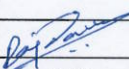

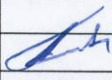


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1.0 GENERAL

1.1 Scope:

- 1.1.1 This specification together with technical specifications for enquiry and subsequently the purchase-order covers minimum technical requirements for Liquid-Ring type vacuum pump and compressor systems in general chemical process applications. This equipment's in vacuum generation applications are sometimes used in conjunction with ejectors and displacement vacuum pumps. In such cases, the equipment's other than liquid-ring vacuum pump shall be subject to a separate engineering specification and not covered herein. Where specified, the systems shall conform to the requirements specified in API Standard 681 also.
- 1.1.2 Various technical aspects of equipment design, construction and manufacturing (including materials, in-process & final inspections, preparation for despatch) described herein are based on particular application considerations in TKIS engineered plants.
- 1.1.3 Vendor shall make all possible efforts to comply with the requirements in full. Should the vendor consider it necessary to propose alternative design, which offers technical and/or commercial advantage to the purchaser, variance in respect of this specification shall be highlighted in vendor's proposal with sufficient explanation. Reduction in scope or basis of engineering & design shall not be considered as valid reason for alternative proposal.
- 1.1.4 Conformance with this specification is mandatory unless a specific deviation is highlighted by the vendor and prior approval from the purchaser is obtained in writing.
- 1.1.5 Mere compliance with provisions of this specification does not relieve the vendor from his responsibility of furnishing the equipment and accessories of proper design and mechanically suited to meet the operating guarantees at all specified service conditions.

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1.2 Supplier's Experience:

1.2.1 Vendor should have designed and manufactured the proposed equipment model (liquid ring pump or compressor as specified), at his works and should have reference of successful operation for at least two units in the last two years in comparable / similar service conditions. An installation list shall be submitted upon request.

1.2.2 In case the proposed manufacturing location is different from the principal location of supplier's works (as registered in TKIS records), the same shall be clearly stated in vendor's proposal with details of manufacturing and testing facilities, duration for which the facility is in operation, etc.

1.3 Bought-out items

Details of bought-out items drive motor, mechanical seal, coupling, fabricated vessels & coolers and instruments, as a minimum shall be given in the offer. Vendor shall normally provide bought-out items from purchaser's selected suppliers, if so requested in enquiry specifications.

1.4 Precedence

In case of any conflicting requirements, following order of precedence shall govern:

- a) Statutory regulations
- b) Requisition for enquiry and subsequently the purchase order
- c) Equipment technical data sheet
- d) Job specification (as applicable for a particular project)
- e) This specification
- f) Referred Codes & Standards

It shall be the responsibility of the vendor to also ensure compliance with any statutory regulations governing the supply of specified equipment type from its proposed location of manufacturing.

1.5 Codes and Standards

The current editions of the referenced publications, to the extent specified herein, shall be applicable

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- | | | |
|-----|-------------------------|---|
| 1. | MSS-SP 55 | Quality Standards for Steel Castings, Visual Method |
| 2. | ISO 1940 | Balancing Quality of Rotating Rigid Bodies |
| 3. | ISO 281-1 | L10 rating for antifriction bearings |
| 4. | DIN 50049
(EN 10204) | Inspection Documents for Delivery of Metallic Products |
| 5. | ANSI B16.1 | Cast Iron Pipe Flanges & Flange Fittings |
| 6. | ANSI B16.5 | Pipe Flanges and Flanged Fittings, Steel, Ni alloy and other special alloys |
| 7. | ASTM or equivalent | Material specifications |
| 8. | ASTM or equivalent | NDT method and acceptance criteria |
| 9. | ANSI or equivalent | Piping and fittings |
| 10. | ASME or equivalent | Design of fabricated components and Strength calculation |
| 11. | ASME or equivalent | Welding / fabrication methods. |

2.0 DESIGN AND CONSTRUCTION

2.1 Basic Design

2.1.1 The complete package shall be designed for continuous operation in an unsheltered outdoor installation. Other conditions of site location such as weather, max / min ambient temperatures, etc. shall be as specified in pump/compressor datasheet and shall be considered in selection of equipment and its auxiliaries.

2.1.2 Unless specified otherwise, the suction capacity value specified in technical specification shall mean the volume flow rate of fluid in gas-phase to be displaced from suction system at the specified pressure or vacuum. Vendor's proposal shall indicate correction factors or effective capacity curve based on service liquid temperature and condensation effect in inlet gas stream. Performance shall be stated for the specified discharge pressure (for vacuum pump applications) and specified

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suction pressure (for compressor applications).

- 2.1.3 Unless agreed otherwise, the system shall be suitable for running on air (atmospheric) during shop tests and commissioning. Vendor's proposal shall state extra provision required in his design and additional care to achieve this.
- 2.1.4 Where felt necessary by the vendor, suitable measures for cavitation protection in vacuum pump applications shall be incorporated in vendor's design and stated in its proposal. Use of vacuum breaker that draws-in atmospheric air shall not be used unless approved.
- 2.1.5 Service liquid and its mode of operation shall be as stated in technical specification. One of the following, i.e. fresh liquid supply (no recirculation), liquid circulation and make-up, close circulation with cooler shall be used. Requirement of a booster-pump in closed circulation systems shall be determined by vendor.
- 2.1.6 When a common discharge separator is provided, sizing of the separator shall be based on the simultaneous operation of running and standby pump/compressor.
- 2.1.7 When specified, the discharge separator shall be designed to separate condensed vapours from service fluid and allow removal of separated condensate.
- 2.1.8 Unless specified otherwise, design of coolers in service liquid re-circulation lines shall take into account the fouling factors for circulating fluid / cooling media as per specification. Use of plate type heat-exchangers that allow addition of plates for extra heat transfer surface shall be preferred.

2.2 Pressure Casings

- 2.2.1 Pressure containing parts (casing and cover including connected nozzles, shaft-seal housing, gland-follower or end-plate) shall be suitable for at least the specified relief valve set pressure at discharge. Where more than one compression stage is incorporated in a single casing, all parts of casing shall be designed for maximum allowable working pressure of the higher pressure stage. Pressure containing parts for

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metallic pumps/compressors shall have a corrosion allowance of min. 3mm unless otherwise agreed.

2.2.2 All fabricated parts, viz. separator, coolers and other pressure vessels shall have its mechanical strength calculated according to ASME Section VIII, Div.1 or equivalent.

2.2.3 Confined gasket designs that prevent blow-out on the atmospheric side, shall be preferred for radial split casing covers joints.

2.2.4 Pump/compressor designs that permit rapid and economical maintenance with standard tooling are preferred. When jack-screws are provided as a means of separating the contact faces, one of the faces shall be relieved (counter-bored or recessed) to avoid the possibility of creating a leak or poor fit. Hollow-head jacking screws should be avoided.

2.3 Nozzles & Miscellaneous Connections

2.3.1 Suction & discharge nozzles shall be flanged or studded and shall have drilling / facing according to relevant ANSI standards. Surface finish of the flange sealing area shall be 125 or 250 Ra (acc. To B16.1 or B16.5) or better.

2.3.2 Casings with double flow inlet or discharge connections shall be manifold into a single inlet / outlet connections.

2.3.3 Unless specified otherwise, the vendor shall make provision of make-up and draining of service liquid. Where required, it shall be automatic or through control valves.

2.3.4 Tapped openings in casings shall be seal-welded for flammable or toxic service. Tapped openings not connected to piping shall be plugged with solid plugs in same material as the casing or one in superior corrosion resistance. Tapped openings are not permitted for cast iron equipment for connections where disassembly is necessary for maintenance.

2.3.5 Provision shall be made for draining at lowest point(s) in the pump/compressor. Whether these connections are to be drilled and to be fitted with plug (or blind flange with isolation valve) shall be specified in technical specification. Auto drain system for casing shall be provided

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when specified.

2.4 Rotating Elements

- 2.4.1 Hollow rotors, if offered shall be by purchaser's approval only.
- 2.4.2 Means of external adjustment (without dismantling of the pump) of impeller axial clearance shall be provided where an adjustment is required by design.
- 2.4.3 Renewable shaft sleeves are preferred in the shaft sealing areas. When furnished, sleeves shall be positively locked onto the shaft and shall be not less than 2.5 mm thick. Sleeve shall have at least the same corrosion resistance as the pump casing and shall have outside surface to suit the specific seal application.
- 2.4.4 Pump rotating elements shall be balanced to G6.3 according to ISO 1940, as a minimum, after final machining. Two plane balancing is required when ratio of maximum diameter to width is less than 6.

2.5 Mechanical shaft seals

- 2.5.1 Unless specified otherwise, mechanical seal shall be furnished for shaft sealing. Mechanical seal shall be such that it provides sealing from or into the vacuum pump / compressor over entire operating range specified including start-up & shutdown. In vacuum service, the seal design shall be suitable to seal against atmospheric pressure also when it is not in operation.
- 2.5.2 Cartridge type mechanical seal shall be preferred.
- 2.5.3 When specified dual seal in tandem or back to back arrangement shall be provided. Seal flushing piping system including piping or tubing, fittings, valves, strainers, orifices, separators and instruments shall be provided by vendor.
Alternative proposals for flushing, if necessary, can be furnished at offer stage.
- 2.5.4 Single mechanical seals for pumps handling flammable & hazardous liquids shall be provided with a non-sparking throttle-bush to control leakage in case of complete seal failure.

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2.5.5 Seal flushing plan shall be designated as per HIS unless specified otherwise. Other nomenclature for designating the flushing plan can also be used by vendor, provided it is elaborated in his proposal.

2.5.6 For dual seals utilising thermo siphon pot (plan 52 or 53) for seal flushing, minimum requirements of such flushing systems shall be as follows;

- a. Seal pot volume shall be 9 litres as a minimum. Vendor shall consider higher volume based on expected seal-leakage rate to minimise topping-up interval.
- b. Seal pot and piping (including cooling coils) shall be made in AISI 300 series stainless-steel. Where cooling-coils are provided in the seal-pot itself, it shall be of seamless tube or pipe with minimum opening of 8 mm and 1 mm wall thickness. A reflex pad type level indicator shall be provided.
- c. Seal pot shall include a pressure-gauge and provision for venting and draining. These connections shall be provided with an isolation valve.
- d. Plan 52 systems shall include a fill-port with swing type lid, vent (with an orifice plate), pressure switch and when specified, a level switch.
- e. Plan 53 systems shall include a hand-pump for topping-up, pressurisation kit where pressurisation of bladder is required (one for a lot as loose supply), level switch and when specified, a pressure switch.

2.6 Bearings and Bearings Housing

2.6.1 Unless specified otherwise, the antifriction bearings shall be designed to meet an L-10 rating life of at least 25000 hrs, calculated in accordance with ISO 281-1 at loads acting on bearing corresponding to pump rated conditions. Pump/compressor vendor shall provide the calculation upon request.

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2.6.2 Bearing housings shall be made in ductile material (such as S.G. Iron or carbon-steel) and shall be constructed to protect the bearings from water, dust and other contaminants by incorporating Lip-seal, Labyrinth or Magnetic oil-seals in design.

2.6.3 Bearings housings for oil-bath lubrication shall be provided with tapped and plugged drain hole at its lowest point. Where grease lubricated designs are provided, means for grease relief shall be provided in design.

2.7 Materials

2.7.1 Material for major components shall be as specified in pump technical specification. Vendor shall state in his offer the equivalent ASTM, AISI or ASME designation of material used.

Chemical composition, Mechanical properties & Heat treatment shall be furnished if material designation as per American standards' equivalent (mentioned above) is not feasible. Decision of the purchaser in determining whether proposed material grade is acceptable for the service shall be final.

2.7.2 Unless agreed otherwise, material certification for major metallic parts shall be provided which shall be in accordance with BS EN 10204 / DIN 50049 of the type indicated in table below. Requirement of traceability for material certificates and shall be as specified in purchaser's requisition.

COMPONENT	MATERIAL CERTIFICATION CLASS
PRESSURE CASING	3.1
AUXILIARY PROCESS & SEAL PIPING	2.2
IMPELLER /SHAFT	3.1
SLEEVE	3.1
PRESSURE BOLTING	2.2
MECHANICAL SEAL HJARDWARE	3.1

2.7.3 Casting repair procedure shall comply with those specified in the relevant material specifications and shall be submitted for purchaser's approval. In general, repair of defects by plugging, pinning, and use of plaster

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sintered compound and welding for cast-iron material is not acceptable.

3.0 **ACCESSORIES**

3.1 **Driver**

3.1.1 Electric motor is excluded from pump vendor's scope of supply, unless otherwise specified. Motor shall be supplied by purchaser in accordance with vendor's recommendations. Special requirements, if any for smooth and satisfactory operation of the driven equipment & drive motor as a unit, shall be highlighted by vendor in his proposal.

3.1.2 Vacuum pump / compressor vendor shall have the unit responsibility for performance which includes specifying the complete requirements for drive motor or turbine (as applicable). Supply of motor or turbine fixing bolts, shims, couplings, guards shall be the in vendor's scope unless agreed otherwise.

3.1.3 Vendor shall provide, after placement of order, the following details for drive electric motor which shall be basis for drive selection.

- a) Recommended motor rating (kW), Synchronous speed, Direction of rotation (viewed from non-drive end), Shaft orientation (horizontal / vertical) & Method of mounting (foot / flange)
- b) Driven equipment rated kW
- c) GD² value for driven equipment and other components (viz. gearbox, coupling, etc.) in drive train, referred to motor speed.
- d) Speed / Torque curve
- e) Speed range in case variable speed arrangement.

3.1.4 Selection of electric motor KW rating shall be higher of those based on the followings -

- a) 115% of power required at rated condition
- b) 110% of power required at safety valve set pressure

Power required shall include power loss in transmission.

3.1.5 When the driver is also supplied by the pump vendor, it shall be in accordance with technical specifications of the purchaser.

3.2 **Couplings & Coupling guards**

3.2.1 Driven equipment shall be coupled to the drive by a non-lubricated

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flexible coupling or v-belts. Due consideration to high starting-torque shall be given in selection of couplings. Flexible couplings shall be one of – pin & bush, tyre type or flexible element type.

3.2.2 Unless specified otherwise, all drive system couplings shall be supplied by the vendor and in fully machined condition (finish bore and with keyway). Flexible type coupling shall be rated for a min. service factor of 1.5 over motor rated power, which in no case shall exceed the driven equipment's shaft strength.

3.2.3 Couplings shall be dynamically balanced to the same grade specified for impeller. Certificate to that effect shall be submitted as part of manufacturing record for the pump/compressor.

3.2.4 In case of v-belt drive systems, the pulleys would incorporate a taper bush for easy dismantling and assembly. Only matched sets of v-belts shall be used.

3.2.5 Coupling or belt guard shall be strong enough to withstand bodily contact of a person without distortion. If required, it shall be adequately strengthened by bracing. Guard shall be non-sparking type for services handling flammable gases.

3.3 Base Frames / Mounting Plates

3.3.1 Unless specified otherwise, all components of service liquid system, instrument panel (as applicable) and discharge separator shall be mounted on a common skid with vacuum pump / compressor. The bottom of mounting frame shall be in one plane for single level foundation.

3.3.2 Vacuum pumps or compressors and all other components of drive train shall be provided with machined mounting plates.

3.3.3 Unless specified otherwise, mounting provision for driver shall be made by the vendor even when the driver may have been purchased separately. Provision for vertical adjustment by shims (2 to 3 mm) shall be made. Mounting surfaces for pump/compressor, motor, gearbox, etc. shall have planarity and surface finish according to good manufacturing practice.

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3.3.4 Jacking screws shall be provided for each driver and gearbox to facilitate longitudinal and transverse adjustment, where the motor ratings are above 45 KW.

3.3.5 Unless specified otherwise, foundation or stilt or mounting bolts for mounting frame complete with nuts, washers and necessary inserts shall be supplied by the pump/compressor vendor.

3.4 Auxiliary Piping and Appurtenances

3.4.1 Auxiliary piping is piping or tubing may be required for the followings –

- a. Services which involve process fluids or liquids that can mix with process fluids, viz. seal flush, seal injection, barrier / buffer liquids, vent and drain, balance line, designated as Category 'A'.
- b. Services for liquids which do not enter the process, viz. quench, heating, cooling, designated as Category 'B'.

The minimum requirement for vendor's piping system design based on above criteria is discussed separately under Annexure I.

3.4.2 Unless agreed otherwise, all pipe work within the extent of supply according to technical specification shall be provided by vendor and shall be fully assembled within skid. Piping shall be duly supported and terminated with ANSI flange at the edge of the skid. Piping should be properly tagged with metallic strips.

3.4.3 A check valve at inlet shall be furnished by vendor for vacuum pump applications, unless agreed otherwise. When specified, a check valve and safety valve shall be provided by vendor at outlet of separator.

3.4.4 All piping system shall be provided with detachable joints to permit easy dismantling. Tube fittings shall be compression-type. Flanged joints shall be incorporated when specified or when greater than ¾" in size. Piping system design shall allow complete draining and avoid gas pockets. Pipes having inside diameter of 8 mm or more with minimum wall thickness of 1 mm only shall be used. If restriction-orifices area provided, its hole diameter shall be not less than 3 mm.

3.5 Protective Lining:

3.5.1 Rubber or other protective lining on piping, fittings and fabricated vessels

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shall be of uniform thickness. Spark test at 6 kV / mm thickness of lining and peel-off test shall be performed and record shall be part of supplier's documentation.

4.0 INSPECTION & TESTING

4.1 The inspection and testing requirements shall be as specified in the technical specifications. Inspection shall however, in no way release the supplier from guarantees as to materials, workmanship and performance of the equipment. A detailed procedure for shop performance testing shall be furnished upon request for purchaser's review & approval.

4.2 Pumps/compressor shall be tested at the rated speed (+/- 5% variation due to supply frequency is allowed) with vendor's shop motor (calibrated). Limitations in testing facilities shall be highlighted in supplier's proposal indicating alternatives for purchaser's review.

4.3 All internal test certificates shall be made available to the Inspection Engineer (TKIS / Client representative) prior to commencement of inspection. Only measuring equipment, which can be demonstrated to have been previously calibrated satisfactorily and still within the documented calibrated period, shall be used for inspection and testing.

4.4 Pressure casing including jackets shall be hydrostatically tested with liquid to at least 1.5 times the maximum allowable working pressure for minimum of 30 minutes. Test shall be acceptable, when no casing or casing joint seepage is observed.

4.5 Completely assembled package shall be subjected to an air leak test. Test shall be carried out at rated discharge pressure in case of a compressor and at pressure of 1 bar g minimum for a vacuum pump. Duration of test shall be min. 30 minutes and subjected to soap bubble test.

4.6 When a performance test is specified it shall be according to vendor's standard. Performance test procedure and acceptable tolerance for performance shall be stated in vendor's proposal and subject to Purchaser's approval.

4.7 Unless agreed otherwise, noise level shall be measured during shop

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tests.

- 4.8** Vibration shall be measured during performance test / MRT. The maximum unfiltered vibration at the bearing location shall be less than 4.5 mm/sec-rms.
- 4.9** Bearing or lubricating-oil temperature rise shall be lower than 40°C above ambient or 82°C. Pump/compressor may have to be run for sufficient duration to allow bearing temperature to stabilise. Where temperature is measured at bearing housing surface, the temperature rise shall not exceed 30°C above ambient.
- 4.10** Fabricated pressure containing vessels (such as discharge separator, seal flushing pots, filters, etc.), coolers (for seal flush, lube-oil, etc.) shall be separately hydro tested and certificates to that effect to be submitted.
- 4.11** After satisfactory completion of tests, the pump/compressor shall be completely drained and allowed to dry-up. Vendor shall consider applying 'water displacing rust-preventive paint' to the pump/compressor internal parts (bearing housing etc.) which may get affected either in transport or open storage at site.
- 4.12** Spares shall be offered for visual inspection. All the spare parts shall be properly tagged with TKIS item number and vendor's part number.
- 4.13** A final inspection may be carried out to verify the scope of supply, painting, preservation, tagging of loose parts, packing, etc.
- 4.14** **Material Inspection**
- 4.14.1 As a minimum following NDT requirements shall be offered :

Component	Required Material Inspection	Remarks
Castings	MPI / DPI	Critical Areas.
Forgings	MPI/DPI + UT	UT in case or shaft diameter > 100 mm. and/or Motor rating > 500 Kw.
Nozzle weld	MPI / DPI + RT(spot)	Spot radiography in case design pressure > 6 kg/cm ² .g.

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Butt weld	MPI / DPI + RT(spot)	Spot radiography in case design pressure > 6 kg/cm ² .g.
Fillet weld	MPI / DPI + RT(spot)	Spot radiography in case design pressure > 6 kg/cm ² .g.
Internals	Visual	Visual

- Additional inspection, viz. susceptibility to inter-granular attack, impact test may be required based on material specifications & service conditions or where specified in technical specifications.

5.0 PAINTING

5.1 Painting shall be of manufacturer's standard which shall suite the site conditions, viz. Corrosive atmosphere, dust, humidity, etc. as specified in technical specifications. Project specific painting specifications shall be fully complied with if provided with purchaser's requisition.

5.2 In general, Stainless steel, Aluminium, Lead, Plastic or other non-corrodible material need not be painted.

6.0 SPARE PARTS

6.1 Unless an alternative criterion is specified, vendor's proposal shall include provision of spares for pump/compressor and auxiliaries as given in Annexure II.

6.2 For the purpose of vendor's proposal spares are categorised into – Commissioning, 2-years operation and Capital spares. Commissioning spares are required for every pump irrespective whether specifically requested or not. 2-years operation and capital spares would normally be finalised at purchaser's discretion.

6.3 Spares to be supplied along with the main equipment would have testing (including material certification) to the same extent. The vendor shall also provide a certificate of compliance in respect of dimensional and material interchangeability with main components provided in main equipment.

6.4 All spares shall be individually packed and tagged for identification, which would mention part name / number & drawing no./ manufacturer's part

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no. Packing shall be suitable for unheated storage.

6.5 Special provision for storage of capital spares would be as per the requirements stated under technical specifications.

7.0 SUPPLIER'S DOCUMENTATION & RELEASE FOR DESPATCH

7.1 The vendor shall ensure that one complete set of its document updated for the project and specific to the equipment is prepared and made available to the inspector for checking at the time of final inspection. The extent of documentation shall be as specified in technical specification and complete with installation instruction, operation and maintenance instructions, lubrication and bearings schedule, procedure for preservation & lifting / handling of equipment, etc.

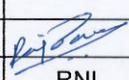

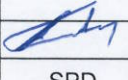
7.2 Unless specified, a nameplate in stainless-steel with details of – TKIS TON (or Item no.), Service, Drive motor rating, Speed, Speed reduction ratio, Bearing details, Supplier's name, equipment serial no. and year of manufacturing shall be securely attached with the equipment. When required the name-plate shall be made according to project standard.

7.3 The direction of rotation shall be marked for easy identification.

7.4 Equipment shall be normally despatched only subject to acceptance of tests at works, fulfilment of complete scope and work as defined in technical specification and completion of documentation by the vendor. In all cases, vendor shall await issue of 'Release-Order' from purchaser before despatching.

7.5 Unless specified otherwise, vendor is responsible for proper preparation for transport. Packing shall be suitable for the type of transport specified and un-sheltered storage for 6 months at job-site. As a minimum, exposed machined surfaces shall be protected with anti-rust paint (removable with thinner, etc.), loose parts shall be properly tagged, and spares shall be properly wrapped for long term storage with identification of part. Any special instructions for handling during transport and installation shall be prominently displayed on the packing. One set of vendor's final documents (without the test-reports) shall be also included in the packing.

Plant ---	Client ---	Contract Code ---	Document Identification Code PIN-LES-EQM-0016-A1	Contract No. ---
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Rev.	Status	Description	Date	Prepared	Date	Checked	Date	Approved	AC
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Plant ---	Client ---	Contract Code ---	Document Identification Code PIN-LES-EQM-0016-A1	Contract No. ---
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ANNEXURE - I

MINIMUM REQUIREMENTS FOR PUMP VENDOR'S PIPING SYSTEM DESIGN

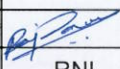
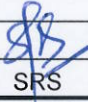
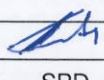
1.0 CATEGORY A

- a) Pressure and temperature rating shall not be less than that of pump/compressor discharge flange.
- b) Except for seal flushing systems in back to back seal arrangement or in back-up seal arrangement, the piping material shall have a corrosion resistance at least equal to or superior than that of pump/compressor wetted parts.
- c) Seal flush lines shall be seamless with minimum of 8mm inside diameter and 1mm wall thickness.
- d) Valve body up to sizes < 2" NPS and flanges shall be forged and welded construction.

2.0 CATEGORY B

- a) Cooling water piping shall not be smaller than the connections on the exchanger (if applicable) or at least ½" nominal pipe size.
- b) Except for cooling water piping, only seamless stainless-steel piping shall be used. Cooling water piping can be carbon-steel or galvanized steel.
- c) Pressure and temperature rating shall be selected based on condition for utilities indicated in technical specification.
- d) Cooling water piping shall incorporate a sigh-flow glass and thermal relief valve if blockable volume requires provision for relief due to temperature excursion up to maximum possible.

Plant ---	Client ---	Contract Code ---	Document Identification Code PIN-LES-EQM-0016-A2	Contract No. ---	
ThyssenKrupp Industrial Solutions (India)	Annexure II - Recommended Spare Parts				
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00		First issue	7/5/2015	RNI	7/5/2015	SRS	7/5/2015	SPD	-
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**ANNEXURE – II
RECOMMENDED SPARE PARTS**

Sr. No.	Part Description	Qty. for commissioning	Qty. for 2-year operations	Capital spares	Remarks
1	Rotor(s)		100%		
2	Set of Shaft sleeves		100%		
3	End shield / inlet cone		100%		
4	Set of gaskets & O-rings for pump and auxiliaries like cooler, separator etc.	100%	200%		
5	Mechanical seal cartridge or complete mechanical seal		100%		1 no. each if DE & NDE are different types.
6	Set of faces for mechanical seal	100%	200%		
7	Set of elastomers for mechanical seal assy.	100%	200%		
8	Set of oil-seals or labyrinths	100%	200%		
9	Set of flexible elements for coupling	100%	200%		
10	Set of bearings (DE & NDE)		100%		