounting accelerometers (X & Y) on each bearing housing.

6.10.2.16 (New)
Bearing housing shall be equipped with magnetic drain plug except for multistage pumps where vendor's standard design may not permit this.

**6.11 Lubrication**

6.11.3 (Substitution)
Provision shall be made for pure/purge oil mist lubrication as specified.

**6.12 Materials.**

6.12.1.8 (Modification)
The words 'if specified' stand deleted.

6.12.1.13 (Modification)
Where even trace quantities of wet H2S are indicated to be present, reduced hardness materials in accordance with NACE MR0175/MR0103 shall be provided by the vendor.

6.12.2.5 (Modification)
The words 'if specified' stand deleted.
The second sentence also stands deleted.

6.12.3.4.1 (Modification)
Requirements of additional examination shall be as specified vide clause 8.2.1.3 of this specification.

6.12.4.3 (Modification)
ASME Sec VIII, Div 1 shall apply with regard to impact testing requirements.

## 7 Accessories

### 7.1 Drivers

7.1.5 (Substitution)
Electric motor drivers shall have a maximum continuous rating (MCR) (i.e. service factor equal to 1) not lower than the following unless higher rating is dictated by the Note 1 and / or Note 2:

| **Pump Rated BKW*** | | **Motor MCR (% of Pump Rated BKW)** |
|---|---|---|
| Up-to 22 kW | : | To suit maximum BKW indicated on pump data sheet or 125% of rated pump BKW, whichever is higher. |
| 22 kW to 55 kW | : | 115% |
| Higher than 55 kW | : | 110% |

* including all mechanical & transmission losses & with 0% +ve tolerance.

The electric motor shall be suitable for the electrical area classification specified on the data sheet.

Note:

1. The motor nameplate rating for pumps under parallel operation or for pumps with auto-start operation shall not be less than the max. BKW indicated on pump data sheet (maximum power at any point on the pump performance curve from shutoff to end of the curve for the rated impeller) or shall have the specified margin as per this clause whichever is greater. The pump motors shall also be suitable for start-up under open discharge valve condition.
2. The motor nameplate rating for applications where the specific gravity of pumped fluid is less than 1.0 shall either be 100% of the BKW of pump at minimum continuous stable flow with clean cold water of sp. gravity 1.0 or shall have the specified margin as per this clause, whichever is greater.

7.1.10 (Modification)
Unless otherwise specified, steam turbine drivers shall be sized to deliver continuously 110% of pump rated power at minimum inlet and maximum exhaust steam conditions.

The steam turbine rating (with minimum inlet and maximum exhaust steam conditions) for pumps under parallel operation or for pumps with auto-start operation shall not be less than the max. BKW indicated on pump data sheet (maximum power at any point on the pump performance curve from shutoff to end of the curve for the rated impeller). The turbine shall also be suitable for start-up under open discharge valve condition.

In any case, Turbine Rating shall be at least equal to the Motor Rating of the standby pump.

### 7.2 Couplings and Guards

7.2.2(g) (Substitution)
Couplings shall be balanced to ISO 21940-11, grade G2.5.

7.2.3 (Addition)
The coupling service factor shall not be less than 1.5 over the driver rating. However, during selection of coupling, vendor to ensure that the maximum service factor (actual SF) for the coupling shall not exceed the allowable stresses of the drive train. Further, for the pumps equipped with gear box, max service factor for coupling shall not exceed the gear box service factor.

7.2.4 (Substitution)

Unless otherwise specified, all couplings required for multistage pump package(s) (greater than two stages) shall conform to API standard 671 where either the driver rating is greater than 160 kW or the maximum continuous speed is greater than 3000 rpm.
However in case of gear box driven multistage pump units, both low speed and high speed couplings shall conform to API standard 671 if any of the above criteria of speed or power is satisfied.

**7.3 Guards**

7.3.2a) (Addition)
Coupling guard shall be open at the bottom to permit manual shaft rotation.

7.3.2d) (Modification)
Coupling guard shall be fabricated from non-sparking material.

**7.4 Base Plates**

7.4.1 (Addition)
Pumps in corrosive service shall have provision to collect and drain the leakage from mechanical seal or packing, through a drip pan of metallurgy equivalent or superior to pump casing. Leakages from drip pan shall be piped to base-plate with a flanged connection for onward disposal by purchaser. Where the design of bearing prohibits provision of drip pan, the material of bearing bracket shall be suitable for the corrosive service. Base plates shall have jacking provision for aligning the prime movers & shall be provided with 2" 150# flanged connection.

7.4.6 (Deletion)
This clause shall stand deleted.

7.4.8 (Modification)
Replace "if specified" by "For all multistage pumps".

7.4.22 (Modification)
The pump manufacturer shall furnish the anchor bolts.

7.4.24 (Modification)
All pumps offered shall have been tested for nozzle load test (either by physical testing or by computer simulation study using finite element analysis) in the past for twice the API loads meeting shaft deflection criteria as per Table-13 for baseplate intended for grouting limits and shall be demonstrated through the past test reports for the offered model. Categorical compliance to the above is mandatory and report may be furnished on demand.

In case pipe load test has not been conducted in the past, the vendor shall demonstrate the pipe load test with the above defined loads & shaft deflection as per Table-13 (either by physical testing at their manufacturing shop or by computer simulation study using finite element analysis) for the proposed pump model(s). Unless otherwise specified, this is not a witness test and only report is required.

7.4.25 (New)
Skid layout of pump trains along-with their auxiliary systems (i.e. seal flushing plans) shall be designed in a manner so as to ensure that there is enough space within the skid for maintenance and operation. Special care shall be taken for pumps provided with seal flushing plans 23, 52, 53, 75, etc., so that couplings and seals can be attended for maintenance without disturbing any seal piping/cables/other items located on the skid. As far as possible, area on motor terminal box and coupling side shall be left clear of all piping and accessories for ease of maintenance.

**7.5 Instrumentation**

7.5.2.2 (Modification)
The words 'if specified' stand deleted. The vendor shall supply the detectors.

7.5.2.5 (Modification)
The words 'if specified' stand deleted.

7.5.2.6 (Modification)
The words 'if specified' stand deleted.

7.5.2.8 (New)
Horizontal multistage pumps intended for pumping temperature above 120°C shall be provided with pump casing skin temperature monitoring system consisting of the following:
- Four thermocouples for number of stages ≥ 4& minimum two thermocouples for number of stages < 4, along-with yoke mounted temperature transmitters with integral indicator for each thermocouple.
- One Junction Box (JB) to be mounted on the pump base-plate.
- Cables between the thermocouples and transmitters.
- Cables between transmitters and junction box.

For multistage pumps in pipeline applications, where MCF recirculation line is generally not provided, casing skin temperature monitoring as defined above shall be provided irrespective of the pumping temperature.

**7.6 Piping and Appurtenances**

**7.6.1 General**

7.6.1.6 (Modification)
The words 'if specified' stand deleted.

7.6.1.7 (Modification)
Flange fasteners on stainless steel piping systems shall be of stainless steel.

**7.6.2 Auxiliary Process Fluid Piping**

7.6.2.3 (Modification)
Auxiliary process fluid piping material shall be SS-316 as a minimum.

7.6.2.6 (Substitution)
Casing shall be provided with drain connection with nipple, threaded and seal welded or manufacturer's standard and provided with a socket welded gate valve terminated at edge of the base plate. Gate valve shall be of minimum 800# rating with material of construction (MOC) equal or superior to the pump casing. For multistage pumps with more than one drain point, block valves at each drain point shall be provided and the piping shall be terminated at edge of the base plate with a flange. Unless made self-venting design, vent connections shall also be provided with a nipple, threaded and seal welded and terminated with a gate valve. Pressure gauge connection shall not be provided unless specifically required in the inquiry. Nipples shall meet the requirements of 6.4.3.4.

7.6.2.8 (Modification)
Flanges are required instead of socket welded unions for all auxiliary process fluid piping.

7.6.2.11 (New)
Unless otherwise specified, material for seal flushing liquid cooler shall be as under:
Tube or Coil : Type 316 stainless steel or Monel.
Casing (or Shell) : Carbon Steel.
Cooling water shall be on the casing (Shell) side.

**7.6.3 Cooling Water Piping**

7.6.3.4 (New)
Sight flow indicator shall have ball or flag for easy verification of water flowing through pipes.

7.6.3.5 (New)
Thermal relief valve (in each isolatable cooling water circuit) shall be provided upstream of globe valve on the cooling water outlet line. Set pressure of thermal relief valve shall be equal to the design pressure of cooling water piping system.

**8 Inspection, Testing and Preparation for Shipment**

**8.1 General**

8.1.7 (New)
Prior to start of test, manufacturer shall furnish the certificate of latest calibration / re-calibration of driver and measuring instruments for review by purchaser's inspection agency. Unless electrical or mechanical failure occurs, driver used for shop testing need not be recalibrated and original calibration certificate shall remain valid.
Duration of recalibration for all measuring instruments shall be as per the recommendations of HI Standards.

**8.2 Inspection**

8.2.1 GENERAL

8.2.1.3 (Substitution)
The minimum inspection requirements for pressure containing casing shall be as per the following:

| Inspection category | Inspection requirement | Remarks |
|---|---|---|
| CATEGORY A | Visual inspection and Magnetic Particle or Liquid Penetrant inspection of following components as a minimum:<br>- Nozzle weld<br>- Butt welds on pressure containing components<br>- Fillet welds on pressure containing components.<br>- Shaft<br>Radiographic or ultrasonic inspection of the following as a minimum:<br>- Nozzle weld<br>- Butt welds on pressure containing components. | C1. Liquid penetrant inspection shall be performed only when specified magnetic particle inspection is not feasible.<br><br>C2. Magnetic particle or liquid Penetrant inspection shall be carried out in accordance with Table 14.<br><br>C3. Ultrasonic inspection shall be carried out when radiography is not feasible. Radiography or ultrasonic inspection shall be carried out in accordance with Table 14. |
| CATEGORY B | Visual inspection and Magnetic Particle or Liquid Penetrant | B1. Liquid penetrant inspection shall be performed only when |

| Inspection category | Inspection requirement | Remarks |
|---|---|---|
| | inspection of following components as a minimum:<br>- Nozzle weld<br>- Butt welds on pressure containing components<br>- Fillet welds on pressure containing components.<br>- Shaft | specified magnetic particle inspection is not feasible.<br><br>B2. Magnetic particle or liquid penetrant inspection shall be carried out in accordance with Table 14. |
| CATEGORY C | As per vendor's standard Quality Assurance Plan | |

**Note:**
**Category A**:
This category is applicable for services with process design pressure above 70 kg/cm²g or process design temperature below -29°C or above 300°C.

**Category B**:
This category is applicable for services within the design pressure and temperature range other than covered under category A above and category C below.

**Category C**:
This category is applicable for carbon steel and cast iron for services with process design pressure up to 40 kg/cm²g and design temperature from 0 to 150°C.

8.2.1.5 (New)

Inspection shall also include dimensional check of pump, driver and auxiliaries (if any) duly mounted on the base plate, in accordance with certified general assembly drawing. This will include all main pump dimensions, base plate dimensions, location of foundation bolt holes, size/position/rating of flanges, coupling guard arrangement, verification of the required material certificates and their trace-ability to the respective components. In addition, following checks shall also be carried out:

- A measurement of the actual running clearances throughout the pump.
- A check for the hardness of wear rings.
- A check of discharge nozzle bore size
- A check for good workmanship and finish throughout.

8.2.1.6 **Inspection & Testing requirements:** (New)

A. Pump-Centrifugal Horizontal (SPP) / Pump-Centrifugal Vertical (SPP) / Pump-Centrifugal Canned Motor / Pump-Centrifugal Submerged Motor (Cryogenic) / High Speed Integrally Geared Centrifugal Pumps:

| Sno. | Inspection & Tests | Scope of Inspection (Note-1) |
|---|---|---|
| 1 | Shop Test / Inspection | R |
| 2 | Material Certificates | R |
| 3 | Hydrostatic test | R |
| 4 | Performance Test / Sound level Test | W |
| 5 | NPSH Test as required (as per specification) / Minimum Submergence Test (for Vertical pumps) | W |
| 6 | Dismantle Inspection & Re-assembly after test | W (Note-2) |
| 7 | Unitization / Check of direction of rotation of pump | O (but not required for PMC jobs; to be governed by contractor's quality plan) |
| 8 | Visual, dimension and skid completeness check | W (Conventional jobs)<br>R (PMC jobs) |

B. Pump-Centrifugal Horizontal Multistage (SPP) / Pump-Centrifugal (BFW)

| Sno. | Inspection & Tests | Scope of Inspection (Note-1) |
|---|---|---|
| 1 | Shop Test / Inspection | R |
| 2 | Material Certificates | R |
| 3 | Hydrostatic test | W |
| 4 | Rotor Dynamic Balancing (Both Main & Spare Rotor) | O |
| 5 | Performance Test / Sound level Test | W |
| 6 | NPSH Test as required (as per specification) | W |
| 7 | Dismantle Inspection & Re-assembly after test | W |
| 8 | Unitization / Check of direction of rotation of pump | O (but not required for PMC jobs; to be governed by contractor's quality plan) |
| 9 | Visual, dimension and skid completeness check | W (Conventional jobs)<br>R (PMC jobs) |
| 10 | Complete Unit Test | W (Note-3) |

Legends:

R: Required: Reviewing of manufacturer's shop test reports shall be considered as adequate.
O: Observed: Purchaser shall be notified but work may proceed after scheduled date.
W: Witnessed: A HOLD shall be applied and work shall not proceed without approval.

Notes:

1. The inspection & test requirements specified are applicable for each pump unless otherwise specified.
2. Dismantle Inspection of pump after performance test shall be applicable only in case of abnormality in mechanical behavior (such as excessive noise & vibration, bearing temperature rise etc.) during performance test.
3. All the pumps (except for steam turbine drive pump) with forced feed lubrication system shall undergo complete unit test at rated speed. Job drive, job mechanical seal & job coupling shall be used (with motor getting loaded only upto its full load current value). Shop LO system, Shop machine monitoring instrumentation & controls & shop sealing system can be utilized for this test.

**8.2.2 Pressure Casing and Process Piping Materials Inspection**

8.2.2.6 (Modification)
The words "if specified" stand deleted.

8.2.2.7 (Modification)
The words "if specified" stand deleted.

**8.3 Testing**

8.3.1 GENERAL

8.3.1.1 (Modification)
The words 'if specified' stand substituted with 'Unless otherwise specified'

8.3.1.2 (Modification)
Table 16 stands modified as under:
Rated Head : Zero negative tolerance @ rated flow rate & rated speed
Shut-off Head : Following criteria shall apply:
a) Positive tolerance permitted as long as maximum shutoff pressure corresponding to shut-off head (as observed during the shop performance test) and the maximum suction pressure (as specified on

pump data sheet), does not exceed the downstream design pressure (as specified on pump data sheet).
b) Negative tolerance (as per Table-16) may be permitted only if test curve still shows continuously rising characteristics & shutoff head is minimum 110% of rated head for pumps in parallel operation and minimum 105% of rated head for pumps not in parallel operation.
[Note: Generally, shutoff head should be limited within 120% of rated head.]

NPSHR : Zero positive tolerance.

Rated BKW : Zero positive tolerance. (However, pumps may be accepted upto 104% of guaranteed BKW subject to Penalties as defined elsewhere.

8.3.1.4 (New)
Unless otherwise specified the following tests shall be witnessed by the Purchaser or by their authorised representative or by both together.

1. Hydrostatic test as per 8.3.2 for Multistage Pumps.
2. Performance test as per 8.3.3.
3. NPSHR test as per 8.3.4.3 when specified in the material requisition or when the difference between NPSHA and NPSH3/NPSHR is less or equal to one (1) meter.
4. Unitization of Pump with Job Driver at shop.
5. Dismantling inspection and reassembly, after the running test
6. Dynamic balancing of Complete Rotor in case of Multistage Pumps
7. Sound level test.

Test Certificates for Hydrostatic Test & Dynamic Balancing of Impeller(s) will suffice for single & two stage pumps. These test certificates shall be furnished to purchaser's inspector for review prior to performance testing.

**8.3.3 Performance Test**

8.3.3.6.3 (Modification)
During the performance test, rise in temperature of bearing oil shall be measured and results recorded on the test log. If specified, pumps provided with oil mist lubrication (Purge/Pure) shall be tested with shop oil mist system & suitable performance at vendor's shop shall be demonstrated.

8.3.3.8.2 (Modification)
The words 'if specified' stand deleted.

8.3.3.10 (New)
Shop driver shall be used for testing and the rating of the driver shall not exceed 150% of power that may be consumed while running at duty point with water; or power at full valve open condition, whichever is higher. The limitation of 150% is applicable only for medium voltage motors.

8.3.4 **Optional Tests**

8.3.4.2 **Mechanical Run Test**

8.3.4.2.2 (Modification)
The words 'if specified' stand deleted.

8.3.4.3 **NPSH Required Test**

8.3.4.3.1 (Addition)
If NPSH Required test is specified or if it is required to be done as per para 8.3.1.4, NPSHR shall be determined at each test point defined in 8.3.3.4 except shut-off and in-case of parallel operation additionally at 120% of BEP.

8.3.4.5 **Sound Level Test** (Modification)
The words "if specified" stand deleted.

During the performance test, the equipment shall be checked for its sound level at minimum flow, at rated flow, at flow at best efficiency point and at 120% BEP flow.

The maximum allowable value shall not exceed the value specified under clause 6.1.14 or as specified in the datasheet, whichever is lower, when measured at one (1) meter from pump surface.

Where complete unit test is specified, vendor is required to demonstrate the noise levels within the maximum permissible sound level for the complete unit.

Recorded sound levels during shop test shall be taken for reference only & not for final acceptance or rejection. However sound level as specified in the inquiry document shall be guaranteed at site.

8.3.4.6 **Auxiliary Equipment Test** (Modification)
The words "if specified" stand deleted.

**8.4 Preparation for Shipment**

8.4.2 (Modification)
Unless otherwise specified, the equipment shall be protected for an outdoor storage of 12 months at site. If any extra precaution is to be taken by the Purchaser for storage beyond 12 months the same shall be explicitly indicated in the operation and maintenance manuals.

8.4.7 (Substitution)
Two copies of the manufacturer's job specific installation manual shall be packed and shipped with the equipment.

**9 Specific Pump Types**

**9.1 Single Stage Overhung Pump**

9.1.1 (Addition)
Unless otherwise specified, overhung pumps for rated flow exceeding 1000 $m^3$/hr or differential head above 200 m are not acceptable.

9.1.1.3 (Substitution)
The shaft flexibility index shall be calculated in accordance with K.2 and shall be indicated by the pump vendor in his proposal / technical data sheet. The value of shaft flexibility index for overhung pumps, $I_{SF}$, for the given pump size factor, $K_t$ shall not exceed 1.2 times the equation K.4 (SI units) or K.5 (US units).

9.1.3 **Integral Gear Driven (Type OH6) Pumps**

9.1.3.5 (Modification)
Diameter of gauges shall be 100mm (4 in.) as a minimum.

**9.2 Between Bearing Pumps (Types BB1, BB2, BB3 and BB5)**

9.2.1.2 (Substitution)
Pumps for all services shall be centreline mounted irrespective of pumping temperature.

9.2.2.3 (Modification)
The words 'if specified' stand deleted.

9.2.2.5 (New)
Unless otherwise specified, Maximum number of stages shall not exceed 12 for horizontal pumps subject to meeting PTR with respect to Bearing Span & Speed and similar service.
Unless otherwise specified, Maximum number of stages shall not exceed 15 for vertical pumps subject to meeting PTR with respect to Bearing Span & Speed and similar service.

**9.2.4 Dynamics**

9.2.4.1.1 Table 18-Decision logic for rotor lateral analysis (Modification)
The words 'similar or' stand deleted from step-2.

**9.2.6 Lubrication**

9.2.6.5 (New)
In case a pressure lubrication system is required and is supplied with shaft-driven main oil pumps (MOP), the MOP shall be suitable for safe coast down of the complete equipment train without necessitating the requirement of overhead rundown tank.

In case MOP is not suitable for safe shutdown of the complete equipment train, the vendor in his offer may propose for purchaser's consideration any special arrangement/provision provided for equipment safety and protection when the equipment decelerates. Provision shall be adequate for coast down time and cool-off time as applicable.

Due to space constraints, mechanical seals for lube oil pump can be as per API 610 / API 676.

9.2.6.6 (New)
External pressure-lubrication systems shall comply with the following additional requirements:

- Pumps, filters, strainers, coolers, traps, valves and all other components that retain oil under pressure and are external to the reservoir shall be made of steel.
- Except in case of shaft driven pumps, if a positive displacement type of oil pump is supplied, a separate relief valve (not integral with the pump) shall be provided. The relief valve shall not be used for pressure regulation. Horizontal oil pumps shall not be installed on top of the oil reservoir.
- A removable tube bundle design is required for shell and tube coolers with more than 0.5 $m^2$.
- The oil side operating pressure of the oil cooler shall be higher than the water-side operating pressure to prevent contamination of oil in case of cooler failure.
- Filters shall be equipped with a continuous flow transfer valves and an equalising line.
- Oil system shall have drain rim or pan to catch oil spills.
- Unless otherwise specified, heating element shall not be provided. However, if in the opinion of vendor such an arrangement is required (especially in view of the lowest ambient temperature prevailing at job site), the same shall be supplied by the pump manufacturer with specific approval of the purchaser.

**9.2.7 Testing**

9.2.7.4 (Modification)
The words 'if specified' stand deleted.

**9.2.8 Preparation for Shipment**

9.2.8.2 (Modification)
The words 'if specified' stand deleted.

9.2.8.3 (Modification)
The words 'if specified' stand deleted.

9.2.8.4 (Modification)
The words 'if specified' stand deleted.

**9.3 Vertically Suspended Pumps (types VS1 through VS7)**

9.3.1 **General**

9.3.1.1 (Modification)
Hydraulic performance shall also be corrected for friction head losses in the inlet strainer.

9.3.1.5 (New)
Unless otherwise specified, in case of tank-mounted pumps, the setting depth shall be so arrived that the pump minimum submergence is ensured within the boot of the vessel, i.e. minimum liquid level shall be considered to correspond to bottom of the tank level for ensuring complete evacuation of the tank.

9.3.1.6 (New)
All vertically suspended pumps shall be with shaft segment length not exceeding 750mm.

9.3.2 **Pressure Casings**

9.3.2.11 (New)
Bowls and columns shall be flanged and bolted.

9.3.3 **Rotors**

9.3.3.2 (Addition)
Multi-piece vertical pump line shaft shall not be joined by threaded couplings.

9.3.6 **Bushings and Bearings**

9.3.6.1 (Addition)
Unless otherwise specified, for vertical pumps, material of guide bushing shall be suitable for dry running during start-up / transient conditions as well as running on lubrication by pumping fluid/external source.
These bushing shall be non-metallic [material as per table H.3 (only PEEK continuous-carbon-fiber wound or PFA/CF carbon-fiber filled) suitably selected for service. These bearings after start up shall be lubricated by the pumped fluid or external fluid. A letter from the bush bearing material manufacturer shall be furnished with the bid certifying compatibility of offered line shaft bearing material with the process liquid and operating and design conditions.

9.3.6.2 (Modification)
Pump thrust shall not be transferred to driver motor. Vertical pumps shall be provided with their own thrust bearing to carry rotor weight and pump generated axial forces.
Thrust bearing shall be positively locked on the pump shaft (shouldered shaft) and the bearing housing.

9.3.8 **Accessories**

9.3.8.1.1 Drivers (Modification)
For vertical pumps, not provided with non-reverse ratchet, vendor shall describe the precaution taken, to prevent damage due to reverse rotation.

9.3.8.3 **Mounting Plates**

9.3.8.3.1 (Modification)
The words 'if specified' stand deleted.

9.3.8.3.2 (Modification)
The words 'if specified' stand substituted with 'unless otherwise specified'.

9.3.10 **Single Case Diffuser (VS1) And Volute (VS2) Pumps**

9.3.10.4 (Modification)
The words 'if specified' stand deleted.

9.3.13 **Double Casing Diffuser (VS6) And Volute (VS7) Pumps**

9.3.13.1 (Modification)
The words 'if specified' stand deleted.

9.3.13.4 (Modification)
The words 'if specified' stand deleted.

**10 Vendor's Data**
Refer Annexure-L

## Annex-C: Hydraulic power recovery turbines

### C.1 General

### C.1.1 EXPERIENCE CRITERIA

C.1.1.1 The HPRT model offered shall be from the existing HPRT model series and shall be from the regular manufacturing range of the vendor (Prototypes are not acceptable).

The mechanical design as well as the hydraulic performance for the complete range of operation of the offered model shall have been established in the shop test. (Details to be furnished, if required).

The offered HPRT model shall be field proven (at least ONE unit) with minimum operating experience of one year for similar operating/design conditions & power generated, rotor dynamics, mechanical design, pumping liquid and material of construction, supplied in the last Ten (10) years, from the proposed manufacturing plant, as on BDD.
(Note: Similar operating/design conditions & power generated would mean approx. 80% or higher. For pumping liquid and material of construction references in the same model series are also acceptable.)

C.1.1.2 The vendor shall complete the Experience Record Proforma enclosed with the inquiry document to amply prove that the offered HPRT model meets the above criteria by furnishing details of similar operating/design conditions {flow, head, operating/design pressures & temperatures, % vapour handled at discharge, speeds, efficiencies, power generated, no. of stages, bearing span etc.}, Rotor Dynamics {Impeller Arrangement, No. of Impellers, Bearing Span, Speeds etc.}, Mechanical Design {Bearing Type & Lubrication, MAWP etc}, pumping liquid & material of construction etc. as applicable in the format.

Past Test Curves of HPRT tested as HPRT shall also be submitted (when requested) to justify the quoted efficiencies.

Multiple references may be furnished to justify the above. Only pumps working as HPRT will be construed as valid reference.

In addition, manufacturer's catalogue and general reference list for "Centrifugal Pumps-Special Purpose Process Service working as HPRT" shall also be furnished along with the proposal.

### C.2 Terminology (Addition)

Unless otherwise specified, all the requirements for centrifugal pumps, specified herein this Standard Specification, shall be applicable for HPRT, as applicable. However, the word 'Centrifugal Pump' shall be read as 'HPRT'.

### C.3 Design

### C.3.1 Liquid Characteristics

C.3.1.2 (Addition)
Vendor shall estimate the vapour volumes expected at each stage of the HPRT and furnish a stage- wise profile of the vapour evolution. Vendor shall justify that the HPRT is capable of handling the expected vapour volumes with suitable references and supporting design documents.

**C.3.3 Overspeed Trip**

C.3.3.1 (Addition)
The Hydraulic Power Recovery Turbine (HPRT) shall be provided with a speed detector and a non- over latching over- speed trip contact (Mechanical/ Electronic through Speed Transmitters (2oo3 voting logic)) and an additional contact for pre- alarm. The over- speed trip contact will be incorporated into shutdown system by the Purchaser to close the inlet valve of the HPRT. Pump operation shall, however, be allowed without interruption.

The over speed trip setting for HPRT shall be verified at Manufacturer's test bed during Performance Testing. In case of any limitation at Vendor's Works, the same shall be demonstrated during Field Trial Run Test.

**C.3.4 Dual Drivers**

C.3.4.2 (Substitution)
Power availability from HPRT shall not be considered for the purpose of motor sizing as pumps are supposed to run even without HPRT and motor shall be sized for full load.

C.3.4.3 (Substitution)
The HPRT shall be equipped with an overrunning (one way i.e., a clutch that transmits torque in one direction and freewheels in the other) clutch- coupling for connection with the Electric Motor driving the Pump. The clutch coupling shall be designed for 1.7 times the maximum recoverable kW of the HPRT. Vendor shall propose clutch Manufacturer having suitable past supply references for similar power ratings and speed and same shall be subject to Purchaser's review and approval during Detailed Engineering Stage.

C.3.4.5 (Substitution)
Unless otherwise specified, the HPRT cum Electric Motor driven Pump trains shall consist of a double ended motor with pump on one side and an overrunning clutch with HPRT on the other side.

Train configuration with HPRT + PUMP + Single Ended Motor may be permitted only in case of axially split pump design.

Pump operation shall, however, be allowed without interruption, in case of HPRT outage.

**C.3.6 Throttle Valves** (Addition)
All the trips connected to the HPRT will only be configured to shutdown the inlet valve of the HPRT, thereby allowing the pump operation without interruption.

**C.3.9 Miscellaneous Technical Requirements** (New)

C.3.9.1 The rated speed of the Pump- HPRT Train shall not exceed 3000 rpm (synchronous). No gear box is normally envisaged.

C.3.9.2 Dual Pressure Rating (Suction/ Discharge) for HPRT is not acceptable

C.3.9.3 Impeller of HPRT shall also be positively locked against axial movement in the direction opposite to normal hydraulic thrust.

C.3.9.4 Maximum Allowable Working Pressure (MAWP) & Maximum Allowable Working Temperature (MAWT) of HPRT shall neither be less than the Upstream Design Pressure/ Maximum Suction Pressure (as the case may be) & Design Temperature, as specified in the respective Process Datasheets nor less than those specified in specifications, codes & standards.

The HPRT casing shall also be suitable for operation at maximum pressure available at HPRT minimum flow with Specific Gravity= 1.0 (i.e. water). This is required during Shop Performance test with water at Rated Speed.

**C.3.10** **Base plate** (New)

The Pump, Electric Motor and HPRT with Clutch assembly shall be mounted on a common base plate, to be erected at site at Grade. However, if found infeasible due to transportation constraints, the Pump and Electric Motor shall be mounted on one base plate and the HPRT with clutch assembly may be mounted on one separate base plate for ease of assembly at site. Vendor shall provide both the base plate sections with machined mating surfaces and all provisions for integrating (dowelling/ bolting etc.) and matching for accurate field reassembly and unitizing the two base plate sections to make one single common base plate under pump train at site. For this, horizontal and vertical jack screws shall be provided for ease in alignment. LO Console & SO Console may be mounted on separate base plates subject to Purchaser's approval.

**C.4** **Testing**

**C.4.1** **Performance Test** (Substitution)

a) Test Facilities, Arrangements & Procedures:

The vendor shall have the testing facility for testing HPRT as HPRT and not as a Centrifugal Pump to establish Guaranteed Power recovered from HPRT. A high pressure source (or another pump) shall be used to run the HPRT for Performance Test and power output from HPRT shall be measured at various points as per details below.

Vendor shall furnish the details of the proposed test arrangements and testing procedures to be followed on conducting the Performance Tests of HPRT and the Complete Unit Test (Mechanical Run), during detailed engineering stage. However, detailed test procedures for testing of HPRT shall be subject to Purchaser's review/ approval.

Note: Sample test procedures of test conducted in the past by the vendor should be furnished in proposal. Past supply references of jobs wherein proposed testing of HPRT is carried out as HPRT should also be furnished by the vendor, in the proposal.

b) Performance Test of Hydraulic Power Recovery Turbines (HPRTs):

Performance test of the HPRT at its full load and full speed with Job / Contract Mechanical Seals, shall be carried out at Manufacturer's shop either as separate performance test as HPRT or during complete pump-HPRT train complete unit test. HPRT shall be performance tested as HPRT and not as a pump.

The performance Test shall establish the guarantee power output and shall also fully establish the performance curves covering at least four (4) points. Dismantling inspection of all close clearance parts, bearings & seals, shall follow the performance test in case abnormality in mechanical behavior such as excessive noise, bearing temperature rise, etc. is encountered.

Note: Vendor shall provide brief technical proposal for the HPRT performance test along with the Bid.

Performance Test shall be followed by Mechanical Run Test for four (4) hours and Over-speed trip demonstration test.

**C.4.2** **Performance Tolerances** (Addition)

No negative tolerance on power for the specified operating conditions, as per Process/ Mechanical Datasheet is permitted.

C.4.5 **Complete Unit Test** (New)

Unless Otherwise specified/ agreed, Complete Unit Test (applicable for all the Pump- HPRT Trains) of the Pump, along with Job Coupling, Job Mechanical Seal, Job Electric Motor driver, Job HPRT and Job Probes (except Job Lube Oil System & Job Seal System), shall be performed for at least four (4) hours at Pump Manufacturer's Shop. Use of Shop Panel/ Monitoring System & Shop Strainers, is acceptable.

**Annex-L : Contract Documents and Engineering Design Data** (Informative)

L.1.1a) (Substitution)
The purchaser's/owner's/consultant's corporate name

L.2 **Proposals**

L.2.1 **General** (Substitution)
The vendor's proposal shall as a minimum include the following:
- All data sheets, drawings and documents specified under "WITH BID" Section in the Vendor Data Requirement Form.

Note: Clearance less than those required by 6.6.4 and Table 6, shall be stated as an exception to API 610.

L.2.4 **Curves**

a) (Modification)
This clause stands deleted.

**L.3 Engineering Design Data**

L.3.1 **General** (Substitution)

L.3.1.1 Engineering Design Drawings and data as required after purchase order has been specified in Vendor Data Requirement. Vendor to note that the drawing/document descriptions/titles as given in the Vendor Data Requirement are generic in nature. It is possible that against one drawing / document specified there are several drawings to be furnished by the vendor or vice versa.

L.3.1.2 All vendor data/drawings/documents shall be in English Language and in Metric Systems. All post order documents shall be submitted / approved through EIL VDM portal.

L.3.1.3 Final documentation shall be submitted in hard copy and soft (CDs/ DVDs) in addition to submission through EIL VDM portal. The number of prints and/or reproducible required to be submitted by vendor are specified in Purchaser's inquiry/order.

# निश्चित विस्थापन पम्प – प्रत्यागामी के लिए मानक विनिर्देश

# STANDARD SPECIFICATION FOR POSITIVE DISPLACEMENT PUMPS - RECIPROCATING

| Rev. No | Date | Purpose | Prepared | Checked | Standards Committee Convenor | Standards Bureau Chairman |
|---|---|---|---|---|---|---|
| | | | Approved by | | | |
| 5 | 02/12/24 | REVISED & ISSUED AS STANDARD SPECIFICATION | SCS | JSD/TK | NK | MN |
| 4 | 22/01/20 | REVISED & ISSUED AS STANDARD SPECIFCATION | NGAS | NK | SM | RKT |
| 3 | 30/07/14 | REVISED & ISSUED AS STANDARD SPECIFCATION | SKK | AM | DB/AKN | SC |
| 2 | 15/06/07 | REAFFIREMED & ISSUED AS STANDARD SPECIFICATION | SPS | VKM | RK | ND |
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| 0 | 30/12/97 | ISSUED AS STANDARD SPECIFICATION | SM | KDS | SKG | AS |

**Abbreviations:**

| | |
|---|---|
| ANSI | : American National Standards Institute |
| API | : American Petroleum Institute |
| ASTM | : American Society for Testing and Materials |
| BIS | : Bureau of Indian Standards |
| DCI | : Document Control Index |
| EC | : Experience Criteria |
| engDMS | : Engineering Electronic Document Management System |
| GA | : General Arrangement |
| ISA | : Instruments Society of America |
| ISO | : International Organization for Standardization |
| MAWP | : Maximum Allowable Working Pressure |
| MCR | : Maximum Continuous Rating |
| NPSH | : Net Positive Suction Head |
| NPSHA | : Net Positive Suction Head Available |
| NPSHR | : Net Positive Suction Head Required |
| P&ID | : Piping and Instrumentation Diagram |
| PTR | : Proven Track Record |
| VDR | : Vendor Data Requirements |
| VDM | : Vendor Document Management |

**Rotating Equipment Standards Committee**

**Convenor:** Mr. Nalin Kumar

**Members:**
Mr. Tarun Kumar
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Mr. Abhay Kumar
Mr. Mahesh Easwaran
Mr. Mahesh Gupta
Mr. Pintu Lal
Mr. Aasheesh K Handa (Projects)

## CONTENTS

1 **Scope** (Substitution)

1.1 **General**

(i) This specification together with the attendant Data Sheets and other specifications/attachments to inquiry/ order defines the minimum requirements for Positive Displacement - Reciprocating pumps, direct acting and power frame types for use in process and pipeline application.

(ii) Vendor shall comply with the requirement of this specification and other specifications/attachments to inquiry/order. No deviation or exception shall be permitted without the written approval of the purchaser.

(iii) Compliance with this Specification shall not relieve the vendor of the responsibility of furnishing equipment and accessories /auxiliaries of proper design, materials and workmanship to meet the specified start up and operating conditions including part load conditions.

In case the vendor considers requirement of additional instrumentation, controls, safety devices and any other accessories/auxiliaries essential for safe and satisfactory operation of the equipment, they shall recommend the same along with reasons in a separate section along with his proposal and include the same in their scope of supply.

(iv) Except as modified herein, the reciprocating pumps shall be designed, manufactured, tested and supplied strictly in accordance with the **API Standard 674 - Positive Displacement pumps - Reciprocating, Third Edition, December 2010 (Reaffirmed November 2016)**.

(v) Except for new paragraphs, the number and title of the paragraphs in this specification correspond to the respective sections and paragraphs of the above standard. Paragraphs not addressed in this specification shall be strictly in accordance to **API Standard 674, Third Edition, December 2010 (Reaffirmed November 2016)**.

The word in parenthesis following the number or title of a paragraph indicates the following:

| | | |
|---|---|---|
| (Addition) | : | An addition to a part, section or paragraph referred to. |
| (Modification) | : | An amplification or rewording has been made to a part of the corresponding section or paragraph but not a substitution replacing the entire section or paragraph. |
| (Substitution) | : | A substitution has been made for the corresponding section or paragraph of the standard in its totality. |
| (New) | : | A new section or paragraph having no corresponding section or paragraph in the Standard. |
| (Delete) | : | This paragraph is deleted. |

1.2 **Conflicting Requirements** (New)

In case of conflict between this specification and the attendant data sheets, job specifications (if any) and other attached specification the following order of precedence shall govern:

1. Process Data Sheet / P&IDs / Process Package
2. Mechanical Data Sheets.
3. Job Specifications/scope of work (if any)
4. This specification
5. Other standards & specifications
6. Other referred codes and standards

The editions of referenced publication that are in effect at the time of inquiry or at a date specified in the inquiry documents shall be applicable.

In case of any ambiguity in the above documents, the vendor/supplier shall seek clarification from the owner/purchaser and the decision of the owner/purchaser shall be final and binding.

1.3 **Experience Criteria** (New)

1.3.1 The pump model offered shall be from the existing pump model series and shall be from the regular manufacturing range of the vendor (Prototypes are not acceptable).

The mechanical design as well as the performance of the offered model shall have been established in shop test / field experience. (Details are to be furnished, if required).

The offered pump model and design shall be field proven (at least ONE unit) with minimum operating experience of one year for similar operating/design conditions & driver rating, mechanical design, pumping fluid & material of construction, supplied in the last Ten (10) years, from the proposed manufacturing plant, as on bid due date.
(Note: Similar operating/design conditions and driver rating would mean approx. 80% or higher)

1.3.2 The vendor shall complete the Experience Record Proforma enclosed with the inquiry document to amply prove that the offered pump meets the above experience requirements furnishing details of similar operating/design conditions {Inlet flow, operating/design pressures & temperatures, speeds (Rotational/Piston Linear), driver rating etc}, Mechanical Design {No. of heads, stroke length, piston diameter, valve type, lubrication etc}, liquid handled & material of construction etc. as applicable in the format.

In addition, manufacturer's catalogue and general reference list for Reciprocating Pumps shall also be furnished along with the proposal.

Multiple references may be furnished to justify the above.

2 **Normative References**

2.1 (Modification)
For undated references (including any amendments) the latest edition as on date of issue of inquiry or at a date specified in the inquiry document shall be applicable.

2.4 (Modification)
The last paragraph stands deleted.

3 **Terms and Definitions**

3.41 (Substitution)
The pump vendor shall have UNIT RESPONSIBILITY of complete positive displacement pumps (reciprocating) package & shall be responsible for complete design, engineering, manufacturing, packaging, testing, supply & supervision of erection & commissioning of total package as per specification requirements. Vendor's scope shall include but not limited to the responsibility for execution, coordination of all technical aspects of equipment and its auxiliary systems, their selection & integration into a complete package constituting total order. All drawings/documents pertaining to the order shall be duly approved by the vendor before onward submission.

3.42 (Substitution)
Unless otherwise specified, **Supplier / Vendor** shall be a manufacturer of positive

displacement pumps – reciprocating (as per API Std 674) having adequate design, engineering, manufacturing, packaging and testing facilities and shall have supplied complete positive displacement pumps – reciprocating (as per API Std 674) package as a single point responsibility vendor.

## 6 Basic Design

### 6.1 General

6.1.5 (Substitution)
Unless otherwise specified, the maximum permissible sound pressure level of the complete equipment (pump + driver) train shall not exceed 85 dBA measured at 1 meter from pump surface in any direction for the recommended range of operation at site.

6.1.6 (Substitution)
Unless otherwise specified, cooling water system shall be designed for the following conditions:

| | | |
|---|---|---|
| Velocity over heat exchanger surface | : | 1.5 - 2.5 m/sec. |
| Maximum Allowable Working Pressure | : | $\geq$ 8.0 kg/cm$^2$g |
| Test Pressure | : | = 1.5 x MAWP |
| Maximum Pressure Drop | : | 0.7 kg/cm$^2$ |
| Maximum Inlet Temperature | : | 33°C |
| Maximum Outlet Temperature | : | 45°C |
| Maximum Temperature Rise | : | 12°C |
| Minimum Temperature Rise | : | 6°C |
| Fouling Factor on Water Side | : | 0.0004 m$^2$ hr °C/kcal |
| Shell Side Corrosion allowance | : | 3.2 mm |

Note: To avoid condensation, the minimum inlet water temperature to water-cooled bearing housing should preferably be above the ambient air temperature.

6.1.8 (Modification)
The "Note" stands deleted.

6.1.12 (Substitution)
All electrical components and installations shall be suitable for the area classification and grouping specified in the data sheet/ inquiry document.

6.1.16 (Modification)
Unless otherwise specified, equipment will be made suitable for outdoor installation without a roof.

6.1.21 (New)
Where multi cylinder arrangement with a common drive is offered, suitable common suction manifolds and common discharge manifolds shall be provided by the vendor to connect suction and discharge nozzles of each pumping head respectively. The suction and discharge manifolds shall be terminated with flanged connections of suitable rating for purchaser's interface.

### 6.3 Ratings

6.3.1 (Modification)
The Maximum Allowable Speed Ratings for Reciprocating Pumps shall not exceed Eighty percent (80%) of the values, indicated in Table 3 & Table 4.

Note 2: Pumps where difference between NPSHA (including estimated system

acceleration head) and NPSHR is 0.6 meter or less are not acceptable.
For installations where NPSHR is within one meter of the NPSHA (including estimated system acceleration head), consideration shall be given to speeds lower than Eighty percent (80%) of those indicated in Table 3 & Table 4.

6.3.2 (Substitution)
For temperature above 150°C and/or viscosities above 200 cSt, speeds shall not exceed Sixty percent (60%) of the speeds indicated in Table 3 & Table 4.

**6.4 Pressure Containing and Pressure Retaining Parts**

6.4.7 (New)
Maximum Allowable Working Pressure (MAWP) of the pump cylinder & pulsation suppression devices shall be at least equal to the specified Relief Valve Set pressure plus the required over- pressure (i.e., accumulation pressure which is normally 10% above the specified relief valve set pressure).

6.4.8 (New)
Hydrostatic Test Pressure of liquid end including pump cylinder & pulsation suppression devices shall be 1.5 times MAWP at ambient temperature.

**6.5 Cylinder Connections**

6.5.1 (Modification)
Openings of the sizes 32mm (1¼ inch), 65mm (2½ inch), 90mm (3½ inch), 125mm (5 inch), 175mm (7 inch) and 225mm (9 inch) shall not be used.

6.5.14 Flanges:

6.5.14.1 (Addition)
Flange dimension standard shall be as per ASME B16.5 (up to NPS 24) and ASME B16.47 Series B (for above NPS 24).

6.5.14.8 (Modification)
In all cases, mating parts shall be furnished by the vendor.

6.5.14.13 (New)
Unless otherwise specified Suction side nozzle shall be designed for same pressure & temperature conditions as that of discharge side nozzle.

**6.7 Liquid End Features**

6.7.2 Pistons, Plungers, and Piston Rods

6.7.2.6 (New)
Unless otherwise specified, single acting pumps shall be provided with three or more heads.

In single acting pumps, high suction pressure actually increases the bearing loads and for this reason corrections shall be made to plunger size selection, if the suction pressure is more than five percent (5%) of the discharge pressure.

For Triplex pumps, the plunger size shall be determined on the basis of a notional discharge pressure (Px) equal to the actual discharge pressure (Pd) plus one-half the actual suction pressure (Ps).
i.e. $Px = Pd + 0.5*Ps$ (for single acting, triplex pumps)

For Quintuplex pumps, the plunger size shall be determined on the basis of a notional discharge pressure (Px) equal to the actual discharge pressure (Pd) plus two-thirds the actual suction pressure (Ps).

i.e. $P_x = P_d + 0.67 * P_s$ (for single acting, quintuplex pumps)

6.7.2.7 (New)
Unless otherwise specified, the offered pump type shall be single acting Plunger / Piston type. Double acting pumps are not acceptable.

6.7.5 Stuffing Boxes, Packing and Glands

6.7.5.1 (Modification)
Unless otherwise specified cooling jacket shall be designed for 8 kg/cm² g working pressure and 12 kg/cm²g test pressure.

6.7.5.2 (Modification)
If recommended by the vendor, glands shall be of the quenched type.

6.8 **Power End Running Gear**

6.8.1 (Modification)
The words "If specified" stand deleted.

6.8.10 (Modification)
The distance piece shall be equipped with gasketed solid covers.

6.10 **Lubrication**

6.10.1 Lubrication for Power Pumps

6.10.1.4 (Modification)
The words "if specified or if recommended by the vendor and approved by the Purchaser" stand deleted.

6.10.2 Lubrication for Liquid End and Power End (Substitution)
Unless otherwise specified, mechanical lubricator shall not be used and vendor shall provide self lubricated packings.

6.12 **Nameplates and Rotation Arrows**

6.12.4 (Addition)
MKS / SI units shall be followed and shown on the name plate.

7 **Accessories**

7.1 **Drivers**

7.1.2 Motors

7.1.2.1 (Modification)
Electric motor drivers shall have a rating not lower than 110% of the maximum power required for any of the specified operating conditions or 105% of power required at relief valve set pressure, whichever is higher. In addition, Electric Motor driver shall also be suitable for operation at 100% of the Pressure Relief Valve Accumulation Pressure (which is normally 10% above the specified Relief Valve Set Pressure).
Notwithstanding the above, the motor rating shall be adequate to start the pump at the

specified maximum suction pressure.

7.1.4 Gear Units

7.1.4.2 (Substitution)
Unless otherwise specified, gear shall conform to API Standard 677. The Gear Box/ Reducer shall be "Single Step" or "Double Step" helical with parallel shaft configuration.

7.1.4.3 (Substitution)
The Gear service factor shall be minimum 2.0.

7.1.4.4 (New)
The Gear Rated power shall not be less than 110% of the Motor Nameplate Rating.

7.2 **Couplings and Guards**

7.2.1 (Addition)
Couplings (with manufacturer's standard spacer length), coupling-to-shaft juncture, and guards shall conform to API 671. The make, type, and mounting arrangement of couplings shall be agreed upon by the purchaser and the vendors of the driver and driven equipment.

Couplings shall be Metallic (SS Membrane), Non- lubricated, Flexible Element (either Diaphragm or Disc) type with spacer.

7.2.5 (Substitution)
The coupling service factor shall not be less than 1.5 over the driver rating. However, during selection of coupling, vendor to ensure that the maximum service factor (actual SF) for the coupling shall not exceed the allowable stresses of the drive train. Further, for the pumps equipped with gear box, max service factor for coupling shall not exceed the gear box service factor.

7.2.8 a) (Modification)
Removable, coupling guard, non sparking type shall be supplied and mounted so that they cover rotating parts within 15 mm (½") of stationary housing.

7.2.8 b) (Modification)
The guard shall be sufficiently rigid to withstand deflections as a result of 100 kgs of load. Coupling guard shall have a hinge to open and Inspection window to see the healthiness of the coupling shims.

7.2.8 c) (Deleted)

7.3 **Belt Drives (Substitution)**
Unless otherwise specified, V-belt drive shall not be used between the Pumps & Electric Motor Driver.

7.4 **Mounting Plates**

7.4.1 General

7.4.1.10 (Modification)
Anchor bolts will be furnished by the vendor.

7.4.2 Baseplate and Skid

7.4.2.1 (Modification)

The vendor shall supply the common baseplate of fabricated steel, drain pan type, suitable for mounting of pump, driver and all associated auxiliaries.

7.4.2.3 (Modification)
The words "if specified" stand deleted.

7.5 **Controls and Instrumentation**

7.5.4 Instrumentation

7.5.4.4 Pressure-limiting Valves

7.5.4.4.2 (Modification)
The relief valve shall be as per purchaser's specification and of the make approved by the purchaser and supplied by vendor as loose item to be installed on purchaser's piping.

7.5.4.4.3 (Modification)
The words "if specified" stand deleted.

7.7 **Pulsation and Vibration Control Requirements**

7.7.1 General

7.7.1.4 (New)
When bladder type suppression device is specified or required by the vendor, gas charging assembly (kit) and pressure regulator shall be supplied (as a common item, for all pump tags in an order) by the vendor along-with necessary instruction for use.

7.7.1.5 (New)
Design code for pulsation dampener shall be ASME Sec VIII Div. I & preferred type is volume bottle, direct contact type unless otherwise specified. In case, the same is not possible or sufficient, bladder type can be provided.

8 **Inspection, Testing and Preparation for Shipment**

8.1 **General**

8.1.1 (Modification)
For all witnessed tests specified in equipment technical data sheet and specifications attached with the inquiry, vendor shall give at least 30 days prior notice to the purchaser and shall reconfirm the date of testing at-least one week before the date of test.

8.1.10 (New)
Unless otherwise specified, the inspection and tests shall be witnessed by the Purchaser or by his authorised representative or by both together.

8.2 **Inspection**

8.2.1 General

8.2.1.1(f) The words "if specified" stand deleted.

8.3 **Testing**

8.3.2 Hydrostatic Testing
8.3.2.6 (Modification)

Unless otherwise specified all water side cooling passages shall be tested at a minimum pressure of 12 kg/cm²g.

8.3.4 Mechanical Run Test

8.3.4.1 The words "if specified" stand deleted.

8.3.4.2 The words "if specified" stand deleted.

8.3.4.3 The clause stands deleted.

8.3.4.7 The clause stands deleted.

8.3.5 Performance Test, Direct-Acting Pump

8.3.5.6 (New)
During shop performance test, the pumps along-with other job accessories shall be run for a minimum period of four hours to verify mechanical performance of the pump unit.

8.3.6 Performance Test, Power Pump

8.3.6.4 This clause stands deleted.

8.3.6.6 (New)
During shop performance test, the pump along-with other job accessories shall be run for a minimum period of four hours to verify mechanical performance of the pump unit.

8.3.7 Test Tolerances (Modification)
Test tolerance on rated power (at rated pressure and capacity) shall be +zero percent (0%).

8.3.8 NPIP / NPSH Test (Modification)
A witness NPSH test shall be carried out when the margin between NPSHA (including allowances for acceleration head) and NPSHR of the pump is less than 2 m.

8.3.9 Optional Tests

8.3.9.1 (Substitution)
During shop performance test, the pumps along-with other job accessories shall be run for a minimum period of four hours to verify mechanical performance of the pump unit.

8.4 **Preparation for Shipment**

8.4.1 (Modification)
The equipment shall be protected for an outdoor storage of 12 months at site, if any extra precaution is to be taken by the Purchaser for storage beyond 12 months the same shall be explicitly indicated in the operation and maintenance manuals.

9 **Vendor's Data**

9.1 **General**

9.1.2a) (Substitution)
The purchaser's/owner's/consultant's corporate name.

9.2 **Proposals**

9.2.1 General

9.2.1.2 (New)
All vendor data/drawings/documents shall be in English Language and in Metric Systems.

9.3 **Contract Data**

9.3.1 General (Substitution)

9.3.1.1 Drawings and data as required after purchase order have been specified in Vendor Data Requirement. Vendor to note that the drawing/document descriptions/titles as given in the Vendor Data Requirement are generic in nature. It is possible that against one drawing / document specified there are several drawings to be furnished by the vendor or vice versa.

9.3.1.2 Vendor shall complete & forward a document "Document Control Index (DCI)" to the purchaser (Destination & contact person as per order). This shall be the first document to be submitted by vendor within two weeks of order.
This document shall list out in consolidated form all drawings and documents required by purchaser (As specified in Data Sheets, Specifications and Vendor Data Requirement forms enclosed with the order).
Against each drawing/document vendor shall indicate the vendor's drawing numbers, titles, Rev. No., category (whether for information or approval) and schedule of submission.
**No drawing shall be taken up for review till DCI for the inquiry/order is finalized by vendor.**

9.3.1.3 All transmittal letters (covers), drawings and data shall have a title block (in addition to vendor's standard title block) which shall as a minimum contain the following contract information:

- Purchaser's and Consultant's Corporate Name
- Project Name.
- Client / Customer's Name.
- Equipment Name and Item No.
- Purchase Order No.
- Purchase Requisition No.

Title Block on drawings shall be placed on the lower right hand corner.

9.3.1.4 Data specified in the VDR is the minimum requirements of Purchaser. Any additional document/data required or requested by Purchaser for engineering or construction shall also be made available by the vendor.

9.3.1.5 All post order documents shall be submitted / approved through EIL eDMS portal.

9.3.1.6 Final documentation shall be submitted in hard copy and soft (CDs/ DVDs) in addition to submission through EIL eDMS portal. The number of prints and/or reproducible required to be submitted by vendor are specified in Purchaser's inquiry/order.

# निश्चित विस्थापन पम्प - नियंत्रित आयतन के लिए मानक विनिर्देश

# STANDARD SPECIFICATION FOR POSITIVE DISPLACEMENT PUMPS - CONTROLLED VOLUME

| Rev. No | Date | Purpose | Prepared by | Checked by | Approved by: Standards Committee Convenor | Approved by: Standards Bureau Chairman |
|---|---|---|---|---|---|---|
| 6 | 13/11/24 | REVISED & ISSUED AS STANDARD SPECIFICATION | RT | JSD/TK | NK | MN |
| 5 | 26/06/19 | REVISED & ISSUED AS STANDARD SPECIFICATION | MKA | NK | SM | RKT |
| 4 | 18/10/13 | REVISED & ISSUED AS STANDARD SPECIFICATION | HM | TK | DB | SC |
| 3 | 15/09/07 | REAFFIREMED & ISSUED AS STANDARD SPECIFICATION | NK | VKM | RK | VJN |
| 2 | 04/09/92 | REVISED & ISSUED AS STANDARD SPECIFICATION | KNJ | KDS | VJN | GRR |

**Abbreviations:**

| | | |
|---|---|---|
| ANSI | : | American National Standards Institute |
| ASTM | : | American Society for Testing and Materials |
| BIS | : | Bureau of Indian Standards |
| EC | : | Experience Criteria |
| GA | : | General Arrangement |
| ISA | : | Instruments Society of America |
| MAWP | : | Maximum Allowable Working Pressure |
| MCR | : | Maximum Continuous Rating |
| NPSH | : | Net Positive Suction Head |
| NPSHA | : | Net Positive Suction Head Available |
| NPSHR | : | Net Positive Suction Head Required |
| P&ID | : | Piping and Instrumentation Diagram |
| PTR | : | Proven Track Record |
| VDM | : | Vendor Drawing Management System |
| VDR | : | Vendor Data Requirements |

**Rotating Equipment Standards Committee**

**Convenor:** Mr. Nalin Kumar

**Members:**
Mr. Tarun Kumar
Mr. J S Duggal
Mr. Abhay Kumar
Mr. Mahesh Easwaran
Mr. Mahesh Gupta
Mr. Pintu Lal
Mr. Aasheesh K Handa (Projects)

## CONTENTS

1 **SCOPE** (Substitution)

(i) This specification together with the attendant Data Sheets and other specifications/attachments to inquiry/order defines the minimum requirements for controlled volume-positive displacement type, direct plunger or hydraulically operated diaphragm type and their accessories/auxiliaries.

(ii) Vendor shall comply with the requirement of this specification and other specifications/attachments to inquiry/order. No deviation or exception shall be permitted without the written approval of the purchaser.

(iii) Compliance with this specification shall not relieve the vendor of the responsibility of furnishing equipment and accessories/auxiliaries of proper design, materials and workmanship to meet the specified start up and operating conditions.

In case the vendor considers requirement of additional instrumentation, controls, safety devices and any other accessories/auxiliaries essential for safe and satisfactory operation of the equipment, he shall recommend the same along with reasons in a separate section along with his proposal and include the same in his scope of supply.

(iv) Except as modified herein, the controlled volume pumps shall be designed, manufactured, tested and supplied strictly in accordance with the **API Standard 675 - Positive Displacement pumps - Controlled volume, Third edition, November 2012**.

(v) Except for new paragraphs, the number and title of the paragraphs in this specification correspond to the respective sections and paragraphs of the above standard. Paragraphs not addressed in this specification shall be strictly in accordance with **API Standard 675, Third edition, November 2012**.

The word in parenthesis following the number or title of a paragraph indicates the following:

| | | |
|---|---|---|
| (Addition) | : | An addition to a part, section or paragraph referred to. |
| (Modification) | : | An amplification or rewording has been made to a part of the corresponding section or paragraph but not a substitution replacing the entire section or paragraph. |
| (Substitution) | : | A substitution has been made for the corresponding section or paragraph of the standard in its totality. |
| (New) | : | A new section or paragraph having no corresponding section or paragraph in the Standard. |
| (Delete) | : | The paragraph is deleted. |

1.1 **EXPERIENCE CRITERIA (New)**

1.1.1 The pump model offered shall be from the existing pump model series and shall be from the regular manufacturing range of the vendor (Prototypes are not acceptable).

The mechanical design as well as the hydraulic performance (including NPSHR & Precision Requirements) for the complete range of operation of the offered model shall have been established in the shop test. (Details are to be furnished, if required).

The offered pump model size and design shall be field proven (at least ONE unit) with minimum operating experience of one year for similar operating/design conditions and pumping liquid and material of construction, supplied in the last Ten (10) years, from the proposed manufacturing plant, as on bid due date.

(Note: Similar operating/design conditions would mean approx. 80% or higher)

1.1.2 The vendor shall complete the Experience Record Proforma enclosed with the inquiry document to amply prove that the offered pump model meets the above experience requirements furnishing details of flow, differential pressure, operating pressures & temperatures, pumping liquid, viscosity, driver rating, stroke speed, mechanical design (i.e. number of heads), material of construction etc., as applicable in the format. In addition, manufacturer's catalogue and general reference list for Positive Displacement Pumps (Controlled Volume) shall also be furnished along with the proposal.

1.1.3 Multiple references can be furnished to justify the above. Bareshaft pump supplies/partial scope supplies will not be construed as valid references.

## 2 NORMATIVE REFERENCES

2.1 (Modification)
For undated references (including any amendments) the latest edition as on date of issue of inquiry or at a date specified in the inquiry document shall be applicable.

## 3 TERMS & DEFINITION

3.61 **SUPPLIER / VENDOR** (Substitution)
The vendor shall be a manufacturer of positive displacement pumps - controlled volume (as per API 675) having adequate design, engineering, manufacturing, packaging and testing facilities and shall have supplied complete positive displacement pumps - controlled volume package as a single point responsibility vendor. The vendor shall also be the manufacturer of the proposed positive displacement pumps - controlled volume.

## 4 GENERAL

4.1 **UNIT RESPONSIBILITY** (Addition)
The pump vendor shall have UNIT RESPONSIBILITY of complete pump package & shall be responsible for complete design, engineering, manufacturing, packaging, testing, supply & supervision of erection & commissioning of total package as per specification requirements. Vendor's scope shall include but not limited to the responsibility for execution, coordination of all technical aspects of equipment and its auxiliary systems, their selection & integration into a complete package constituting total order. All drawings/documents pertaining to the order shall be duly approved by the vendor before onward submission.

4.2 **GOVERNING REQUIREMENTS AND UNITS OF MEASUREMENT** (Modification)
Unless otherwise specified, MKS system of units shall be used.

## 5 STATUTORY

### 5.2 REQUIREMENTS

5.2.1 **Conflicting Requirements** (Addition)
In case of conflict between this specification and the attendant data sheets, job specifications (if any) and other attached specification the following order of precedence shall govern:

1. Process Data Sheet / P&IDs / Process Package
2. Mechanical Data Sheets.
3. Job Specifications/scope of work (if any)

4. This specification
5. Other standards & specifications
6. Other referred codes and standards

The editions of referenced publication that are in effect at the time of inquiry or at a date specified in the inquiry documents shall be applicable.

In case of any ambiguity in the above documents, the vendor/supplier shall seek clarification from the owner/purchaser and the decision of the owner/purchaser shall be final and binding.

## 6 BASIC DESIGN

### 6.1 GENERAL

6.1.5 (Substitution)
The maximum permissible sound pressure level of the pump driver train shall not exceed 85 dBA measured at 1 meter from pump surface for the recommended range of operation.

6.1.13 (Modification)
Unless otherwise specified, equipment shall be designed to be suitable for outdoor installation without a roof.

6.1.15 (Modification)
Unless otherwise specified, the pump flow rate shall be adjustable over the range of "10% OR Process turndown flow (whichever is lower)" to 100% of rated capacity while the pump is running with all design requirements of 6.1.16 / 6.1.17 / 6.1.18 being met.

6.1.16 (Substitution)
Pump rated capacity shall be at least equal to the maximum capacity specified by the Purchaser.

6.1.17 (Addition)
The pump speed shall not exceed 100 strokes per minute. Due consideration shall be given for the viscosity of pumping liquid as well as NPSHR, while selecting the pump speed.

6.1.21 (Modification)
When requirement of jacketed housing is specified/required, jackets shall be suitable for design pressure of heating/cooling medium specified.

6.1.22 (New)
For multi-head pumps, suction and discharge nozzles of individual heads shall be manifolded together to result in one common inlet and one common outlet flanged connection for customer's connection. Material of the manifold shall be equivalent to cylinder head material.

6.1.23 (New)
Pumps where difference between NPSHA (considering acceleration head loss) and NPSHR is less than one (1) metre are not acceptable.