شرکت مهندسین مشاور کاوشگران	**250 KTPY Iron Ore Concentrate Plant**	راهبران فولاد اصفهان

Tender Document

of

Slurry Pumps (Rev 01)

(T.S)

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Page	00	01	02	03	04	05	06	07	08
1	✓	✓							
2	✓	✓							
3	✓	✓							
4	✓	✓							
5	✓	✓							
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27	✓	✓							
28	✓	✓							
29	✓								
30									
31									
32									
33									
34									
35									
36									
37									

Page	00	01	02	03	04	05	06	07	08
38									
39									
40									
41									
42									
43									
44									
45									
46									
47									
48									
49									
50									
51									
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62									
63									
64									
65									
66									
67									
68									
69									
70									
71									
72									
73									
74									

Contents

1. Introduction

The project is **Rahbaran Foolad Isfahan** Project in the center part of Iran. Construction items include grinding, magnetic separation, classification, dewatering tailing via thickener, filerpress, dewatering concentrate via drum filter.

1.1 Scope

This specification details the technical requirements for the design, fabrication, and supply of submersible fresh water pump for the Plant. The types of pumps used in this project are: slurry pump. Water pump and Sump pump.

The slurry pump is the most important of them.Slurry pump is mainly used for conveying ore pulp to the needed place by pressure. This specification covers minimum requirements for the design, materials, fabrication, inspection and testing, painting, training and supervision, packing, forwarding and loading into transport vehicle at manufacturer shop of “Slurry pumps".

1.2 Site conditions

General

Elevation	1,495 m AMSL Max
Ambient temperature	+ 43 °C
Min ambient temperature	- 10 °C Relative
humidity	Average: 10-50 %
	Max. 69 %

1.3 Normative Codes and Standards

Equipment furnished under this section shall comply in all respects with the requirements of the latest edition of international standards and codes including latest ruling amendments. All mentioned standard shall be changed to equivalent international standards as per contract

The description of codes and standards shall be mentioned correctly and completely.

IEC 60204-1:2005 IEC 60204-32:1998 IEC 60204-11:2000 IEC 60204-31:2001	IDT IDT IDT IDT	GB 5226.1-2008 GB 5226.2-2002 GB 5226.3-2005 GB 5226.4-2005 Mechanical and Electrical Safety, Mechanical and Electrical Equipment
ANSI/AWSZ49.1	EQV	GB 9448-1988 Welding and Cutting Safety
ISO 3952-1:1981; ISO 3952-2:1981	EQV	GB/T 4460-1984 Mechanical Drawing-Kinematic Diagram Symbol of Mechanism
IEC 60617 60617DB:2007	IDT IDT	GB/T 4728.1-2005 MGraphic Symbol for Electrical Diagram, Section-I: General Requirements GB/T 4728.10-2008 Graphic Symbol for Electrical Diagram, Section-X: Telecommunication Transmission GB/T 4728.11-2008 Graphic Symbol for Electrical Diagram, Section-XI: Building Erection Plan Layout GB/T 4728.12-2008 Graphic Symbol for Electrical Diagram, Section-XII: Binary System Logic Element GB/T 4728.13-2008 Graphic Symbol for Electrical Diagram, Section-XIII: Simulation Element
IEC 61082-1 : 2006	IDT	GB/T 6988.1-2008 Compilation of Document for Electrical Technology, Section-I: Rules
IEC 60848:2002	IDT	GB/T 21654 -2008 GRAFCET Specification Language for Sequence Function Chart
ISO 1000:1992	EQV	GB 3100-199 International System of Units and Application

ISO 286-2:1988	EQV	GB/T 1800.4-1999 Limit and Cooperation Standard Tolerance Grade and Limit Deviation of Hole and Shaft
ISO 2768-2:1989	EQV	GB/T 1184-1996 Shape and Position Tolerance, Unnoted Tolerance Value
ISO 2768-1:1989	EQV	GB/T 1804-2000 General Tolerance, Unnoted Tolerance, Linear and Angle, Dimension Tolerance
ISO 13920:1996	IDT	GB/T 19804-2005 General Dimension Tolerance and Shape Tolerance of Welding Structure
BS EN 10031:2003	IDT	GB/T 20911-2007 Tolerance on Dimension, Shape and Quality of Semi-finished Product for Forging
ISO 4063:1998	IDT	GB/T 5185-2005 Welding and Relevant Process Method Code
ISO 10485:1991	IDT	GB/T 3098.12-1996 Mechanical Property of Fastener: Nut Taper Guarantee Load Test
IEC 61969-1:1999 IEC 61969-2:2000	IDT	GB/T 19183.1-2003 GB/T 19183.2-2003 Mechanical Structure of Electronic Equipment: Outdoor Casing
DIN 267-13:2007	IDT	GB/T 3098.8-2010 Mechanical Property of Fastener: Bolt Fastening Component for -200℃~+700℃
ISO 14731:1997	IDT	GB/T 19419-200 Welding Management Task and Responsibility
ISO 15609-1:2004	IDT	GB/T 19867.1-2005 Arc Welding Process Regulation
ISO 15609-5:2004	IDT	GB/T 19867.5-2008 Resistance Welding Process Regulation
ISO 2808:2007	IDT	GB/T 13452.2-2008 Determination of Paint Film Thickness of Color Paint and Varnish
ISO 8501-1:2007	IDT	GB/T 8923.1-2011 Visual Evaluation of Surface Treatment Cleaness of Steels Before Painting

ISO 3746:1995	EQV	GB/T 3768-1996 Acoustics--Determination of sound power levels of noise sources using sound pressure--Survey method using an enveloping measurement surface over a reflecting plane
ISO 544:2003	MOD	GB/T 25775-2010 Welding Material Supply Technical Conditions-Product Type, Size, Tolerance and Symbol
ASMEB16.5:2009, EN 1092-1:2007	MOD	GB/T 9124-2010 Technical Conditions of Steel Pipe Flange
API 598:2009	MOD	GB/T 26480-2011 Valve Inspection and Testing
ASTM D3951		Standard practice for commercial packaging
AWSD1.1		Structural welding code -steel
BS5493		Code drafting committee prevention of corrosion
EN ISO12944		Corrosion protection of steel structures by protective paint systerms
API677		General purpose for Gearbox
API 671		Special purpose for coupling
AGMA		American gear manufactures association
ANSI/HI12.1-12.6-2005		Rotodynamic centrifugal slurry pumps for nomenclature definitions ,applications and operation
ISO 4413:1998	EQV	GB/T 3766-2001 Hydraulic fluid power-general rules and safety requirement for safety requirements for systems and their components

1.4 Process Technical Parameter of Pumps

Pump No.	Service	Head	Pulp capacity (m3/h)	Pulp Density (t/m3)	Water capacity (m3/h)	Solid capacity (m3/h)
1&2	Primary Ball mill sump to cobber	18	226	1.22	212	42
3&4	From cobber sump to primary cyclone	30	80	1.5	66	54
5&6	From Secondary Ball mill sump to secondary cyclone	30	263	1.43	225	149
7&8	From mixer to drum filter	15	48	1.77	38	45
9&10	To Evo Wash Screen	18	226	1.22	212	42
11&12	From thickener to buffer tank	10	78	1.41	62	50
13&14&15	From buffer tank to filter press	20	78	1.41	62	50

2. Design Requirement

This specification covers the minimum requirements for the design, manufacture, assembly, testing, painting, supply, transport and documentation of the centrifugal slurry pumps.

Selected equipment shall be in all respect within the range of the manufacturer's proven experience and not involve the use or application of any prototype design or component.

Compliance with the provisions of this specification does not relieve vendor from the responsibility of supplying equipment of satisfactory and proven design, mechanically suited to meet operating guarantees at the specified service conditions.

The pump shall be supplied completely with driver, coupling, base plate and all other accessories which are required for safe operation of the pump.

In the event of conflict between codes and/or standards, this specification precedence to reference codes / standards. In case of conflict between the various documents, their order of precedence is as follows:

- Purchase Order and Variations thereto
- Data Sheets
- This Specification
- Other relevant standards

Any deviations to this specification, data sheet, codes, standards etc., shall be clearly listed in the supplier’s bid

2.1 Quality assurance

The supplier shall have sound quality assurance system and submit complete quality assurance plan along with the bidding document. This plan includes quality assurance procedure, organization method, related personnel qualification certificate and each activity affecting the project quality such as design, purchasing, manufacturing, transportation, installation, commissioning and maintenance. The vendor shall have full time staff responsible for quality assurance.

Quality assurance plan shall clearly mention following points:

- Vendor goods supply source inspection and control:
- The purchased equipment or material technical documents control;
- Material control;
- Special process control;
- Site construction supervision
- For important parts test run witness and quality control activity, the purchaser's representatives shall be involved and the purchaser has the right to analyze and correct the activity which is not meeting the purchaser's requirement.
- Equipment design shall meet related standard and regulation requirement and full consider local environment condition and using condition influence.
- Equipment material adopts high quality material which can meet using condition. For selection of components, the basic principle is advanced, mature and reliable technology, safety and durability. Disused product is strictly prohibited.
- The vendor proposes construction site installation notes and installation quality assurance method.

2.2 Performance requirement

2.2.1 Pump performance parameters shall meet this specification、purchasing list and related data sheet requirement .

2.2.2 The manufacturer confirms pump allowed working scope and provide performance curve (head, shaft power, efficiency, meet NPSH and flow relationship curve).

2.2.3 The selection process for centrifugal slurry pumps needs to include consideration for impeller size and design for solids passage, appropriate shaft seal possibilities and optimum, long life material selections.

2.2.4 Unproven, prototype or "first-off" equipment is not acceptable, only proven equipment may be used. Proven equipment is defined as equipment that has been in continuous

operation elsewhere for a minimum of two years without major breakdowns, on similar duties, and under similar conditions. In this context, similar does not mean absolutely identical. However, casings of given sizes and pressure ratings must have been operated at powers and speeds of the same order of magnitude on the application under consideration. Supplier is to provide an experience list within the bid .

2.2.5 Vendor shall specify the following data for each pump item in his proposal:

i. The maximum sound pressure level for pump and its driver (dBA) .

ii. Percentage of shut - off head to rated head .

iii. Minimum steady flow

iv. BEP capacity

v. Pump BKW

vi. Maximum power at rated impeller

vii. Driver power

viii. Percentage of head reserve for installation of maximum diameter impeller

ix. Proposed sealing type .

x. Suction specific speed

xi. NPSHR at rated point

xii. Maximum NPSHR at maximum capacity

xiii. Design temperature

xiv. Design pressure

xv. Hydro test pressure.

xvi. Material of all parts

xvii. Pump and Driver mounting

xviii. Gland Water Seal quantity and pressure requirement

2.2.6 The pump manufacturer shall be responsible for consideration of mesh/pulp affect on pump performance and use of applicable percent of solids and particle size correction factors based on given slurry composition as listed in the data sheet.

2.2.7 Best efficiency point for the furnished impeller shall be specified by vendor and it is preferred to be between the rated and the normal point .21.2.8 Pumps having a shut off head not exceeding 120% nor less than 110% of the rated head are most preferable .

2.2.9 The NPSHA shall exceed the NPSHR at least 1 m throughout the operating range .

2.2.10 The sound pressure level at any point 1 m from the pump unit shall not exceed 85 dBA .

2.2.11 The impeller shall have the characteristic of decreasing head with increasing capacity from shutoff to operating point.

2.2.12 The velocity at which the slurry pumped within the pipeline must be evaluated to ensure sufficient velocity will be available to maintain the solids in suspension while they are being pumped for preventing blockage of the pipe .

2.2.13 Ease of maintenance and minimum spare parts requirement is of prime consideration in the selection of the equipment .

2.2.14 If pumping liquid contains slurry plus bubbles, the actual flow rate shall be calculated considering the product of slurry flow rate and froth factor.

2.2.15 Material shall be in accordance with ASTM/AISI。

2.2.16 SPARE PARTS AND SPECIAL TOOLS

Vendor is to include in his proposal recommended special tools and spare parts for start-up, commissioning and two years operation, indicating price and delivery.

2.2.17 PAINTING

Painting of slurry pumps shall be in accordance with project painting specification document .

2.2.18 Pumps handling fluids at temperature exceeding 120 C shall have liquid cooled bearings .

2.2.19 Centrifugal pumps shall be normally motor driven, but consideration shall be given toother type of drive where particularly suitable and economical.

2.2.20 Pump speeds of 1500 RPM are preferred in the case of electric motor drive. Lower or higher speeds may be adopted if required, as per design

2.2.21 Drives shall be furnished with all vertical pumps as a unit. In case of horizontal pumps, they shall also be furnished with drives as a unit when so specified on data sheet.

2.2.22 Wherever applicable, mechanical seals of an approved type shall be used. For pumps handling highly volatile and toxic liquids, mechanical seals shall be fitted.

2.2.23 Motor drives shall be sized in accordance with API Specification 610, unless otherwise specified.

2.2.24 Flanges shall be as per ANSI/ASME B 16.5.

2.3 Structure design requirement

2.3.1 Motor

Motor shall be selected as per pump running condition max shaft power. When the power is not more than 100kW, motor power shall not be less than 1.2 times of pump max shaft power. When the power is more than 100kW, prime motor power shall not be less than 1.1 time of pump max shaft power. Size the motor to have enough power to operate at the factored flow rate at the highest expected specific gravity

The driver shall be selected among the following types：

i. V-Belt

ii. Motor + Gear Box

iii. Variable Speed Motor

Belt drives are limited to 200 kW and shall be variable pitch types and furnished complete with suitable guards and protection complying with all prevailing safety standards and codes.

Guards for V-belt drives shall be designed to accommodate the maximum diameter sheave combinations and the maximum centre to centre distance required for design conditions. Belt drives shall be designed for 1.5 service factor.

Where a motor size exceeds the practical limitations for V-belt applications, a direct coupled motor in conjunction with a speed reducing gear box can be selected.

If variable speed motor is selected, it shall be variable speed eddy current type. Eddy current drives shall be air-cooled with minimal slip characteristics. Speed control equipment, accessories and design requirements shall be in accordance with the variable speed drive specification and data sheets included with this specification.

All motors shall be suitable for operation in area classification and conditions as specified in the relevant data sheet.

Drivers shall have horsepower ratings at least equal to 110 of the design brake horse power.

All electrical equipment shall comply with standards stated in electrical systems design criteria.

a. V-belt Driver

Flat belt drives shall be used when the center to center distance of the drive and driven pulley is large and velocity ratio is low.

Pulleys shall be designed to keep down the friction value of the face surface and for the ability to resist load, shock and heat. Where ease of removal and assembly is required split design shall be adopted.

Normally crown face shall be furnished. Only pulleys for shifting belts shall be provided with straight face.

Wherever required, fly-wheel effect shall be considered.

V-belt drives shall be used for higher velocity ratio up to 10.

When V-belts are used for power transmission, V-belts shall be used up to 200 KW power at proposed velocities up to 35m/sec.

They shall be supplied as complete units including belts, sheaves, facilities for belt take up belt guards, belt guard brackets, and all accessories required for installation of the same.

V-belts shall be supplied in standard lengths. They shall be in matched sets for all multi-belt drive applications, and the belts shall be checked for balance to eliminate excessive vibration.

Sheaves shall be statically balanced for all applications involving belt speeds up to 1500 m per minute. Sheaves shall be statically and dynamically balanced for all applications involving bet speeds above 1500 m per minute. Dynamic balancing shall be performed for application involving slower belt speeds if vibration problems occur. All sheaves shall be furnished with tapper-lock hubs.

Pulleys for V-belt drive should be designed to keep down the friction value of the face surface. For large size pulleys split design shall be adopted as far as possible for easy removal and maintenance.

Belt tensioning device shall be provided for all belt drives, it shall be located on the pulling force side of the drive system.

2.3.2 Critical rotation speed

The pump operating speed shall not be greater than seventy percent of the first critical speed of the combined rotating elements at the specified maximum operating conditions. Moreover, the rotors shall be of rigid type, having the first critical speed at least 20% higher than maximum operating speed.

2.3.3 Balance

Metal impeller or rubber lining metal frame shall have balance test.

2.3.4 Casing

（1） The casing shall take max working pressure or water test pressure within allowed working scope.

（2） Water test pressure is 1.5 times of pump max working pressure (for double shell pump, not less than 1.25 times). No leakage is allowed in the pressure maintaining time.

（3） Suction inlet and outlet flange shall take pump allowed max working pressure.

（4） Casings shall be designed to permit removal of the rotor or inner elements without disconnecting the suction or discharge piping or moving the driver.

（5） The casing shall be of single wall, radially split, end suction, semi-volute or annular type with large clearance at the cutwater.

（6） Suitable materials shall be selected with rubber lining.

（7） Rubber lining shall be replaceable and shall be of the composition required for reliable service with the reagents and other foreign liquids that may be present in the slurry as listed in the data sheet by type and percentage.

（8） Pump casings shall be equipped with flanged connections for vent (unless the casing is self – venting) and drain. These connections shall be at least ½ inch in diameter and covered with carbon steel plugs.

（9） The pumps shall always be supplied with flanges according to ASME B16.5 standard (the latest edition).

（10） The maximum allowable working pressure shall apply to all parts referred to in the definition of pressure casing.

（11） If needed, provisions shall be made for preventing air locks by providing a froth vent pipe.

2.3.5 Impeller

（1） Impeller shall adopt closed, half open type or full open type structure.

（2） Impeller shall fix at the shaft firmly to prevent circumferential direction or axial movement.

（3） When the impeller axial direction gap required adjusting, external adjusting mechanism will be provided.

（4） Rubber liner impeller max head is not more than 63m and max allowed linear speed is not more than 30m/s.

（5） The impeller shall be of one-piece construction and shall be statically and dynamically balanced.

（6） The type of impeller shall be selected considering the type of slurries mentioned in datasheets and shall be chosen among closed, semi-open or open type with Plain or Francis type vane having pump out or expelling vanes on the back and front shroud because of reducing pressure and inhibiting recirculating flow back to the impeller eye and keeping solids out of the gaps between the casing and impeller by centrifugal action.

2.3.6 Shaft and shaft sleeve

（1） Pump shaft each position diameter shall have strength check as per max shaft power and highest lift according to the third strength theory. The max combined stress shall not be more than 30% of all material yield strength limit or 18% of tensile strength limit.

（2） For the thread rotation direction in the shaft, its connection piece shall be closed when the shaft is rotating.

（3） The shaft shall keep two ends center hole.

（4） Padding shaft sleeve shall be provided between the shaft and padding. Padding shaft sleeve excircle surface hardness shall not be less than 50HRC.

（5） Shaft sleeve shall be fixed at the shaft firmly to prevent the liquid leakage between shaft and shaft sleeve.

（6） For the pump used packing seal, the shaft sleeve shall extend outside of gland end face.

（7） The shaft shall be made of the corrosion and wear-resistant materials. Protection

by a deposit of metal or ceramic material either on the sleeve or on the shaft itself may be accepted with the purchaser approval.

（8） High speed shafts shall be designed for critical speed. The ratio of critical speed to speed of shaft shall be in the range of 0.8-1.2.

（9） Long shaft shall be supported on bearings with proper center distance.

（10） Shafts shall be easily accessible throughout their lengths and shall be designed as far as practicable in interchangeable lengths.

（11） All steel shafting 150 mm or less in diameter and not requiring enlarged portions (as for gear or other hubs) shall be hot rolled and turned, forged and turned, cold rolled or cold drawn. All forged shafting shall be annealed or normalized before machining and then heat-treated, if necessary.

（12） The deflection in line shaft shall not exceed 1 mm per meter of length.

（13） Shafts and axles shall be checked for endurance and strength. In proportioning shafts, allowance shall be made for keyways and splines. Change of sections in shafts and axles shall be made with due allowance for stress concentration.

（14） Shafts shall be designed with a minimum number of steps. The length of the shaft portions of various diameters should be, as far as possible, equal. Provision shall be made for a groove between adjacent steps. Maximum unification of the radii of curvature shall be ensured.

（15） Splines, tapered ends on shafts shall generally conform to the following DIN standard: DIN 5480 Straight-sided splines (for cylindrical shafts)

2.3.7 bearing housing

Generally adopt rolling bearing, lubricated by thin oil or grease; its operating temperature shall not exceed 75.

（1） The gap on the bearing body connected with the outside shall be able to guard against dirt and prevent loss and leakage of lubricating oil (grease) under normal operating conditions.

（2） In case the bearing is lubricated by lubricating oil, the bearing body shall be provided with oil drain and oil level indicator.

（3） Bearing selection shall be based on maximum axial and radial loads imposed by pump and driver throughout the full operating range.

（4） Bearing design shall be based on the Anti-friction Bearing Manufacturer's Association B-10 minimum life of one hundred thousand (100,000) hours.

（5） Bearing arrangements shall be designed for ease of maintenance and replacement and shall be complete with all required lubrication and/or cooling systems.

（6） In heavy duty services, roller bearings with separate roller thrust bearings shall be used. Designs with ball bearings are suited only for light service pumps.

（7） Bearings lubricated with grease shall be fitted with grease caps having an opening for the evacuation of grease.

（8） The appropriate dynamic coefficient for duty regime shall he considered for designing antifriction bearings.

（9） Roller and ball bearings shall be fitted with grease or oil seals. Oil bearings shall be fitted with caps-finished male or female, and provided with split removable shells, except sealed bearings.

（10） Bearings shall be arranged to prevent oil running along the shaft and dropping on other parts of the machinery. Types of bearings shall be held to a minimum.

（11） The ball and roller bearings shall generally conform to IS0-15, IS0-1 04 and IS0-355.Self-aligning bearings shall generally conform to ISO 6124/1 and 6125.

2.3.8 Shaft seal

The shaft seal of pump could adopt mechanical seal, packing seal, auxiliary impeller plus packing seal and other seals.

The complete seal system including accessories shall be supplied by pump vendor. Also, Shaft sealing shall meet the specified operating requirements and shall be easily maintained and replaced.

Seal flushing system requiring external sources will be completely described on the manufacturer's construction drawing.

2.3.9 Base plate

Bracket and support shall have sufficient strength and stiffness, the installation surface of bracket shall be flat.

(1) Direct-drive horizontal pumps shall be mounted on a common base plate supplied by the pump vendor. The layout of skid shall allow easy access for maintenance without the need for disassembling auxiliaries.

(2) The vendor shall carry out the fitting up and preliminary alignment of the driver and the pump on the common base plate at his shop.

(3) The vendor shall supply driver fitting bolts, leveling shims and jackscrews (if required).

(4) A lifting ring or other equivalent device shall be provided to facilitate handling the frame and associated assembly if it’s mass exceeds 27 kg.

(5) The vendor shall provide jackscrews for the electric motors having power ratings over 30 kW.

2.3.10 Pedestal

The pedestal shall be able to sustain the forces and moments from the pipe and make the coaxiality of bearing from pump motor not exceed specified value. Sufficient numbers of grouting hole with diameter no less than 100mm or that with equivalent areas shall be set on the pedestal.

2.3.11 Transmission elements device

（1） The transmission of pump could adopt extended diaphragm coupling, elastic pin coupling, gear reducer or hydraulic coupler, etc. The transmission shall be furnished with safety hood.

（2） The transmission shall be able to transmit the maximum torque of motor.

（3） Couplings shall be designed for the maximum torque to be transmitted. Couplings shall be designed to suit the maximum torque required to be transmitted or

to suit the total braking torque of the mechanism whichever is greater.

（4） All couplings shall be flexible spacer type.

（5） All couplings shall have rigidly supported removable non-sparking coupling guards for personnel protection to prevent any physical contact with moving parts. Coupling guard may be of the manufacturer's standard type. They must be able to withstand the weight of about 75 kg without permanent deformation.

（6） It is preferable to use forged materials for couplings. Bolt connection of the couplings shall be easily accessible for inspection and tightening.

（7） Flexible couplings shall adequately provide for lateral and angular misalignment and longitudinal displacement of shafts. Maximum permissible misalignment taken up by coupling shall be stated by the Manufacturer.

（8） Couplings shall have enough torsional flexibility to reduce starting and running shock loads so that quiet and smooth running is obtained.

（9） Couplings requiring lubrication shall have protection against dirt and dust either incorporated into their design or shall have steel covers tightly and smoothly fitted over.

（10） Flexible couplings shall preferably be of gear type, especially where direction of rotation is reversible in operation. The hardness of gear coupling casing and toothed bush shall be more than 220 BHN.

（11） Where the driven unit operates at speeds other than the motor speed, and where speed reduction or increase is required through use of motorized reducers, motor and individual reducers, or a combination thereof, all component members shall be connected to each other through gear-type flexible couplings.

（12） Couplings shall be of modern, compact design for given required torque and horse power capacity. All couplings shall have adequate service factor for required horse power, rpm and duty. Wherever required fluid coupling shall be provided with air breathing and coolant facilities.

2.3.12 Hoisting

Hoisting device shall be provided for the heavier components and parts in pump apparatus.

2.3.13 Pillow Blocks

Pillow blocks shall be adapter-mounted with double row taper or spherical self aligning roller bearings. (According to ANSI & AFBMA STANDARDS)

One pillow block shall be of "fixed type" and the other of "expansion type" to provide for shaft thermal expansion. Pillow block housings shall have end closures where possible. Housings are to be oriented on the supporting structure in such a manner that no shaft loads will be transmitted to the housing cap. The housings shall be heavy cast iron or cast steel construction or made of fabricated steel. Centralized lubrication system with suitable hand pumps shall be considered, if many large size pillow blocks are located within a limited space.

2. 3.14 Key:

Machine components subject to torsion shall be fitted with parallel or taper keys. Wherever required, jib head taper keys shall be used or reversing loads shrink fits are preferred.

Keys shall be designed for crushing and shear corresponding to maximum load acting on mechanism.

The dimensions of keys and keyways shall generally conform to DIN standards, DIN 6885 and DIN 271 or comparable national standard Maximum unification of the width of keyways is preferred.

2.3.15 Gears

All straight and helical spur gear-teeth shall be produced by process of generation and shall normally be used for all motions. The gears shall conform to the following ISO standards: ISO 53, ISO 54.

Gear boxes shall be mounted on common base plate or directly grouted on the concrete foundation. The gear box housing shall be of fabricated or cast steel: cast iron housing for low torque transmission may be permitted.

The inside surfaces of gear boxes shall be sandblasted and painted with oil resistant paints.

The gear boxes shall be provided with breath vents and easily accessible drain plugs. Bearing housings, if removable, shall be dowelled or located by spigots.

Gear transmission must be properly lubricated. In case of totally enclosed gear boxes splash or automatic lubrication system shall be used. On horizontal gearing, the oil level shall reach the smallest gear.

On vertical gearing, level of oil bath shall be sufficient to provide adequate lubrication and heat transfer without causing churning. Oil pumps shall be used if necessary.

Gear drives shall generally be designed for cooling by natural convection under normal plant working conditions. In the case of large drives external cooling by fans or heat exchangers may be acceptable.

2.4 Material requirements of major components & parts

Material performance of major components and parts of pump shall not be lower than the provisions shown in Table 1.

Table 1 Materials of pump major components and parts

Name of components & parts	Material name or designation	Code of standards
Bearing body	HT200	GB/T 9439
Bracket	QT450-10	GB/T 1348
Pump body & cover of double casing pump	ZG230-450	GB/T 11352
Impeller Sheath,guard plate Pump body & cover of single casing pump	Wear resisting white cast iron	JB/T 6880.3
Auxiliary impeller, pressure relief cap	HT200	GB/T 9439

	QT450-10	GB/T 1348
	Stainless acid resistant steel	GB/T 2100
	Wear resisting white cast iron	JB/T 6880.3
Shaft	45	GB/T 699
	40Cr	GB/T 3077
Shaft sleeve	45 (chrome-faced)	GB/T 699
	30Cr13	GB/T 1220

If the flow passage components could meet requirements of medium and operating conditions, other materials could also be adopted.

2.5 Manufacturing

2.5.1 Casting

（1） Casting head, burr, oxide scale, burnt-on sand and casting lump/agglomeration, etc. on the casting shall be removed, no defects such as pore, porosity and crack reducing strength are allowed.

（2） Gradual repair welding is allowed without affecting working conditions.

2.5.2 Welding

Type and dimension of weld seam and groove for components and parts of carbon steel and low alloy steel shall conform to the provisions of GB/T985.1 and GB/T985.2, defects that reduces usability such as incomplete penetration, pore, crack, burning through and slag inclusion are not allowed.

2.5.3 Assembly

（1） All components and parts shall be assembled only if they are up to the standards.

（2） For the assembled rotor component, the circle run-out on external round surface of shaft sleeve shall not be higher than the provisions in Table 2.

Table 2 Correspondence between shaft excircle and circle run-out unit: mm

Excircle of shaft (or shaft sleeve)	120	>120~250	>250~500
Circle run-out	0.08	0.10	0.12

（3） After pump assembly, rotating rotor shall be adjusted, no clamping/binding. Pump with packing shall be checked before the packing is not compressed.

（4） After rust prevention and painting, the pump suction inlet and discharge outlet shall be tightly covered by the cover board.

（5） After assembly, the axial adjustment of pump impeller shall not be more than 8mm.

2.5.4 Rust prevent and painting

（1） The compatible/matched part interlocking-prone for the component material shall be coated with proper lubricant.

（2） Anti-rust oil shall be coated on the exposed finished surface after assembly.

（3） Painting for the pump shall meet requirements of JB/T 4297.

（4） After test, water in the pump shall be removed; components and parts prone to rust and corrode shall be re-conducting rust prevention.

2.6 Marking, packing and transportation

2.6.1 Firmly fix product label at the evident part of the pump.

2.6.2 Pump spindle rotating direction shall be indicated by cast arrows or arrow plate at the evident part of the pump, the arrows shall be red color.

2.6.3 In case the pump body and pump cover is of non-gray cast iron, material designation /trademark or code name shall be cast on the obvious part of exposed surface.

2.6.4 Vendor shall follow project Marking, packing and transportation technical specification.

2.6.5 When the Equipment is disassembled for shipment or components are fabricated without assembly, each piece shall be adequately identified for the Ease of assembly at Site.

2.6.6 All mechanical parts, all items with electrical or electronic components, all instrumentation, all fire able Materials or components or other material subject to damage by moisture shall be packed sealed with aluminum foil protection. For sensitive items such as the precision instrumentation and electronic, such cases shall be housed in standard containers for sea and road transport.

2.6.7 Small parts such as nuts, bolts, washers, small machine parts and similar items shall be corrosion protected, put into sealed plastic bags marked for identification and packed into a drum or box and shall be included in container. Welding rods shall be vacuum packed in metal cans and shall be included in a container.

2.6.8 For pieces which are not skidded, provisions shall be made for safe lifting by cables, i.e., lifting lugs or equal.

2.6.9 Fragile Materials, oil products and all inflammable and combustible Materials shall be separately packaged in suitable drums, cases, etc. and clearly identified.

3. Test and Inspection

3.1 General

3.1.1. Vendor shall submit a quality plan indicating the intended amount and type of tests and inspections that will apply on all parts. Purchaser will complete this quality plan by indication of the inspections and tests which will be witnessing or observing.

3.1.2. At least 6 weeks before the first schedule running test, the vendor shall submit detailed procedure for all running tests to the purchaser for his review and approval.

3.1.3. Pressure containing parts shall not be painted except for anti-corrosion primer until testing and inspections are completed.

3.1.4. The material test certification shall be given by vendor for all components.

3.2 Hydrostatic Test

3.2.1. All pressure containing parts including their fasteners shall be hydrostatically tested with clean water at ambient temperature (15°C minimum for carbon steel).

3.2.2. The test pressure for all pressure containing parts exposed to the pumped fluid shall be at least 1.5 times the maximum allowable working pressure (MAWP) of the pump.

3.2.3. The hydrostatic test shall be considered satisfactory when the test pressure is maintained for at least 10 minutes without visible leakage.

3.3 NPSH Test

NPSH test shall be conducted if margin between NPSHR and NPSHA is lower than 1 meter. Measurements shall also include a point at maximum allowable flow.

3.4 Performance Test

3.4.1. Unless otherwise specified each pump shall be given a performance test.

3.4.2. The pump curve derived from a performance test on water shall be corrected for the actual process medium. The rated point, shut-off, minimum continuous stable flow and maximum allowable flow shall be clearly marked on the curve.

3.4.3. Performance test shall be performed using water at a temperature less than 65 °C.

3.4.4. If the test is made with the contract electric motor, no speed corrections shall be made. If the pump is driven by the electric motor of the pump manufacturer's test bench, the results shall be corrected to the speed mentioned in the particular specification.

3.4.5. Substitute seal may be used during performance test.

3.4.6. During performance test, following additional conditions may be checked:

a. Vibration
b. Bearing Temperature

4. Guarantee and Quality Assurance

Guarantee and warranty should be based on the main contract.

4.1 Guarantee

The Supplier should guarantee that the equipment can be run normally as per the stated process requirements. The supplied equipment should not have the defects caused by improper engineering, material or structure, and can be safe and reliable run in the scope of maximum load capacity; the manufacturer should guarantee to adopt the high quality materials and advanced technology, and the performance can accord with the requirements of this technical specification and annex. For performance guarantees it should be mentioned that capacity performance in full 24 hours operation in 5 consecutive days (based on the main contract) should be realized and guaranteed.

4.2 Warranty

“Warranty Period” means 12 months of regular, reliable working of the Contract Plant commencing from the date of issue of Provisional Acceptance Certificate (PAC)