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Technical Specification for Slurry Pumps



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1. GENERAL

This project involves the engineering and construction of a new mineral processing facility, designated as “Phase 3,” dedicated to copper and molybdenum concentration as a primary and byproduct recovery operation.

The facility is engineered to process mineral ore with the following operational capacity parameters:

- Nominal Capacity: 2,340 dry tonnes per hour (dtph) of fresh ore feed.
- Design Capacity: 2,700 dry tonnes per hour (dtph) of fresh ore feed.

The plant design configuration incorporates sufficient operational flexibility and redundancy to ensure reliable performance under “Maximum” throughput conditions, adhering to the specified design capacity requirements.

2. SCOPE

This specification includes the minimum requirements for the design, fabrication, inspection, testing and supply of centrifugal type slurry pumps, intended for installation for Phase III Copper-Moly concentrate plant project. In addition to requirements of this criteria, work shall be done in accordance with recognized and accepted theories, methods, codes, standards and good engineering practice. Compliance by the manufacturer with the provisions of this specification does not relieve him of the responsibility of furnishing Centrifugal Pumps and relevant accessories of proper design, mechanically suited to meet operating guarantees at the specified service conditions. No deviations or exceptions from this specification shall be permitted without written approval of the Contractor.

Supplier shall follow requirements of this specification together with all its due referred approved documents (such as P&ID, data sheets, material requisition, specification for pressure vessels, welding procedure specification, surface preparation and painting specification, etc.) as well as latest available edition of all

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specified international codes and standards which most of them are mentioned in following section. In addition, manufacturer specifications set on the basis of international standards will be implemented together with requirements of this specification, for centrifugal type slurry pumps. Positive displacement pumps, such as diaphragm type, hose type, etc. are beyond of this specification and usually are referred to due manufacturer standards.

3. CONFLICTING REQUIREMENTS

When contradictions are between the information to be applied, the order of following priority shall be applied:

- Data sheet and drawings.
- This specification
- Other codes and standards which are referred to.

4. THE SUPPLIER'S RESPONSIBILITIES

- a) The supplier shall design, fabricate, test, prepare documentation and deliver all Pumps and accessories to complete the work.
- b) The Supplier shall ensure compliance with the code and authority regulations.
- c) Any deviation from the Purchaser's requisitions, specifications or standards must be submitted to the Supplier in writing for approval prior to the start of work.
- d) The supplier shall execute his services in accordance with good engineering practice and workmanship.
- e) The Purchaser's review of the Supplier's documentation does not relieve the supplier of his responsibility for the services as defined in the Purchaser's purchase orders.
- f) The pumps shall be suitable to start-stop and run at entire design minimum and maximum temperature range of site

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5. GENERAL REQUIREMENTS

- Unless otherwise specified, pumps, drivers and accessories shall be considered base on outdoor Installation/Operation and totally unprotected from the weather in a dusty environment.
- All instrumentation, motor insulation and similar equipment, which may be subject to attack by dust, moisture, fungus or insects, shall be suitably treated to inhibit such attack.
- Pump and driving motor set along with accessories shall be supplied as per technical specification / Data Sheet given in this specification.
- This specification together with the pump and motor data sheets and attachments defines the minimum requirements pump, driver (electric motor), accessories and spares.
- Each pump shall be fully assembled with motor on base plate/ mounting plate. Required number of anchor bolts, nuts & lock nuts for pumps base plate shall also be provided for all the pumps.
- Centrifugal pump shall have stable performance characteristics requiring that at the rated speed over the whole flow range it shall have a continuously rising curve i.e. the developed head shall continuously increase with decreasing flow up to shut off head. There shall be no inflection point at any partial load in the Head-Capacity curve.
- Pumping unit and auxiliary equipment shall be designed and constructed for safe operation at full load duty and continuous service. The pumps shall be of robust construction, suitable for long periods of maintenance-free service.
- Closed type impellers are preferred for clean liquids. Casing wear rings are required as minimum for closed impeller application.
- NPSH required shall be based on water. The NPSH available shall exceed NPSH required by a margin of at least 1 meter at all flows from minimum continuous flow to rated flow. Supplier shall specify on the data sheet the net positive suction head required (NPSHR) when the pump is operated on water at the rated capacity and rated speed.

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- Pumps, which handle liquids with viscosity more than water, shall have their performance corrected in accordance with the Centrifugal Pump Section of the Hydraulic Institute Standards.
- All electrical and mechanical equipment shall be designed and manufactured so that no damage results from inland transportation and during storage, installation and operation of equipment under the climatic conditions to which it will be subjected.
- Pump and motor assembly shall be designed to permit ease of access during inspection, maintenance and repair.
- Clamps, lifting lugs and eyebolts of adequate capacity shall be provided to ensure safe and easy handling of the pumps and motors.
- Unit shall be provided with proper doweling between pump and motor for ease of assembly
- Pump shall be assembled at manufacturer's shop and mating parts shall be match- marked for ease of assembly at site. Also, it is preferred that all slurry pumps are delivered on skid to mount easily at site. This is applicable for spare rotating assembly also, if any.
- No deviations or exceptions from this specification shall be permitted without written approval of purchaser. Intended deviations shall be separately listed with supporting reasons, for consideration by the purchaser.
- Compliance with this specification shall not relieve the supplier of the responsibility of furnishing equipment and accessories of proper design, materials and workmanship to meet the specified operating conditions.
- Quality Assurance Plan shall and due ITP be prepared by the supplier and submitted for approval.

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6. DESIGN REQUIREMENTS

6.1. GENERAL

- All the centrifugal pumps shall be of single stage, horizontal, radial split, volute casing in rugged construction, end suction, top discharge. All the centrifugal pumps shall be designed to at a maximum efficiency under specified conditions consistent with good operating characteristics and high efficiency.
- The rated flow may be within the region of 70 -120 % of best efficiency point of the furnished impeller.
- The pump shall be designed to permit maximum interchangeability of parts for shaft assembly including bearings, sleeves and sealing components. All casting and forging shall be conformed to their respective materials specification and shall be free from flaws and objectionable imperfections, machined true and in good workmanship like manner
- All accessories as called for in Data Sheet and any other accessory required for proper and safe operation shall be furnished with the pumps.
- Pump-Motor assembly shall be capable of starting with full valve open condition.

6.2. DRIVER

- Electric motor drivers 250 kW and below shall comply with project requirements & specifications for LV Motors
- Electric motor drivers above 250 kW shall comply with project requirements & specifications for MV Motors
- The motors shall be complete in all respects and shall be as per specification attached. The motor selected shall be to suit the pump's operation requirement as per data sheets. The motor input KW shall be at 125% of the designed capacity (rated) or to suit the requirement of pump at the design point with 15% margin whichever is higher.
- Motors shall be mounted and aligned on the base plate/ mounting plate by the pump supplier unless otherwise specified

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- Variable speed drive unit shall be sized to be non-overloading over the entire pump head capacity range (at maximum pump speed for adjustable speed pumps).

6.3. BEARINGS

Anti-friction bearings shall be incorporated on each rotor. Radial loads shall be carried by straight roller bearings. Axial loads shall be carried by two sets of angular contact ball bearings.

- Bearing life (L10) shall be at least 60000 for design capacity.
- The rise in bearing grease with continuous running of the pump shall be within the allowable limit which shall not exceed 20°C for grease bearing above ambient.
- All instruments required for lubrication system and cooling system shall be provided by supplier.
- Bearing in the pump shall be arranged so as to permit measurement of shaft vibration adjacent to at least one bearing.
- Bearing housing shall be arranged so that bearing can be replaced without disturbing pump driver or mounting.

6.4. SEALING

- Pump sealing and its material shall be selected in compliance with standard ISO 5199.
- The pump supplier shall furnish all piping and accessories required for the satisfactory operation of the mechanical seals (if any).
- Gland seal water will be available at the site and points required where applicable. Supplier shall notify the clear water demand and pressure needed for gland seal of each Horizontal slurry pump.

6.5. CASING

- The surface finish of casing should be smooth. The casing design pressure shall not be less than the maximum suction pressure plus shut off head of the

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pump. It should be rigid and properly supported to resist misalignment and distortion from pipe loads.

- Replaceable type wear rings shall be provided. The rings shall be so fitted as to prevent turning.
- The pumps shall have flanged suction and discharge nozzles integrated with the casing. Flanges shall comply with ASME B16.5 suction and discharge flanges shall have the same rating.
- The casing for shall have proper venting and draining provision with valves. The casing joints shall be provided with dowels for accurate re-assembly after opening.
- Material of slurry pump shall be high resistance cast alloy supported by rubber lining. Rubber lining shall be replaceable, and shall have enough resistance against damage and corrossions by particles in slurry which mentioned in data sheet.
- For slurry pumps, in case of froth vertical pump, an especial hopper above the casing shall be considered to break the froth.

6.6. IMPELLER

- The impeller selected shall be at least 5% smaller in diameter than the maximum size that can be accommodated in the selected size of casing and shall have high efficiency.
- Rotor assembly including impeller, shaft etc. shall be statically and dynamically balanced as per the pump data sheet. Wherever such requirement is not specified by the pump data sheet then, as a minimum requirement, the dynamic balancing shall be carried out as per ISO 1940 Gr 2.5.
- The impeller shall be keyed to the shaft and proper lock nut provision shall be made to prevent loosening of impeller in case of reverse rotation etc.
- Impeller material of slurry pump shall be ductile iron with rubber lining. Rubber lining shall be similar to cast lining.

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6.7. SHAFT & SHAFT SLEEVES

- The shaft shall be preferably being machined from bar / forging and ground finished. The surface finish in critical areas of mechanical seal shall be better than 0.8 micron.
- Shaft shall be ample size and stiffness to transmit the maximum torque required under any specific operation conditions
- Shaft sleeves shall be positively secured against circumferential and axial movement. The shaft sleeve shall be sealed against the impeller hub so that the shaft is not wetted.
- Shaft sleeves shall be replaceable and with high surface hardness materials. Shaft sleeves shall be positively driven, clamped and sealed at impeller end but it should be free to expand at the other end. The surface finish shall be better than 1micro inch.
- The shaft shall be of rigid type, having the first critical speed at least 20% higher than all specified speeds

6.8. COUPLING

- The horizontal pumps which are designed so that directly connected to motor, should be coupled to motor through suitable flexible/spacer type coupling to take care of usual shaft misalignments, shaft expansion and ease of dismantling during maintenance of pumps. Couplings should be properly guarded. The coupling shall be preferably spacer coupling with sufficient spacer length, so that the coupling, bearings, seal and rotor as applicable, can be replaced without disturbing the driver or the suction and discharge piping. The couplings shall be statically and dynamically balanced.
- Guards shall be made of expanded metal, heavy duty type. Guards for V-belt drives shall be designed to accommodate the maximum diameter sheave combinations and the maximum center to center distance required for design conditions. Belt drives shall be designed for 1.5 service factor.

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- Pulley material should be made from steel and should have dynamic balancing.

6.9. FRAME & BASEPLATE

- The common base plate for pump and motor shall be in one piece. Suitable holes shall be provided for grouting and these shall be so located that the base can be grouted in place without disturbing the pump and motor. All pumps and motors shall be properly, aligned, bolted and dowelled to the base plates by the supplier.
- Adequate space shall be provided between pump drain connections base plate for installation drain piping. Pumps shall be supplied with suitable drain pans or drain rim type base plates with valves drain connections
- Base plate shall be constructed with sufficient structural stiffness to minimize misalignment of the pump and driver shaft due to piping load effects.
- Base plate shall be provided with lifting lugs for at least a four-point lift of the base plate completed with all equipment mounted without permanently distort or damage the base plate. Two earth lugs are required at diagonally opposite corners on the base plate

6.10. SLURRY CENTRIFUGAL PUMPS

A slurry pump is also known as a lined pump or dredge pump and is a centrifugal pump for transporting a fluid handled containing highly abrasive solids such as flotations, suspensions of slag, coal or ore in mining and sinter sludges, or in sand and gravel extraction. They are particularly heavily exposed to erosive wear. They are therefore designed in such a way that their wetted surfaces are hard-faced by deposit welding and the components exposed to wear such as rings, bushes, discs, casing inserts, impellers and all types of linings, can easily be replaced by new ones. They must therefore be reasonably inexpensive and consist of materials which are particularly resistant to abrasion or a combination of abrasion and corrosion. See Fig. 3 Slurry pump: Slurry pump with replaceable suction-side wear plate

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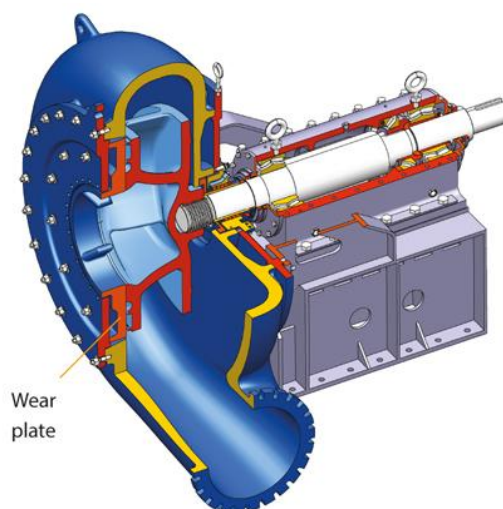


Fig. 3 Slurry pump: With replaceable suction-side wear plate

The operating requirements also include quick and easy pump dismantling and a reliable spare parts service for the replaceable parts. In addition to these pumps specifically developed for hydraulic solids transport, there is a number of centrifugal pumps that are, depending on their design and material properties, suitable for handling fluids of different contamination degrees and solids content.

6.11. NAMEPLATE

- Each pump shall have a name plate made of stainless-steel material (Type 316) giving at least the following information:
 - ▶ Project Title
 - ▶ Company
 - ▶ Size and Model of the pump
 - ▶ Total weight (kg)
 - ▶ Pump services (fluid)
 - ▶ Serial number,
 - ▶ Flow rate, (m³/h)
 - ▶ Pumping head, (m)

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- ▶ Rotating speed.
- ▶ Maximum allowable working pressure (barg) (MAWP)

7. MATERIALS OF CONSTRUCTION

- The material of construction of parts for pump shall be as per the data sheets. Pump mounting plate and bolts shall be as per the data sheets.
- Only the best quality and type of material shall be used. Castings used for any part shall be free from shrink or blow-holes, scale, blisters etc. Similarly, forgings shall be free from flaw and objectionable imperfections, machined true and in a workman like manner.
- Materials are normally stated in the data sheet. If the materials are selected by the purchaser but the pump manufacturer/supplier considers other materials to be more suitable, these should be offered as alternatives by the manufacturer/supplier according to the operating conditions specified on the data sheet.
- For hazardous liquids, the manufacturer/supplier shall propose suitable materials for agreement by the purchaser.
- Non-ductile materials should not be used for the pressure-containing parts of pumps handling flammable liquids.
- For high or low temperature applications (i.e., above 175 °C or below -10 °C), the pump manufacturer/supplier shall give due consideration to mechanical design.
- Material composition and quality, chemical composition, mechanical properties, heat treatment and welding procedures shall be in accordance with the relevant material standards.
- When tests and certificates for the above-mentioned properties are required, the procedures shall be agreed between the Client and supplier.

Material of Wet Parts

Material selection for pump parts depends on fluid properties such as:

- Physical properties of the fluid, such as density, viscosity, etc.

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- Chemical and corrosive properties of fluid
- Design temperature
- Total dissolved solids and abrasive particles contents of the fluid
- Relative cost and alternative materials

As long as fluid properties are in the normal to slightly corrosive- erosive range, usually the following materials will be suitable:

- Pump casing, casing cover and seal chamber: ASTM A 743-Gr. CF3M or Type 316 Stainless steel
- Impeller: ASTM A 743-Gr. CF3M
- Shaft: 12CrMn Martensitic Stainless Steel or ASTM A 276- Gr. 316L

In some cases, coating (e.g., ceramic coating, PTFE coating, etc.) of pump's casing, impeller and some internal components of pumps may be necessary and this shall be performed as per process and performance requirements defined in design requirements of pumps.

Usually, material selection table is performed based on Tables G.1 and H.1 of API 610/ ISO 13709: 2021 Standard. In addition, the following brief table may be used in most cases adequately.

Based on philosophy control of process and pump design characteristics, metering of fluid flow may be of multi-head or single-head type. The manufacturer shall follow project's requirements highlighted in due finalized P&ID and Pump Data Sheet for design and selection of his proposed system.

Also, for positive displacement type pumps, the stroke adjustment may be performed in some common ways, such as:

- Manual adjustment, which is extensively used in most process loops of plant
- Electrical adjustment, which may be used in fluctuating flow loops of process lines which shall be controlled via proper "Feedback Control Systems" circuits, usually controlled by due PLC. This type of actuator only needs definite electrical power, usually DC.
- Pneumatic adjustment, which may be used in fluctuating flow loops of

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process lines which shall also be pneumatically controlled via proper “Feedback Control Systems” circuits, usually controlled by due PLC. The required feed of dry compressed air (instrument air) shall be adequately available for proper operation of this type of actuators.

For pump skid or other fabricated or welded parts:

- Welding of fabricated parts shall be done only by qualified welders.
- For each weld, the following documents shall be submitted to purchaser for review:
 - ▶ Welding procedure specification (WPS)
 - ▶ Procedure qualification record (PQR)
 - ▶ Welding map with reference for identification of welds and parts to be welded
 - ▶ Welding Person Qualification (WPQ)

8. FACTORY ACCEPTANCE TEST (FAT)

Prior to shipment of any equipment to the site, the equipment shall be tested at the vendor’s facility to demonstrate to EPC contractor or client representatives according to QC plan, that the equipment is performing all specified functions. All equipment shall be individually tested.

9. MATERIAL, PAINTING & FINISHING

Material, paint and finishing used shall be in accordance with those shown on the equipment data sheets. The vendor is responsible for ensuring that all material used are suitable for the operating and ambient condition specified. Where materials of construction are not specified, the vendor should offer their standard and proven material for approval.

10. PACKING

Vendor shall pay attention to the following particular requirements. A packing list shall be placed both on the inside and outside of each individual package of container.

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Vendor shall furnish recommendations for further protective measures (if required) to be taken to protect the equipment after its receipt at the construction site. One complete set of installation, operation and maintenance instructions shall be packed in the boxes or crates with the equipment.

11. TRANSPORTATION

Vendor shall pay attention to the following particular requirements. All equipment shall be protected against damage which might be expected to occur in transport, storage, during installation and commissioning. Equipment and other related devices shall be properly prepared for transport to prevent damage and shall be labelled to ensure that it is not lost in transportation; In addition, the following measures shall be taken:

- ☐ All external connections shall be protected by temporary closures to exclude dirt and other foreign matter.
- ☐ One packing list to be included inside every package (box) and one packing list to be in metal enclosure attached to the package.

Adequate shipping supports and packing shall be provided in order to prevent internal damage during the transportation. The enclosure roof shall be properly designed to avoid the accumulation of moisture and rainwater.

12. DOCUMENTS TO BE FURNISHED BY SUPPLIER

Supplier shall prepare final book (required copies) together with equipment (for approval) and shall responsible for all related documents such as Spec. Datasheet, drawings and installation details.

A material list shall be furnished listing the quantity, rating, type, and Supplier's catalogue number of all equipment in each unit.

all engineering data provided for equipment shall show equipment as specified and ordered, Engineering data, Catalogues, Installation, maintenance, recommendations, certificates and all related request documents shall be supplied in quantities as shown on the purchase order. (Operating manuals incorporating, installation,

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commissioning, operating and maintenance instruction, and also fault-finding and troubleshooting procedures.)

Review of supplier's drawings, calculations and other documents by the EPC subcontractor does not relieve the supplier of the responsibility for correctness under the terms of the order.

13. GUARANTEE & WARRANTY

- a) The SUPPLIER shall guarantee the operating point for the rated case and performance of his equipment as defined in data sheet and /or specifications, during commissioning and for one year operating starting from the date of completion of commissioning but not exceeding 18 months after the date of shipment against the following defects:
 - All operational defects.
 - All material defects.
 - All fabrication and design defects.
- b) All defective parts shall be replaced by the SUPPLIER in the shortest possible time, free of charge, inclusive of dismantling, reassembly at site and all transportation costs.
- c) The SUPPLIER shall guarantee the provision of spare parts to the EPC subcontractor for a minimum period of 10 years from the date of dispatch. In the event the SUPPLIER cannot supply the required spares (whether of his own supplier or other's) within the period of time, the costs of complete replacement units will be borne by the SUPPLIER.

14. REPLACEMENT OF DEFECTIVE PARTS

All defective parts shall be replaced in the shortest possible time free of charge including dismantling reassembling at site and all transportation costs.

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15. SPARE PARTS & SPECIAL TOOLS

Spare parts shall be marked and numbered for easy identification, and preserved against damage & deterioration during transport and storage.

Adequate quantity of commissioning spare parts shall be provided for all firefighting and safety components.

At the quotation stage the following lists of parts and tools shall be submitted by the SUPPLIER and shall be finalized in the end of engineering phase.

- a) Commissioning Spare Parts
- b) Priced spares for 2-year Operation
- c) Special tools (if applicable)

Together with the supply of all equipment under this specification, a complete set of spare parts for commissioning shall be supplied for each equipment. The supplied spare parts shall comply with the same specifications as the original parts and shall be fully interchangeable with the original parts without any modification.

16. INSPECTION AND TESTS

Supplier shall submit for approval a detailed schedule of inspection and workshop testing in accordance to an agreed quality plan. The costs for all inspection and testing shall be to the supplier account. Supplier shall allow the purchaser's representative onto his premises as and when required for the purpose of carrying out inspection and testing of the equipment. Inspection & test should be done (for approval) at the presence of CLIENT's representative.

Supplier shall make available without charge all reasonable and necessary equipment and facilities required by the purchaser's representative in assisting in inspection and testing. Purchaser's representative shall perform inspection surveillance where necessary and shall assure himself that all equipment and practices are in accordance with specifications and quality plan. Equipment shall be packed for shipment and dispatched from supplier's premises only after release by purchaser's representative. The supplier shall issue instruction of the proper initial and periodic testing of the equipment and shall provide any special equipment

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required for calibration and testing during operation. Test information and results shall be provided in letter certifying that the equipment was tested and all requirements have been considered.

All tests shall be carried out as per approved Inspection & Test Procedure Forms (ITP forms) and supplier shall prepare QCP/ITP for CLIENT's approval.

Third Party inspector which is nominated by CLIENT/Subcontractor shall inspect the material and equipment at different stages of manufacturing, testing and packing for shipment.

17. CERTIFICATION

Vendor shall furnish all calculations and documents necessary for certification and the EPC contractor, on behalf of the vendor, will submit all the documents to the certifying authority. However, the vendor shall coordinate with certifying authority for all the inspections at vendor's work.

Due clauses and criteria will be defined in relevant contract/ purchase order.