



Technical Requisition For:

RECIPROCATING COMPRESSORS (API618)

Client: NIS AD, Novi Sad, Serbia

Project Number: U211

**Project Name: Replacement Of Rotary Equipment And Installations In Pancevo Oil
Refinery**

Location: Pancevo Oil Refinery

List of Attachments

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RECIPROCATING COMPRESSORS (API 618)

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1. GENERAL

1.1 This "**Technical Requisition**" is issued to cover minimum requirements for purchase, design, manufacturing, inspection, testing, shipment, and documentation of Reciprocating Compressors units including drivers and auxiliaries.

1.2 The equipment shall be in strict accordance with this Technical Requisition and all other documents, codes and standards referred to in the Technical Requisition and its attachments (as listed in the Technical Requisition index). Any **exception to the Technical Requisition** documents and referred codes and standards shall be clearly advised to Client (in writing as part of the bid).

1.3 **Order of precedence** to be used in realization of this job is as follows:

1st. Rules and regulations of Serbia,

2nd. Technical Requisition for the Compressors (this document) and all documents named in "List of Attachments" within this document.

3rd. Serbian or International technical standards.

4th. Vendor's specifications, documents and information.

Any conflict generated within this document and documents named in List of Attachments shall be referred to Client in writing for clarification and resolution.

1.4 Compliance with the Technical Requisition does not relieve Vendor from responsibility to deliver **equipment** of proper design, suitable for specified conditions. Any conflict between the Technical Requisition requirements and Vendor's opinion shall be clearly advised to Client (in writing).

Additionally, Vendor is responsible for:

- All co-ordination with sub-suppliers and collection of all details, drawings, data and all calculations to achieve optimum design and for submission of all documents requested.
- Engineering, performance and guarantee of the complete scope of supply of purchased materials.

In principal, all contacts with sub-suppliers shall be via Vendor.

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1.5 Following **terms** are used in this text:

Vendor: company selected for equipment delivery
 Subsupplier: company which provide particular equipment (e.g. pump, E-motor...) to Vendor
 WBD: project Contractor (Client's agent for design services)
 Client/Purchaser: company assigning the project and operating the plant (NIS Petroleum Industry of Serbia)

2. SCOPE OF SUPPLY

2.1 BY VENDOR

- Design, manufacturing and supply of equipment and material including relevant documents, inspections, testing etc. shall be, as a minimum, in accordance with this Technical Requisition and Reciprocating Compressors Data sheets included in the Technical Requisition.
- **Site Services:**
 Vendor's representative site supervision during equipment installation; SAT/COMMISSIONING and assistance during start-up (assistance during the process of putting compressors into operation)
 - During shutdown approximately 4 consecutive weeks (6 days per week; 12 hours per day), is required (if longer/lesser duration needed for supervision services, payments will be per daily rate all in accordance with the Agreement).
- **Consumables:**
 Vendor will provide all lubricants for pre-commissioning, commissioning and start-up including one year of operation after successful start-up.
- **Spare parts:**
 Spare parts for pre-commissioning, commissioning and start-up shall be included in the supply.
- **Special tools:**
 Special tools required for installation/maintenance (if applicable), shall be included in the supply.

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2.2 BY OTHERS

Exclusions from Vendor's scope are:

- Concrete foundation and grouting material.
- Off-skid Process piping (including on/off valves, instruments...).
- Wiring (cables) to electrical consumers and to instruments, out off compressor skid
- Cable glands.
- Local control station for E-motor (start/stop buttons).
- Equipment installation to the foundation and grouting (however it has to be done under Vendor supervision).
- First fill fluids (to be defined by Vendor, but supplied by others)

3. VENDOR'S OBLIGATIONS / RESPONSIBILITIES

- 3.1. Vendor shall assume full and overall responsibility for the complete scope of supply.
- 3.2. Vendor shall be solely responsible for providing complete and operable API 618 reciprocating compressors in full accordance with applicable industry codes and standards, Serbian regulations, and Purchaser's technical requirements.
- 3.3. Vendor's proposal shall be based on equipment that complies strictly with the requirements of tender documentation, and in conjunction with the technical requirements and listed attached documents. Any proposed exceptions shall be recorded within the TEDS" document and accompanied by a description of the proposed substitution.
- 3.4. Proven, reliable, energy-efficient equipment is required.
- 3.5. Vendor may offer alternative designs that improve energy efficiency without reducing equipment reliability.
- 3.6. Proposed design features having less than two years' operating experience shall be specifically listed and details of construction shall be provided for Purchaser's review and written acceptance.
- 3.7. Vendor is fully responsible for the complete design, performance, implementation of quality assurance procedures and inspection of materials and components, manufacturing, testing and certification of the complete unit in full compliance with the requirements of this Technical Requisition and applicable Codes, Standards and Regulations.
- 3.8. Vendor shall obtain and co-ordinate all sub-supplier equipment activities as required to

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provide fully functional unit in accordance with the documents and requirements referenced herein (all requirements as listed in this Technical Requisition and its referenced documents shall be also imposed on his sub-suppliers).

- 3.9. In principle all contacts and correspondence between Purchaser and sub-suppliers will take place via the Vendor, if any.
- 3.10. Vendor shall ensure compliance with Serbian code and authority regulations. This includes delivery of all documents required to satisfy the code, the regulations and authorities. Status of authority approval shall be forwarded to Purchaser on a monthly basis..
- 3.11. Bidder shall indicate any deviation from tender documentation requirements and Technical Requisition as integral part within it's bidd. Requirements specified in the Technical Requisition shall be considered as minimum.
- 3.12. It is Vendor's responsibility to design, manufacture and deliver equipment in line with requirements of this Technical Requisition. Applicable exceptions, if any, to be listed in TEDS form attached.
- 3.13. For any technical concession request after order, Vendor is obliged to sent to Client vendor concession request for approval. Technical concession request must include all cost and schedule impacts, material availability or delivery issues, if any. Insufficient information may result in rejection. The Vendor Concession Request requires Purchaser's verdict and signature prior to start of the related activities. Any cost consequences related to approved concession request will be at Vendor's cost.
- 3.14. Any increased cost due to changes in the design or fabrication to meet the requirements of this Technical Requisition which are not caused by Purchaser and define through approved technical concession request by Purchaser are at Vendor's cost. If changes are caused by Purchaser cost will be at Purchaser. It will be regulated through change request.
- 3.15. Vendor shall perform all NDE examinations and testing using properly qualified personnel or subcontractors In order to fulfill requirements from Serbian legislation.
- 3.16. Vendor is responsible for all coordination with sub-suppliers and collection of all details, drawings, data and all calculations to achieve optimum design and on time submission of all documents requested in the Technical Requisition.
- 3.17. Purchaser's review of Vendor's documents does not relieve the Vendor of his responsibilities to deliver equipment, documents and services conforming to this Technical Requisition.
- 3.18. Any inspection performed by Purchaser in no way relieves Vendor of his responsibility for equipment to meet the requirements of the Technical Requisition and Serbian legislation.
- 3.19. Vendor is obliged to submit all documents defined in SDR (for all disciplines) within MDB package for Client approval. Documents must be approved by Client prior shipment of equipment.

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- 3.20. Final documentation (MDB) shall be submitted by Vendor in 1 (one) hard copy and 1 (one) electronic copy in English language (with exception of IOM manual with should be included in MDB in both: Serbian and English version, as defined in SDR). Electronic copy have to be “searchable” in the most extent (excluding scanned material certificates and similar documents). Binding and printing requirements will be provided by Client.

4. CODES, SPECIFICATIONS AND STANDARDS

- 4.1 Unless otherwise specified, the latest edition of the specifications, codes and standards as specified in this Technical Requisition and/or its attachments shall be adhered to for the design and material requirements. As such, these documents form part of the Technical Requisition. It shall be Vendor's responsibility to acquire all required codes and standards.

- 4.2 The following listing shall not be considered as complete in case a reference is made in the below mentioned codes, specifications and standards to other relevant codes, specifications and standards these shall also be considered as applicable:

- Project specifications as per documents listed in Attachments.
- Serbian, international codes and standards referred to in Technical Requisition; latest edition unless specified otherwise.

4.3 Order of Precedence

The order of precedence shall be the latest revision of the following:

1. Serbian regulations, standards and codes.
2. Technical Requisition including all documents listed in Attachments
3. International codes and standards

Any conflict generated within the Technical Requisition not solved by the order of precedence shall be referred to Purchaser in writing for clarification and resolution.

5. AUTHORITY APPROVALS

- 5.1 Serbian **authority approvals** (certificates) shall be arranged and delivered by Vendor. This includes submittal of all required documents, assessment of design, arrangement of inspection and tests and obtaining certificates of conformance.

Serbian authority regulations that have to be adhered:

- a) For pressure equipment:

- “PRAVILNIK O OPREMI POD PRITISKOM” (Sl. glasnik RS, br. 114/2021) - Serbian Rulebook for pressure equipment

b) For non-pressure equipment Vendor is obliged to address to the Ministry of Economy in Republic of Serbia for approval of foreign conformity documents

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c) For electrical equipment placed in hazardous area:

- "PRAVILNIK O OPREMI I ZAŠTITNIM SISTEMIMA NAMENJENIM ZA UPOTREBU U POTENCIALNO EKSPLOZIVNIM ATMOSFERAMA" (Sl. glasnik RS, br. 10/2017 i 21/2020) - Serbian rulebook on equipment and protective systems intended for use in potentially explosive atmospheres

d) For machinery:

- "PRAVILNIK O BEZBEDNOSTI MAŠINA" (Sl. Glasnik RS. br. 58/2016 i 21/2020) - Serbian rulebook on machinery safety

In accordance Serbian legislation and standards shall nameplate also bear Serbian mark of conformity "3A".

5.2 "CE" MARKING

Equipment, materials and components which are "CE" certified, shall bear "CE" marking (if applicable) and shall be compliant to applicable EC or EU Directives, such as, but not limited to:

Vendor shall supply all authority documents required by EU legislative:

- Declaration of Conformity is required for complete equipment and also for particular equipment parts (components). Mandatory codes and specifications shall be specified in the declaration.
- Certificates of Conformity issued by Notified Body according to EU directives (if applicable).

Each piece of equipment (including instruments) shall be clearly identified by a nameplate, permanently attached to the equipment.

Vendor shall supply all authority documents required by EU legislative:

EC Declaration of Conformity in accordance with all relevant EU directives (especially e.g. for electrical equipment: LVD 2006/95/EC (73/23/EEC), EMC 2004/108/EC (89/336/EEC), ATEX 94/9/EEC etc.).

EC Declaration of Conformity is required also for particular equipment parts (components).

All equipment, material and components included in the delivery shall be "CE" certified and shall have "CE" marking (if applicable).

EC Certificate of Conformity issued by Notified Body, according to EU directives (e.g. ATEX 94/9/EEC, etc.).

All "CE" certified equipment shall be recertified in Serbia for approval of foreign conformity documents.

- 5.3 Vendor shall include all authority documentation, approval documentation, certification, etc, in the manufacturing data books.



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6. ENGINEERING REQUIREMENTS

6.1 GENERAL

- 6.1.1 Requirements for reciprocating compressors are based on API Standard 618, "Reciprocating Compressors for Petroleum, Chemical, and Gas Industry Services," latest edition.
- 6.1.2 Requirements of this specification are supplementary to API 618, forming a single set of specification requirements for reciprocating compressors.
- 6.1.3 Requirements in the API standard which are not ammended by or mentioned in this specification remain applicable.
- 6.1.4 "Technical Requisition" including all documents listed in Attachment shall be applied for this project.
- 6.1.5 "**SI**" **units** shall be used (except of "bar" required for pressure).
- 6.1.6 Equipment shall be designed for **four (4) years of uninterrupted service** (scheduled plant overhaul interval is 4 years) under conditions specified herein.
- 6.1.7 Unless otherwise stated in Data Sheets, Outdoor, **unsheltered installation** is considered. Vendor shall design proper winterization measures (e.g. scope of electrical tracing and insulation – supplementary material will supplied and installed by Client). See "Site & Utility Data-Sheet" (U211-PR-DS-0002) for climatic conditions and design conditions.
- 6.1.8 Equipment shall be **delivered pre-assembled** to the maximum possible level. All components (include auxiliaries or seal flush plan), after assembly, must be within the boundaries of the skid.
- 6.1.9 Vendor may offer **alternative design** if thus obtaining improvement over the specified equipment at the same or better cost with better operation or maintenance conditions and without decrease in quality. Alternatives require Client's approval.
- 6.1.10 Vendor shall review equipment design with regard to discover and eliminate any **safety hazards** and to assure comfortable operability and maintainability (good equipment **ergonomics**).
- 6.1.11 Vendor shall within offer submitt information regarding location of maintenance facilities applicable for the Client Site (closest to the Site). During equipment guarantee period

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Vendor's maintenance representative shall respond on Client's request till 48 hours after the request (equipment failure announcement) and solve the failure till 10 calendar days after the request (equipment failure announcement)

6.1.12 Experience

All equipment and its elements shall be of a proven design / size and shall be within Vendor's actual experience.

6.1.13 Laws and Regulations / Authority Requirements

Serbian laws, standards and regulations must be followed. Serbian standards are harmonized with EU standards. If EU certification is done Serbian recertification is required.

Vendor is responsible to obtain all required certificates and approvals.

6.1.14 Vendor can use his standard equipment-material Subsupplier (his standard Vendor List), if not specified otherwise within this Technical Requisition.

6.2 REFERENCES

Directive 2014/34/EU	Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres (ATEX) – mandatory from 20-Apr-2016
Directive 2014/68/EC	Pressure Equipment Directive
Directive 2006/95/EC	Low Voltage Electrical Equipment Directive
Directive 2014/30/EC	Electromagnetic compatibility (EMC)
Directive 2006/42/EC	Machinery Directive
API 618	Reciprocating Compressors for Petroleum, Chemical, and Gas Industry Services
IEC 60079	Electrical Apparatus for Explosive Gas Atmospheres
IEC 60529	Degrees of Protection Provided by Enclosures (IP Code)
IEC 60034	Rotating electrical machines
	Rotating electrical machines - Part 2: Methods for determining losses and efficiency of rotating electrical machines
	IEEE Recommended Practice and Requirements for Harmonic

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IEC 60034-2	Control in Electric Power Systems Adjustable speed electrical power drive systems
IEEE Std 519	Amendment 1 - Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy
IEC61800 1-5	Adjustable speed electrical power drive systems
IEC61800-5 1 1:2007/AMD1:2016	Adjustable speed electrical power drive systems - Part 5-1: Safety requirements - Electrical, thermal and energy
IEC 60146	Semiconductor converters - General requirements and line commutated converters
IEC 61508	Functional safety of electrical/electronic/programmable electronic safety-related systems
IEC 61511	Functional safety – Safety instrumented systems for the process industry sector
EN 62337	Commissioning of Electrical, Instrumentation and Control Systems in the Process Industry – Specific Phases and Milestones
EN 62381	Automation Systems in the Process Industry – Factory Acceptance Test (FAT), Site Acceptance Test (SAT) and Site Integration Test (SIT)
EN 62382	Control Systems in the Process Industry – Electrical and Instrumentation Loop Check
EN 13445	Unfired pressure vessels
EN 13480	Metallic industrial piping

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IEC 60502	Power cables with extruded insulation and their accessories for rated voltages from 1 kV
IEC 60445	Basic and safety principles for man-machine interface, marking and identification – Identification of equipment terminals, conductor terminations and conductors
IEC 61439	Low-voltage Switchgear and Control Gear Assemblies
IEC 60085	Electrical insulation – Thermal evaluation and designation
IEC 60027-1	Letter symbols to be used in electrotechnology
IEC 60204-1	Electrical equipment of industrial machines
IEC 60617-DB	Graphical symbols for diagrams
IEC 61082	Preparation of documents used in electrotechnology
IEC 61346	Industrial systems, installations and equipment and industrial products - Structuring principles and reference designations
IEC 60073	Basic and Safety Principles for Man-Machine Interface, Marking and Identification - Coding Principles for Indicators and Actuators
IEC 60079-14	Explosive atmospheres Gas & Dust - Part 14: Electrical installations design, selection and erection
IEC 60204	Safety of machinery – Electrical equipment of machines
IEC 60227	Polyvinyl Chloride Insulated Cables of Rated Voltages up to and Including 450/750 V
IEC 60287	Electrical Cables – Calculation of the Current Rating
IEC 60332	Tests on electric and optical fibre cables under fire conditions
IEC 60364	Electrical Installations of Buildings
IEC 60668	Dimensions of Panel Areas and Cutouts for Panel and Rack-mounted Industrial Process Measurement and Control Instruments
IEC 62305	Protection of Structures against Lightning
IEC 60072	Dimensions and Output Series for Rotating Electrical Machines

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IEC 60331	Tests for Electric Cables under Fire Conditions – Circuit Integrity
ISA S5.1	Instrumentation Symbols and Identification
ISA S5.2	Binary Logic Diagrams for Process Operations
ISA S5.3	Graphic Symbols for Distributed/Shared Display Instrumentation, Logic and Computer Systems
ISA S5.5	Graphic Symbols for Process Displays
EN 10204:2004	Metallic products - Types of inspection documents
EN 13463 –1: 2009	Non-electrical equipment for potentially explosive atmosphere
EN 13463 – 5:2011	Non-electrical equip. for potent. ex atm. Protection by constr. Safety
IEC 61000	Electromagn. Compatib. for Industrial Process Meas. and Control
IEC 61131	Programmable Controllers
IEC 61784	Industrial Communication Networks - Profiles
IEC 62443	Industrial Automation and Control System Security
ISO 20816-1	Mechanical vibration — Measurement and evaluation of machine vibration
ISO 7919-3	Mechanical vibration — Evaluation of machine vibration by measurements on rotating shafts — Part 3: Coupled industrial machines
ISO 281	Rolling Bearings - Dynamic Load Ratings and Rating Life
API 670	Machinery Protection Systems
API 671	Special-Purpose Couplings for Petroleum, Chemical, and Gas industry services
ASME B16.5	Pipe Flanges and Flanged Fittings
ASME B16.10	Face to Face and End-to-End Dimensions of Valves
ASME B16.34	Valves – Flanged, Threaded and Welding End
ASME B31.3	Process Piping
ASME B46.1	Surface Texture (Surface Roughness, Waviness and Lay)

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ASME B1.20.1	Pipe Threads, General Purpose (Inch)
API 614	Lubrication, Shaft Sealing, and Control-oil Systems and auxiliaries for Petroleum, Chemical and Gas Industry Services
API 541	Form wound squirrel cage induction motors – 345 kW (500HP) and larger
API 547	General purpose Form-wound Squirrel cage induction motors-185 kW through 2240 kW
API 682	Shaft Sealing System for Centrifugal and Rotary Pump
API 686	Recommended Practice for Machinery Installation and Installation Design

6.3 COMPRESSOR

6.3.1 **Basic design requirements**

API 618 (last edition) and corresponding Engineering specifications (attached) are applicable for this project.

Compressor ratings shall not exceed the limits of the Vendor’s design and shall be within the Vendor’s actual experience. Only equipment that has proven its reliability in similar operating conditions like requested in these Technical Requisition is acceptable. A reference of at least 3 units of the same type and size and with an accumulated experience of 25,000 hours of operation is required. Equipment that does not have an accumulated experience of 25000 hours is considered prototype and it will not be accepted.

Unless otherwise specified, the compressor shall be horizontal and double-acting. Multi-cylinder units shall be of balanced opposed design.

The Client has specified within technical requisition equipment’s normal operating point and all other applicable operating. The Vendor shall take in account of any other specified operating conditions with different compositions and molecular weights and consequent effect on his pulsation and vibration control analysis.

The Vendor shall confirm the compressor’s performance and mechanical capabilities at the specified operating points (including valve selections). Unless otherwise agreed by the Client, negative tolerances on capacity shall not apply to any specified operating points.

Compressors shall be equipped with unit valve operating control system (hydraulic control system – like "Hydrocom")



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Unless otherwise specified in the data sheets, liquid-cooling systems for lube oil, cylinders and piston rod packing shall be designed for the following conditions on the coolant side: Fouling factor on the coolant side: 0.25 m².K/kW. Provision shall be made for complete venting and draining of the liquid cooling system.

All equipment shall be designed to run safely to the relief valve setting including accumulation.

Reciprocating compressors should normally be specified for constant-speed operation in order to avoid excitation of torsional, acoustic, and/or mechanical resonances.

All electrical components and installations shall be suitable for the area classification, gas grouping and temperature classes specified by the Client in the data/requisition sheets.

The power required by the compressor at the normal operating point shall not exceed the stated power by more than 3%. (NOTE: this power tolerance refers to the required power at Vendor's rated capacity.

The combined performance of the compressor and its driver under all operating conditions shall be responsibility of the Vendor. The combined unit (or complete package, if applicable) shall perform as well on its permanent foundation as it did on the Vendors's test stand.

The unit and its auxiliaries shall be suitable for start-up, operation and periods of idleness under the specified environmental conditions. Installation shall be outdoor without a roof, with maximum and minimum temperatures, unusual humidity, and dusty or corrosive conditions, as difened in U211-PR-DS-0002 Site and Utility DS.

The compressor body(ies), the load gear and the e-motor shall be mounted on a single-lift skid.

6.3.2 Allowable Speeds

The following requirements apply to critical service medium-duty compressors that are rated less than 1,500 kW but equal to or greater than 150 kW:

- a. The compressor rotating speed shall not exceed 350 rpm. For services that are not hydrogen-rich (molar mass less than or equal to 12), higher speeds up to 600 rpm may be used with the Purchaser's written permission.
- b. Average piston speed shall be limited to 3.89 m/s for lubricated machines.

The following requirements apply to critical service medium-duty compressors that are less than 150 kW:

- a. The compressor rotating speed shall not exceed 350 rpm. For services that are not hydrogen-rich (molar mass less than or equal to 12), higher speeds up to 750 rpm may be used with the Purchaser's written permission.

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b. Average piston speed shall be limited to 3.89 m/s for lubricated machines.

6.3.3 Rod and Gas Loads

In accordance with API 618

6.3.4 Critical Speeds

In accordance with API 618

6.3.5 Compressor Cylinders

The MAWP shall be at least equal to the specified relief valve setting plus allowed over pressure.

Unless otherwise specified in the data/requisition sheet, horizontal cylinders shall be provided, which shall have top suction and bottom discharge. When vertical cylinders are specifically allowed, e.g. for dry gases, these shall be designed so that complete drainage of the cylinder is possible.

All cylinders shall be supplied with replaceable liners, In addition, the cylinder shall be thick enough to provide for re-boring to a total of 3.0 mm (1/8 in.) increase over the original diameter. The increase in piston diameter shall not affect the cylinder maximum allowable working pressure, the maximum allowable continuous gas load, or the maximum allowable continuous combined rod load.

Cylinder supports shall be designed to avoid misalignment and resulting excessive rod runout during the warm-up period and at actual operating temperature.

The Compressor Cylinder shall be designed to mount (1) case mounted accelerometer to it on a non-gasketed surface. The location of each cylinder accelerometer shall be easily accessible in the field. The mounting shall be on a "FLAT" Boss cast into the main part of the cylinder. The boss shall be drilled and tapped to accept an accelerometer acceptable to the Client.

Where Cooling Jacket System is selected, the arrangement shall be such that failure of a gasket or other seal does not result in leakage of coolant into the cylinder or gas into the cooling system. When cooling of cylinder heads is provided, separate non interconnecting jackets are required for cylinder bodies and cylinder heads. Cooling water jackets for once-through systems shall have removable covers of ample dimension for cleaning purpose.

When specified in the data/requisition sheet, a self-contained, closed loop jacket coolant system shall be furnished.



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Pumps in Cooling Jacket System shall be centrifugal pumps unless other types are approved in the data/requisition sheet. Centrifugal Pumps shall be in accordance with API 610 .

All connections shall be flanged or machined and studded, except where threaded connections are permitted. All connections shall be suitable for the maximum allowable working pressure of the cylinder.

Flanges shall conform to ISO 7005-1 or 7005-2 or ASME B16.1, B16.5, B16.42 or B16.47 Series B as applicable.

Cast iron flanges shall be flat faced and conform to the dimensional requirements of ISO 7005-2 or ASME B16.1 or B16.42.

Steel flanges shall conform to the dimensional requirements of ISO 7005-1, ASME B16.5 or ASME B16.47.

Non-ferrous flanges shall conform to mutually agreed upon standards such as ISO 7005-3.

6.3.6 Valves and unloaders

Valve and unloader designs shall be suitable for operation with all gases specified. Each individual unloading device shall be provided with a visual indication of its position and its load condition (loaded or unloaded). Non-metallic (e.g. PEEK, engineered polymers) plate, process poppet or ring type valves shall be supplied unless there is evidence of unsatisfactory experience. Engineered polymers shall not contain any re-grind or re processed polymer. In addition, Unloaders are to operate at minimum available air pressure value stated on the datasheet. Other valve designs will be considered only with the Client approval.

The vendor shall conduct a computer study of the valve dynamics to optimize the valve sealing element motion during the opening and closing phase. The study shall also include a valve dynamic response analysis of the valve component's reactions to the piping and compressor cylinder gas passage induced pulsations. The study shall include a review of all operating gas densities and load conditions. "Unless otherwise specified" the vendor shall submit a written valve dynamics report to the Client.

6.3.7 Piston, Piston Rods and Piston Rings

Pistons that are removable from the rod shall be attached to the rod by a shoulder and nut(s) design or a multi-through-bolt design. Other proven attachment methods may be used, and in such cases they shall be noted by the Vendor in the proposal.

Unless otherwise specified, all piston rods, regardless of base material, shall be coated with a wear resistant material. The material and surface treatment of piston rods shall be chosen to maximize rod and pressure packing life and shall be proposed by the Vendor for the Client's acceptance.



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6.3.8 Crankcases, Crankshafts, Connecting Rods, Bearings and Crossheads

For compressors above 150 kW, crankshafts shall be forged in one piece and shall be heat-treated and machined on all working surfaces and fits. The use of removable counterweights is acceptable. For compressors equal to or less than 150 kW, ductile iron is acceptable for crankshafts.

For compressors above 150 kW, replaceable, precision-bored shell (sleeve) crankpin bearings and main bearings shall be used. For compressors equal to or less than 150 kW, tapered roller type bearings are acceptable for main bearings. Cylindrical, roller, or ball type bearings may be used only with the Client's approval.

For compressors above 150 kW, connecting rods shall be forged steel with removable caps. For compressors equal to or less than 150 kW, ductile iron, steel plate, or cast steel connecting rods are acceptable.

For compressors above 150 kW, crossheads shall be made of steel. For compressors equal to or less than 150 kW, ductile iron is acceptable for crossheads.

If specified, the crankcase shall be provided with relief devices to protect against rapid pressure rise. These devices shall incorporate downward-directed apertures (away from the operator's face), a flame-arresting mechanism, and a rapid closure device to minimize reverse flow.

6.3.9 Packing Cases and Pressure Packing

All oil-wiper packing, intermediate partition packing, and cylinder pressure packing, shall be segmental rings with garter springs of a nickel chromium alloy (such as Inconel 600 or X750). If specified, shields shall be provided in the crosshead housings over the oil return drains from the wiper-packing stuffing boxes to prevent splash flooding. Pressure and wiper packing shall be filled Teflon or PEEK segmented rings. Metallic "backup" rings can be used if necessary to prevent extrusion of the non-metallic ring.

For flammable, hazardous, toxic, or wet gas service, the pressure packing case shall be provided with a common vent and drain, below the piston rod, piped by the Vendor to the lower portion of the distance piece. See API Standard 618 Annex G. Packing case vent and drain piping and fittings shall be of AISI 316 L stainless steel if compatible with the process medium. Connections shall be minimum 1" NPT.

6.3.10 Lubrication

In addition to the requirements of ISO 10438-1 and ISO 10438-3 or API 614, the following requirements apply to compressor lube oil systems:

The frame lubrication system shall be a pressurized system. The crankcase oil sump temperature shall not exceed 70 °C (160 °F). Cooling coils shall not be used in crankcases or oil reservoirs.

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The basic oil system, shall contain, as a minimum, the following components:

- reservoir—typically the compressor crankcase;
- main oil pump (rotary internal screw or gear type)— which may be shaft
- driven or motor driven;
- auxiliary pump, driven by an electric motor;
- single cooler;
- dual filters with a full flow transfer valve differential pressure indicator;
- heater—when required;
- pressure relief valve for each pump;
- single regulator for control of delivered oil pressure (separate from relief valves);
- single regulator for oil temperature control;
- valves—material shall be carbon steel with stainless steel trim;
- oil piping—shall be stainless steel pipe and fittings (with the exception of cast-in-frame lines or passages); or stainless steel tubing and fittings

Unless otherwise specified, the Vendor shall supply a divider-block mechanical lubricator system for the compressor cylinder and packing lubrication.

Between oil filter and oil cooler a valved and flanged oil sampling connection shall be provided.

Unless otherwise specified, cylinder lubricators shall be driven by two 100% redundant electric motors. Each compressor cylinder packing box shall have at least two lubricating points, in addition to the cylinder lubrication requirements. Unless the Vendor has better experience and suggests otherwise, lubricating points within the packing box shall be located on the upper side of the piston rod and at each end of the packing assembly. Lubricators shall be suitable for outdoor installation.

6.3.11 STATIC EQUIPMENT

Serbian authority regulations that have to be adhered:

- “PRAVILNIK O OPREMI POD PRITISKOM” (Sl. glasnik RS, br. 114/2021) - Serbian Rulebook for pressure equipment

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- For non-pressure equipment Vendor is obliged to address to the Ministry of Economy in Republic of Serbia for approval of foreign conformity documents

Serbian regulations are harmonized with “Requirements of “Pressure Equipment Directive” PED 97/23/EC

Vendor shall provide equipment classification according to PED and this classification will be submitted to Client for review (draft of “Declaration of Conformity”) prior to equipment manufacturing (or sub-contracting). Corresponding level of “authority / notified body” involvement will be applied during equipment design / manufacturing / inspection and testing.

Static equipment should be fabricated, welded and tested in accordance with EN13445.

Minimum design metal temperature shall be -28 0C (minus).

All documents according to appropriate attached SDR form shall be supplied. All documents shall be marked with valid Client Technical Requisition Number, Client Document Code and signed by responsible person. All revisions/changes shall be marked clearly.

If equipment requires insulation then it will have insulation clips (if needed).

A pulsation dampener must be offered for capacities greater than 100 l/h. Suction dampener, to improve intake conditions to prevent cavitation, is offered if the bidder deems it necessary.

For capacities greater than 1000 l/h The bidder must perform a control calculation of pipeline pulsations.

6.3.12 **Materials**

Unless otherwise specified by the Client, Vendor shall indicate the material code (national) and the actual grade of material he is supplying in the equipment "Data-Sheet". ASTM, AISI or ASME equivalent designation shall be always added based on the operating and site environmental conditions specified.

The presence of any corrosive agents (including trace quantities) in the motive and process fluids and in the site environment, including constituents that can cause stress corrosion cracking, shall be specified by the Client

Note 1: Typical agents of concern are hydrogen sulfide, amines, chlorides, cyanide, fluoride, naphthenic acid and polythionic acid.

Note 2: If chlorides are present in the process gas stream to any extent, extreme care must be taken with the selection of materials in contact with the process gas. Caution should be given to components of aluminum and austenitic stainless steel.

Copper and copper alloys shall not be used for parts of compressors or auxiliaries in contact with corrosive gas or with gases capable of forming explosive copper compounds.

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Low-carbon steels can be notch sensitive and susceptible to brittle fracture at ambient or lower temperatures. Therefore, only fully killed, normalized steels made to fine-grain practice are acceptable. The use of steel made to a coarse austenitic grain size practice (such as ASTM A 515) shall be avoided.

The Vendor shall specify within the bid all proposed materials, including interconnecting pipework, and instrumentation.

The final material selection shall be subject to the Client approval.

All materials used shall be new and shall meet the requirements of the applicable Codes and fabrication Standards.

Construction materials shall be identified according to ASTM-DIN Standard. Proprietary or non-standard identification of materials shall be complemented by standard identification.

Grey cast iron shall not be used.

Asbestos shall not be used in any part of the package.

Stainless steel shall be used for the lube and control oil piping.

Following requirements should be understood as minimal for material certificates:

- Material certificates 3.1B according to EN 10204 shall be submitted at least for pressure-containing parts (including piping) in contact with the fluid handled if being in a service belonging to inspection category B / C (see below), for parts operating in a corrosive atmosphere and for materials not covered by recognized international standards (e.g. APIs).
- Material certificates at least 3.1A in accordance with EN 10204 shall be submitted for pressure-containing parts in a service belonging to inspection category A as well as for non-pressurized parts in contact with the fluid handled and for all auxiliary equipment and piping in non-hazardous service (e.g. lube-oil system, cooling water piping, nitrogen system, air supply...).

6.3.13 Welding and NDE

Welding & Welders shall be qualified according to ASME IX or EN 287. Welding Procedures (WPS) and Welding Procedure Qualification Records (PQR) shall be submitted to Client for approval, prior to commencement of welding.

The Welding inspection and Non Destructive Examination Plan shall be mutually agreed by the Vendor and the Client. Welding inspection for the purpose of acceptance shall be performed after any post weld heat treatment. Radiographic, ultrasonic, magnetic particle

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and dye penetrant examination shall be performed by operators having an internationally recognized qualification according to the acceptance criteria mutually agreed.

The reference Standard for non destructive examination shall be ASME V.

6.3.14 Nameplates & Rotational Arrows

A nameplate shall be securely attached at a visible location on the compressor frame, on each compressor cylinder, and on any major piece of auxiliary equipment.

Rotation arrows shall be cast in or attached to each major item of rotating equipment at a readily visible location.

Nameplates and rotation arrows (if attached) shall be of austenitic stainless steel or nickel-copper (UNS N04400 alloy). Attachment pins shall be of the same material. Welding is not permitted.

The following data, as a minimum, shall be clearly stamped or engraved on the frame. Units used on the nameplates shall correspond to those used on the datasheets:

- Project tag number;
- year of manufacture;
- Vendor's name;
- serial number;
- rated speed;
- stroke.

The following data, as a minimum, shall be clearly stamped or engraved on compressor cylinders. Units used on the nameplates shall correspond to those used on the datasheets:

- Project tag number;
- year of manufacture;
- Vendor's name;
- serial number;
- bore, stroke, model number;
- Rated capacity;

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- Rated power;
- Maximum allowable working pressure;
- Minimum and maximum allowable working temperature;
- Maximum continuous speed;
- Cold piston end-clearance setting for each end;
- Hydrostatic test pressure

The following data, as a minimum, shall be clearly stamped on the nameplate of any major piece of auxiliary equipment:

- Project tag number, if any;
- year of manufacture;
- Vendor's name;
- serial number;
- model;
- Certification marking („3A“/CE)

Nameplates shall be positioned to be clear of equipment surface or insulation by 40mm and in such a way that they can be easily read, wherever possible from grade, adjacent to a man-way or from an access platform.

Any additional information required by the Vendor or by the Client shall be defined during the detail engineering phase.

The Vendor shall reference the Project equipment and instrumentation tag numbers in its technical documentation. The Client will provide the tag numbers during the detail engineering phase.

6.4 ACCESSORIES

6.4.1 **Drivers**

Unless otherwise specified, the compressor vendor shall furnish the driver and power transmission equipment. The type of driver shall be as specified by the Client.

The type of driver and drive system shall be as specified in the data/requisition sheet.

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Driver shall operate under the utility and site conditions specified by the Client. The full flow relief condition at the discharge (see) and normal conditions at the suction shall be taken into account when sizing the driver.

The driver shall be capable of driving the compressor with all stages at full flow and discharging at the relevant relief valve set pressure.

The driver shall be sized to accept any specified process variations such as changes in the pressure, temperature, or properties of the fluids handled and plant start-up conditions.

The compressor Vendor shall be responsible for the performance of the driver/compressor unit.

The Client shall specify anticipated process variations that can affect the sizing of the driver (such as changes in the pressure, temperature or properties of the fluid handled, as well as special plant start-up conditions). The driver shall be sized for all process conditions stated on the data sheet with a 10% margin and shall be capable of operating at the relief conditions.

The Client shall specify the starting conditions for the driven equipment. The starting procedure shall be agreed by the Client and the Vendor. The driver's starting-torque capabilities shall exceed the speed-torque requirements of the driven equipment from zero to operating speed. The unit shall be suitable for starting with the compressor at the maximum specified suction pressure with a bypass line (from the discharge to the suction line) open, or with the compressor unloaded. The driver shall be suitable for torque fluctuation at any degree of unloading.

NOTE: The bypass line pressure drop needs to be mutually agreed upon prior to purchase of the driver.

6.4.2 **Steam and Gas turbines**

Not applicable.

6.4.3 **Electrical Motors and VFDs**

Requirements of following "Engineering Specification" shall be followed:

- U211-EL-SP-0005 ES for LV Motors
- U211-EL-SP-0004 ES for MV Motors.

E-motor Subsuppliers shall be subject of Client approval.

Electrical equipment protection level shall be appropriate to the hazardous area classification of the package installation.

Nevertheless the supplier have to adopt sizing and technical characteristic of the cables.

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6.4.4 Explosion protection

Electrical equipment for installation in zone 2 hazardous area shall be suitable also for installation in Zone 1. Motors for use in zone 1 and zone 2 hazardous area shall be flameproof with an increased safety terminal box, in accordance with IEC 60079. Ex motors in increased safety (e) or non-sparking (n) execution are not acceptable.

Application of “maintenance-free” bearings (greased for the whole lifetime) is preferred against bearings with greasing nipples - if applicable.

6.4.5 Reciprocating Engines

Not applicable.

6.4.6 Coupling and Guards

Unless otherwise specified, a rigid coupling shall be supplied. For low speed applications, couplings may be of the elastomeric type where necessary to avoid torsional resonance problems. The coupling type, Subsupplier, model, and mounting arrangement shall be mutually agreed upon by the Client and the Vendor of the driver and driven equipment.

If specified, the coupling or couplings shall be special purpose couplings conforming to ISO 10441 or API 671. Coupling mountings shall conform to ISO 10441 or API 671.

Guards shall be provided by the vendor for each coupling, auxiliary drive coupling and all moving parts which might be hazardous to personnel. Guards shall comply with specified applicable safety codes.

Non-sparking, all-metal (metal flexible element – set of membranes), non-lubricated shaft coupling with a spacer shall be used.

Coupling data sheet (including dimensions) shall be delivered.

6.4.7 Reduction Gears

Reduction gears shall be in accordance with the specifications identified in the data sheets.

Reduction gears, which require forced feed lubrication, shall be integrated with the compressor oil system unless the selected lubricating oils of compressor and gear do not match. The system shall be arranged to prevent starting unless oil pressure has reached the minimum permissible level.

6.4.8 Barring Device

The compressor shall be fitted with barring gear that is either manual, electrical or pneumatic.

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Manual barring may be achieved by turning the flywheel, provided that the arrangement is such that the barring tool cannot be retained.

The barring device shall be designed so that gas forces acting on the pistons cannot cause the compressor either to accelerate or to rotate in the reverse rotation.

With the barring device engaged it shall not be possible to start the compressor.

6.4.9 Mounting Plates

Unless otherwise specified, the compressor shall be mounted on sole plates. The design and method of installation on the foundation shall be mutually agreed upon.

The vendor shall furnish stainless steel shim packs between the drive equipment feet and the mounting plates. The alignment shims shall be in accordance with API 686, Chapter 7, and shall straddle the hold-down bolts and vertical jackscrews and be at least 5 mm (1/4 in.) larger on all sides than the equipment feet. No more than three shims shall be used at any location.

If a baseplate is required, it shall contain the compressor, drive motor, pulsation vessels, lube system, purge panel and vent header. If possible, all associated piping shall be mounted on the baseplate, including suction, interstage and discharge piping, gas coolers, recycle valve and jacket water system (when specified). A baseplate shall be a single fabricated steel unit, unless the Client and the Vendor mutually agree that it may be fabricated in multiple sections. Multiple-section baseplates shall have machined and doweled mating surfaces to ensure accurate field reassembly, and provisions for a sufficient number of optical leveling targets to record and repeat the required level in the field.

If the compressor driver can be re-aligned after initial installation, removable vertical and horizontal driver alignment jackscrews shall be provided.

Lugs holding these do not interfere with the installation or removal of the drive equipment and shims. Jackscrews shall be plated for rust-resistance (cadmium or other), and shall be placed in locations that do not interfere with removal of alignment shims. Motor shims shall be full bearing. Each alignment support point shall include a minimum of a ground 3mm (1/8 inch) solid stainless steel spacer and 1.5mm (1/16 inch) total various thickness stainless steel shim stock.

Baseplates shall be prepared by commercially abrasive blasting all grout contacting surfaces and shall precoat these surfaces with a inorganic zinc silicate.

The Vendor shall submit drawings and calculations of the proposed baseplate design for Client approval, before commencement of fabrication.

The baseplate shall be designed to meet allowable stress and deflection considering transportation, lifting and operating loads.



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Floor plates shall have drain holes (min 16mm dia) at low points to prevent the accumulation of rainwater.

Anchor bolts for all equipment shall be supplied by the Vendor and they shall be selected according to the site and operating conditions.

Equipment mounting pads shall be machined flat and parallel after welding to baseplate supports. To prevent distortion, the machining of mounting pads shall be deferred until welding on the support base in close proximity to the mounting pads has been completed.

The baseplate shall have vertical jacking screws along the main longitudinal members with maximum intervals not exceeding 1500 mm. Anchor bolts holes shall be located in the same reinforced area as the jacking screws.

The baseplate shall be equipped with pad-type lifting eyes to accommodate a four point lift so that the complete package, including all equipments and accessories, can be lifted with a single hook.

Two grounding bosses shall be supplied, one at each opposite end of the baseplate.

Vertical lift should be assumed for the design of the pad-eyes.

6.4.10 Instrumentation and Control - General

The Vendor shall provide the compressor control and safety system in conformance with requisition and API 618 Standards.

The controls and instrumentation shall be adequate for controlling the compressor safely and efficiently at the operating conditions specified in data/requisition sheet.

6.4.11 Control Systems

The compressor can be controlled on the basis of inlet pressure, discharge pressure, flow, or some combination of these parameters. This can be accomplished by suction throttling, valve unloaders, clearance pockets, speed variation, or a cooled bypass from discharge to suction. The control system can be mechanical, pneumatic, hydraulic, electric or electronic, or any combination thereof.

Vendor will provide the compressor control on the basis of the following as specified by the Client

- a. the type of control system (manual, automatic or programmable);
- b. the control signal;
- c. the control range;



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- d. the process sensing lines handling flammable, toxic, corrosive or high-temperature fluids that require transduced signals to the instrumentation;
- e. the source of the control signal and its sensitivity and range;
- f. equipment to be furnished (by the Client);
- g. speed of response required.

The unloading arrangement for start-up and shutdown shall be stated on the data sheets and shall be agreed by the Vendor and the Client. If specified, automatic loading-delay interlock shall be provided to prevent automatic loaded starting. If specified, automatic immediate unloading shall be supplied to permit re-acceleration of the motor after a temporary electric power failure of an agreed maximum duration. The Vendor and the Client shall agree on the modes and duration of unloaded and partially loaded compressor operation. The Vendor shall be responsible for the loading/unloading sequence.

Capacity control for constant-speed units will normally be achieved by suction valve unloading, clearance pockets, or bypass (internal-plug type or external) or a combination of these methods. Step-less, reverse-flow capacity control acting on suction valves shall be subject to Client's approval. Control operation shall be either automatic or manual as specified on the data sheet. Unless otherwise specified, five step unloading shall provide nominal capacities of 100%, 75%, 50%, 25% and 0%; three-step unloading shall provide nominal capacities of 100%, 50% and 0%, and two step unloading shall provide capacities of 100% and 0%.

Capacity control on variable-speed units is usually accomplished by speed control, but this can be supplemented by one or more of the control methods above specified.

6.4.12 INSTRUMENTATION

The instrumentation shall conform to Instrumentation specification U211-IC-SP-0002, which is part of Technical Requisition.

6.4.13 Piping and Appurtenances

Piping and installation shall first conform to the Client specifications. Unless otherwise specified, in the absence of purchaser specifications, piping shall comply with the requirements of API 614.

The extent of process and auxiliary piping to be supplied by the vendor shall be as specified by the Client.

Auxiliary piping shall be in accordance with API 614. For the seal gas and lube oil systems, piping classes shall be Vendor's standard. Process gas piping, shall comply with Client piping classes, which may be defined on a project basis.



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All terminations up to and including 24" shall have flanges to ASME B16.5; flanges greater than 24" shall be to ASME B16.47 Series A.

Gaskets shall conform to ASME B16.20/ASME B16.21.

All pipework shall be adequately supported and shall have sufficient flexibility to allow for thermal expansion and contraction. Dissimilar metals shall have an effective insulating barrier fitted in between the pipe and the steel support to avoid galvanic corrosion.

Threaded connections should be avoided. If necessary, they may be applied only for non hazardous services (air, water ...) and only up to size 2". Other application requires Client approval. Threaded connections shall be NPT according to ASME B1.20.1

All steel pipe and fittings shall be free of scale, rust, weld flux, oil, grease and other foreign materials. Interior welds of flanges and fittings shall be ground and finished to provide smooth and matching bores.

All equipment shall have provision for drainage and venting. The minimum size of drain/vent pipework and valves shall be 3/4".

All drains and vents to atmosphere shall be fitted with blind flanges.

Drain piping shall be separate from relief valve discharge piping and they normally are collected in a common header and routed to the edge of baseplate.

Where a piping system is connected to another piping system or to equipment of higher design rating, the higher design rating shall prevail for all piping components up to and including the first block valve in the system of the lower rating.

Piping termination points shall be grouped and supported at the edge of the baseplate.

The main piping connections shall be agreed between the Client and the Vendor.

Valves shall not be located on overhead pipe runs. Valves shall be preferably located on horizontal pipe runs and, only when strictly necessary, on vertical pipe runs.

Threading of nuts and bolts shall be in accordance with ASME B1.1.

Piping and pipe supports shall be designed and arranged to allow heat tracing and/or insulation. Any heat tracing and insulation shall be included in Vendor scope of supply (if required).

Piping and pipe supports shall be designed to meet the requirements of vibrating and pulsating service.

6.4.14 Intercoolers, Aftercoolers and Separators

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If intercoolers, aftercoolers or separators are to be supplied, the extent of supply and technical requirements shall be mutually agreed between Client and Vendor.

If specified, the Vendor shall furnish an intercooler between each compression stage. unless otherwise specified, intercoolers shall comply with API 614, Chapter 1 .

If specified, aftercoolers shall be furnished by the Vendor. Unless otherwise specified, aftercoolers shall comply with API 614, Chapter 1.

Rupture discs are not allowed on the shell side of water cooled shell and tube exchangers.

The choice of water on the tube or shell side of shell and tube heat exchangers shall be agreed between the Vendor and the Client, with due consideration to pulsations, pressure levels, corrosion and maintainability.

If specified, liquid separation and collection facilities shall be provided upstream of the compressor, and after every intercooler.

Separators shall be designed, manufactured and tested according to PED.

Separators shall be supplied complete with instrumentation and safety valves.

After-coolers shall be designed, manufactured and tested according to PED.

6.4.15 Air Intake filters

For air compressors taking suction from the atmosphere, a dry type air intake filter silencer suitable for outdoor mounting shall be provided by vendor, unless otherwise specified. Intake filters shall be designed to suppress noise and have sufficient stiffness to prevent filter and filter housing damage due to pulsation-induced vibration.

6.4.16 Pulsation and Vibration Control

The Vendor shall provide pulsation suppression devices at the suction and discharge side of each cylinder. Cylinders operating in parallel may be connected to a common suction and a common discharge pulsation suppression device. The application of pulsation filters and attenuators with internal pulsation control devices such as choke tubes, baffles, and orifices requires an acoustic simulation and analysis, as well a stress evaluation to assure that components are designed to withstand acoustic forces. Intercoolers and/or aftercoolers shall not be used as pulsation suppression device.

Unless otherwise specified, Table 6 of API Standard 618 shall be utilized to determine the Design Approach.

Acoustical simulation and/or mechanical analysis may be performed by the compressor supplier or an approved independent 3rd party contractor.



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As a minimum, pulsation suppression equipment shall be designed and fabricated in accordance with the specified pressure vessel code.

Material selected by the Vendor shall be compatible with process gases being handled.

Suction pulsation suppression devices shall be designed to prevent liquid being trapped and shall not be equipped with internals for moisture removal. All suction piping shall be sloped back toward the KO Drum to prevent liquid accumulation in the machine suction bottles.

If specified, the suction pulsation suppression device(s) shall include a final moisture removal section as an integral part of the vessel.



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6.4.17 Painting and coating

Painting and coating of equipment shall comply with Datasheet. Vendor's standard painting system may be proposed as an alternative, but shall be subject to Client's review and approval.

Additionally, vendor's standard **painting** procedure is acceptable (if suitable for given industrial chemical plant environmental area-class C5-I – very high industrial), however top coating colour shall be in accordance with enclosed Specification for Surface Preparation and Painting (RAL 6029 "mint green" for Compressors, pumps, electromotors, etc.).

The Compressor Package items shall be completely shop painted (including auxiliaries and electric/instrument panels).

6.4.18 Earthing System

All electrical equipment supplied shall be bonded to the related skid.

Each skid shall be provided with two earthing bus bars for connecting to the main earthing system.

All non-current carrying metalwork on the skid, which is not permanently welded to the skid base, shall be bonded to the base using adequately sized earth cables.

Equipment anchor bolts shall not be used for earthing purposes.

All earthing connections shall be clearly identified on the General Arrangement Drawings and the earthing terminals shall be in accordance with the International Standards and Local Regulations.

6.4.19 Special Tools

When special tools and fixtures are needed to disassemble, assemble or maintain the unit, they shall be included in the quotation and furnished as part of the initial supply of the machine, together with complete instructions for their use. For multiple unit installation, the quantities of special tools and fixtures shall be agreed by the Client and the Vendor. These or similar special tools shall be used during shop assembly and post-test disassembly of the equipment.

Special tools for reciprocating compressors which shall be delivered together with compressors shall include, as a minimum:

- a. mandrels for fitting solid wear bands on non-segmental pistons;
- b. a lifting and lowering device for removal and insertion of valve assemblies with a mass greater than 15 kg (33 lb);
- c. a crosshead removal and installation tool;



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- d. sleeve/cone to enable piston rod to be passed through completely assembled acking;
- e. hydraulic tensioning tools.
- f. Lifting devices for installation and removal of cylinders, distance pieces, cylinder heads and distance piece covers (e.g. lifting eyes, spreader bars, etc..) with appropriate lift plans for maintenance of all components.

When special tools are provided, they shall be packaged in separate, rugged metal box or boxes and marked "special tools for (tag/item number)." Each tool shall be stamped or tagged to indicate its intended use.

The equipment "Installation, Operation and Maintenance Manual" shall include a list of special tools and any special drawings or instruction on how to use such tools.

6.4.20 Assembly Degree

The compressor package shall be shop assembled on the baseplate and other skids, if applicable, or prefabricated to the maximum possible extent to minimize assembly at site.

A preliminary alignment, baseplate drilling and coupling installations shall be done at shop.

All auxiliary piping shall be completely assembled within skid limits and, if necessary, prefabricated at shop and installed at site.

All the spools of the interconnecting piping shall be clearly identified.

Finish coats, where required, shall be applied at the workshop. Required insulation and cladding shall be completed at the workshop.

6.5 OPERABILITY AND MAINTAINABILITY

The Vendor shall provide full details for maintaining the package. Due consideration shall be given to the ease of access to all the items, during operation and maintenance, when designing the layout of the package. Access shall be provided to all equipment and any area requiring maintenance. The equipment shall be designed so that maintenance can be carried out with the minimum special facilities/tools. All equipment and piping shall be neatly arranged on the skid in such a way that they do not obstruct maintenance operations. The Vendor shall work closely with the Client to ensure that the most maintenance-effective layout is achieved for the package.

All major equipment items shall be supported on stainless steel shims at each mounting point, to facilitate re-alignment at a later stage. No tapered shims are allowed. Sufficient quantity of pre-cut shims shall be provided loose for site commissioning.

The Vendor shall provide in the proposal maintenance lifting requirements for the equipment, and shall advise suitable methods (runway beam, overhead travelling crane,



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etc.). The Vendor shall provide all the maintenance and analysis necessary to manage the maintenance activities.

6.6 WARRANTY PERIOD

The warranty period for the Goods lasts for a period of 3 years (36 months) from putting the Goods into operation, but not more than 4 years (48 months) as of the date of delivery of the Goods.

6.7 INSPECTION AND TESTING

6.7.1 **General**

Inspection test plan (ITP) for fabrication and Vendor requirements for installation of compressors shall be prepared by Vendor following requirements within this procurement package, Serbian law and approved by Client before start of fabrication.

Acceptance of shop tests does not constitute a waiver of requirements to meet field performance under specified operations conditions, nor does inspection relieve the Vendor of his responsibilities.

Refer to the Compressor Package data sheets and Technical Requisition to determine the complete scope of inspection, testing and Purchaser participation therein.

The Purchaser's and the Vendor's representatives shall indicate compliance in accordance with the inspector's checklist (Appendix K of the API Standard 618, or agreed equivalent) by initialing, dating, and submitting the completed checklist to the Purchaser prior to shipment.

Unless specified otherwise by the Client or legislative requirements, nondestructive examination (NDE) of materials shall be in accordance with PED.



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6.7.2 Mechanical running test

Any portion of oil system furnished shall comply with cleanliness requirements of API 614, regardless of whether it is run in the Vendor's shop. Cleanliness checks shall be performed at each console discharge connection and at a minimum of six strategic points within console specified by Purchaser's inspector, as part of FAT.

All compressors, drivers, and gear units shall be shop tested in accordance with the vendor's standard, and as part of FAT.

The shop test of the compressor shall comprise a 4-hour unloaded running test.

If specified, packaged units, including integral auxiliary system packages, shall undergo a 4-hour mechanical running test prior to shipment. The test shall prove mechanical operation of all auxiliary equipment, as well as the compressor, reduction gear, if any, and driver as a complete unit. The compressor need not be pressure-loaded for this test. The procedure for this running test shall be agreed upon by the Client and the Vendor.

Auxiliary equipment not integral with the unit, such as auxiliary oil pumps, oil coolers, filters, intercoolers and aftercoolers need not be used for any compressor shop tests unless specified. Auxiliary system consoles shall receive both an operational test and a 4-hour mechanical running test prior to shipment. The procedure for this running test shall be as agreed upon by the Client and the vendor.

Mechanical running tests shall meet the following requirements:

- a. A complete compressor operational test and 4-hour mechanical running test shall be performed.
- b. A separate operational test and 4-hour mechanical test shall be performed on all purchased equipment, such as the following:
 - 1) Frame lube oil system
 - 2) Jacket water cooling system, if purchased
 - 3) Cylinder lubrication system
 - 4) Cylinder flushing system, if purchased
 - 5) Couplings
 - 6) Instrumentation

Systems shall be run over their entire operating ranges. Proposal shall describe extent to which Supplier must comply with this requirement.

Unloaders and clearance pockets and their actuators and tubing shall be tested at the factory with nitrogen for leakage and proper operation over entire range of control pressure to actuators. Test shall be conducted, regardless of whether a compressor running test is specified.

The following requirements shall be met before mechanical running test is performed:



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- a. Cleanliness checks shall be made of each component (including cast-in passages of these components). Piping and appurtenances shall be cleaned by pickling or another appropriate method to remove foreign materials, corrosion products, and mill scale.
- b. Oil system components shall comply with cleanliness requirements of API 614.
- c. Joints and connections shall be checked for tightness. Leaks shall be corrected.
- d. Warning, protective, and control devices shall be checked. Adjustments shall be made as required.
- e. Spare components (excluding gaskets and O-rings) shall be installed and dimensionally checked prior to running of main components.
- f. Satisfactory use of all contract special tools shall be demonstrated.

The following requirements shall be met during mechanical running test:

- g. Equipment and instrumentation shall operate correctly.
- h. Systems shall be simultaneously run at their high temperature alarm settings for 1 hour.
- i. Data required by shall be recorded a minimum of every 30 minutes during 4-hour mechanical run.
- j. Unit shall not be removed from test stand until Purchaser receives all test data.

The following requirements shall be met after mechanical running test is completed:

- k. Dismantling for inspection is required (in accordance with API 618, paragraph 8.3.3.7).
- l. If equipment replacement or modifications are required to correct mechanical or performance deficiencies, initial test shall not be accepted. Final shop tests shall be run after such replacements or corrections are made.

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Welding shall not be performed on test stand after equipment being tested is placed thereon. Photographs of any part damaged during testing shall be provided to Purchaser.

Test procedures, which shall be subject to Client review and acceptance, shall be submitted at least 2 months prior to test.

Unless specified otherwise, equipment tested shall be dismantled for inspection.

Where equipment is to be shipped in more than one piece, all equipment and piping shall undergo a complete trial assembly in the factory before shipment.

6.7.3 Performance test

If specified, the compressor shall be subject to a performance test in accordance with ISO 1217 or the applicable ASME power test code.

6.7.4 Other tests

A bar-over test of the frame and cylinders shall be made in the vendor's shop to verify piston end clearances and rod runout. The final bar-over test shall be performed with all compressor cylinder valves in place to demonstrate no piston interference. Vertical and horizontal piston-rod runout (cold) at packing case flanges shall also be measured during this test . Bar-over test results shall become a part of the purchaser's records

6.8 PRESERVATION, STORAGE, PACKING AND TRANSPORT

- 6.8.1 Vendor's standard painting procedure is acceptable (if suitable for given industrial chemical plant environmental area-class C5 for long lasting period), however top coating colour according to plant standard ("mint "green RAL 6029 for all surfaces up to max. 120 °C including E-motor and base-plate; RAL 9006 "white aluminium" for hot surfaces) is required.
- 6.8.2 Equipment preparation (conservation,..) shall allow outdoor installation at Site (on the foundation; protected only by a plastic foil) for at least 6 months period of Plant erection till the equipment first start-up (see "Site & Utility Data Sheet" for climatic conditions). In case that preservation renewal / prolongation would be required by Vendor then appropriate procedure including time schedule shall be included in Instructions for Storage. Vendor shall also specify if his supervision is required. Equipment shall be prepared (protected, conserved ...) for oversea transportation.
- 6.8.3 Interior surfaces shall be thoroughly dried and preserved with suitable rust preventative. Type of conservation and suitable solvent shall be indicated on a tag attached on the device. Preferred type of conservation is such one, which does not require removal prior to operation.
- 6.8.4 All customer's connections shall be identified, according to markings on the general arrangement drawing, with waterproof and weatherproof labels fastened with stainless-steel wire.
- 6.8.5 All openings shall be blinded with suitable covers (fastened in such way that the cover can

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not be removed without a tool.) and sealed against water and dust. Flanged connections shall be provided preferably with a bolted wooden (or aluminium) cover.

Studded openings, shall be car sealed so that protective cover cannot be removed without breaking seal. Seals shall be inspected at the factory by Purchaser's inspector and removed in the field only in the presence of Owner and Vendor representatives.

Tapped openings shall be fitted with solid long shank-type 316 SS plugs

- 6.8.6 All valves will be checked for operability (= hand wheels turn easily after equipment painting) and all will be at "closed" position.
- 6.8.7 If any loose equipment / accessories is to be delivered, it shall have a label with corresponding item № (to make clear to what equipment it belongs). It should be boxed separately.
- 6.8.8 As a minimum, the Vendor shall:
- prepare the supply for shipment and deliver to nominated delivery point i.e. Pancevo Oil refinery, Spoljnostarcevacka 199A, 26000 Pancevo, Republic of Serbia on DAP Incoterms 2020
 - furnish internal and external shipping braces required to prevent damage or movement during transportation;
 - preservation must be done for oversea transport
 - furnish all the crates with relevant Packing List and Shipping Documentation;
 - provide shipping, installation, operation and maintenance weights and centre of gravity;
- 6.8.9 The Vendor shall provide Storage and Maintenance Procedures for Client's review and approval, which shall include, as a minimum, the following subjects:
- weather protection;
 - equipment storage maintenance;
 - periodical inspection;
 - periodical maintenance;
 - notice required for equipment usage;
 - corrosion protection and application of temporary coatings;
 - storage conditions including temperature range and humidity.
- 6.8.10 Storage and Maintenance Procedures should also take in to account filling the compressor accessories with nitrogen or adequate alternative for prolonged storage, preservation and transportation.
- 6.8.11 If size permits, compressors shall be shipped with complete assemblies an lifting beam attached.
For flanged openings, corrosion-resistant metal tags shall be provided that locate the flanged opening in system.
Equipment shall be identified with item number, Purchaser's project number, purchase order number, and serial numbers.