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1 OBJECTIVE

1.1 This technical specification covers the minimum requirements for the design, materials, fabrication, assembly, inspection, testing, preparation for shipment, installation, pre-commissioning and commissioning of positive displacement pumps.

1.2 These requirements shall be complied with, in conjunction with other applicable SUPPLIER's Documents and Standards.

2 DEFINITIONS AND ABBREVIATIONS

2.1 Definitions

All terms and definitions shall be established in the latest revision of I-ET-3010.00-1200-940-P4X-002 – General Technical Terms.


2.2 Abbreviations

g: Gravitational acceleration
SS: Stainless Steel
NPSH: Net Positive Suction Head
VSD: Variable Speed Drive

3 SCOPE OF SUPPLY

PACKAGER scope of supply shall include the following:

- Positive displacement pump;
- Electric motor driver;
- Sealing system;
- Baseplates with drip pans, lifting lugs, grounding lugs, and drains with valves;
- All necessary guards and couplings in non-sparking material;
- Pressure-limiting valve;
- Pulsation suppression devices;
- All necessary instrumentation, including accessories and supports;
- Unit Control Panels, according to AUTOMATION INTERFACE OF PACKAGE UNITS specification [document supplied by OWNER];
- Electrical and instrumentation installation (including cable termination details, motor terminal box details, and grounding);
- Stainless steel (SS 316), copper free aluminum or non-metallic junction boxes mounted at skid edge;
- All piping and their respective utilities skids, such as lube oil, cooling medium and instrument/utility air;
- All raw materials and consumables;
- Gaskets;
- Tightening bolts and nuts;
- Nameplates manufactured in SS 316 in Portuguese for all equipment and instruments;
- Surface preparation and painting proper for offshore installations, according to I-ET-3010.00-1200-956-P4X-002 – General Painting and DR-ENGP-I-1.15 – Color Coding;
- Spreader bars and specific handling devices for installation;
- Technical assistance during installation, pre-commissioning, start-up and commissioning phases;
- Safety signaling in Portuguese;
- Site supervision;
- All required tests at MANUFACTURER's shop;
- Coupling, assembly and alignment;
- Preparation for shipment and preservation, including equipment handling conditioning and storage at job site;
- Consumables and special tools for assembly, disassembly, maintenance, commissioning and start up;

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- Spare parts recommended for commissioning, pre-operation, start-up, NR 13 tests and by Classification Society;
- Warranty;
- Thermal insulation for personnel protection according to I-ET-3010.00-1200-431-P4X-001 – Thermal Insulation for Maritime Installations;
- A complete engineering package including design, fabrication, inspection, testing, commissioning documentation, certification and data required on this specification and pump data sheets issued by OWNER.

4 NORMATIVE REFERENCES

4.1.1 Pump PACKAGE shall comply with the requirements of this technical specification, data sheets and with documents as stated below and with those referred to therein.


4.1.2 Any conflict between the requirements of this specification and related codes and standards, specification, etc. shall be presented in writing for OWNER's resolution prior to manufacturing.

4.2 Applicable Codes and Standards

The latest issue of the following codes and standards shall be fully complied with:

IOGP S-728	Supplementary Specification to API Standard 674 Reciprocating Positive Displacement Pumps
IOGP S-728L	Information Requirements for Reciprocating Positive Displacement Pumps
IOGP S-728Q	Quality Requirements for Reciprocating Positive Displacement Pumps
IOGP S-728D	Data Sheet for Reciprocating Positive Displacement Pumps
IOGP S-712	Supplementary Specification to API Standard 677 General-Purpose Gear Units for Petroleum, Chemical and Gas Industry Services
API Std 670	Machinery Protection Systems
API Std 671	Special Purpose Couplings for Petroleum, Chemical and Gas Industry Services
API Std 674	Positive Displacement Pumps – Reciprocating
API Std 675	Positive Displacement Pumps – Controlled Volume
API Std 676	Positive Displacement Pumps – Rotary
API Std 677	General-Purpose Gear Units for Petroleum, Chemical, and Gas Industry Services
API Std 682	Shaft Sealing System for Centrifugal and Rotary Pumps
ASME B16.5	Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B31.3	Process Piping
ASME BPVC Sec VIII-1	Rules for Construction of Pressure Vessels
ISO 14691	Petroleum, Petrochemical and Natural Gas Industries - Flexible Couplings for Mechanical Power Transmission - General-Purpose Applications
ISO 80079-36 and -37	Explosive Atmospheres – Non-electrical Equipment for Explosive Atmospheres
NR-10	Brazilian Government Regulation – Norma Regulamentadora N° 10, Segurança em Instalações e Serviços em Eletricidade
NR-12	Brazilian Government Regulation – Norma Regulamentadora N° 12, Segurança no Trabalho em Máquinas e Equipamentos
NR-13	Brazilian Government Regulation – Norma Regulamentadora N° 13, Caldeiras, Vasos de Pressão, Tubulações e Tanques Metálicos de Armazenamento
NR-26	Brazilian Government Regulation – Norma Regulamentadora N° 26, Sinalização de Segurança
NR 37	Brazilian Government Regulation – Norma Regulamentadora N° 37, Segurança e Saúde em Plataformas de Petróleo
Classification Society	Rules for Offshore Facilities

4.2.1 Brazilian government regulations shall be mandatory and shall prevail, if more stringent, over the requirements of this specification and other references herein.

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4.2.2 PACKAGER/MANUFACTURER shall comply with any other government regulations stated in the Contract and not listed above.

4.3 Reference Codes and Standards

The following codes and standards shall be used as reference or followed wherever they are mentioned throughout this specification:

API Std 526	Flanged Steel Pressure-relief Valves
DIN 471	Retaining Rings for Shafts - Normal Type and Heavy Type
DIN 472	Retaining Rings for Bores - Normal Type and Heavy Type
EPA AP-42	Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, of the USA Environment Protection Agency
ISO 3601/all parts	Fluid power systems - O-rings
ISO 20816/all parts	Mechanical vibration - Evaluation of Machine Vibration by Measurements on Non-rotating Parts
ISO 15156/all parts	Petroleum and Natural Gas Industries: Materials for Use in H ₂ S-Containing environments in Oil and Gas Production

4.4 Applicable Documents

4.4.1 Typical Project Documents

The following project documents shall be fully complied with:

General

I-ET-3000.00-0000-940-P4X-002	Symbols for Production Units Design
I-ET-3000.00-1200-940-P4X-001	Tagging Procedure for Production Units Design
I-ET-3010.00-1200-940-P4X-002	General Technical Terms
I-ET-3010.00-1350-940-P4X-001	Systems Operation Philosophy

Mechanical


DR-ENGP-I-1.15	Color Coding
I-ET-3010.00-1200-251-P4X-001	Requirements for Bolting Materials
I-ET-3010.00-1200-300-P4X-001	Noise and Vibration Control Requirements
I-ET-3010.00-1200-431-P4X-001	Thermal Insulation for Maritime Installations
I-ET-3010.00-1200-540-P4X-001	Requirements for Pressure Vessels Design and Fabrication
I-ET-3010.00-1200-955-P4X-001	Welding
I-ET-3010.00-1200-200-P4X-115	Requirements for Piping Fabrication Assembly and Commissioning
I-ET-3010.00-1200-956-P4X-002	General Painting

Electrical

I-DE-3010.00-5140-700-P4X-003	Grounding Installation Typical Details
I-DE-3010.00-5140-797-P4X-001	Electrical System Automation Architecture Diagram
I-ET-3010.00-5140-700-P4X-001	Specification for Electrical Design for Offshore Units
I-ET-3010.00-5140-700-P4X-002	Specification for Electrical Material for Offshore Units
I-ET-3010.00-5140-700-P4X-003	Electrical Requirements for Packages for Offshore Units
I-ET-3010.00-5140-712-P4X-001	Low-Voltage Induction Motors for Offshore Units
I-ET-3010.00-5140-712-P4X-002	Medium-Voltage Induction Motors for Offshore Units
I-ET-3010.00-5140-772-P4X-001	Medium-Voltage Frequency Converter for Offshore Units
I-ET-3010.00-5140-772-P4X-002	Specification For Low-Voltage Frequency Converters, Soft-Starters and Inverters For Offshore Units
I-ET-3010.00-5140-797-P4X-001	Electrical System Automation Architecture
I-ET-3010.00-5140-700-P4X-007	Specification For Generic Electrical Equipment For Offshore Units
I-ET-3010.00-5140-700-P4X-009	General Requirements For Electrical Material And Equipment For Offshore Units

Automation

I-ET-3010.00-1200-800-P4X-002	Automation, Control and Instrumentation on Package Units
I-ET-3010.00-5500-854-P4X-001	Machinery Monitoring System (MMS)
I-ET-3010.00-5520-888-P4X-001	Automation Panels

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Naval

I-ET-3010.00-1350-960-P4X-001 Design Requirements – Naval Architecture

4.4.2 Specific Project Documents

4.4.3 The following project documents shall be supplied by OWNER and shall be fully complied with.

Since these documents are specific to each project, their identification numbers are not unique, and their titles may vary slightly from one project to another.

4.4.4 Project's DOCUMENT LIST shall be consulted to verify the correct document number and title.

- METOCEAN DATA
- MOTION ANALYSIS
- PIPING SPECIFICATION FOR TOPSIDE
- PIPING SPECIFICATION FOR HULL
- GENERAL SPECIFICATION FOR AVAILABLE UTILITIES
- FIELD INSTRUMENTATION
- AUTOMATION INTERFACE OF PACKAGE UNITS
- INSTRUMENTATION ADDITIONAL TECHNICAL REQUIREMENTS

5 PACKAGER RESPONSIBILITY

5.1 PACKAGER / MANUFACTURER shall perform the work in accordance with the requirements of Classification Society.

5.2 PACKAGER / MANUFACTURER shall be responsible for submitting to the Classification Society all documentation in compliance with stated Rules.

5.3 PACKAGER shall assume sole contractual and total engineering responsibility for the items supplied.

5.4 PACKAGER's responsibility shall also include but not be limited to:

- Resolving all engineering questions and/or problems relating to design and manufacturing.
- Providing details as requested, for the main and auxiliary equipment, relating to design and manufacturing.
- Training.


5.5 Compliance by the PACKAGER with the provisions of this specification shall not relieve the PACKAGER's responsibility to furnish equipment and accessories of a proper mechanical design suited to meet the specified service conditions.

5.6 PACKAGER shall be responsible for all coordination with MANUFACTURERS and collections of all details, drawings and data to achieve optimum design and full submission of all documents requested in the specification.

6 DESIGN REQUIREMENTS

6.1 Operation Environment

Pump PACKAGE shall be suitable for the marine environment and range of ambient conditions defined in METOCEAN DATA specification [document supplied by OWNER].

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6.2 Motion Requirements

6.2.1 The necessary design data and information regarding motion requirements shall comply with MOTION ANALYSIS report [document supplied by OWNER].

6.2.2 PACKAGER / MANUFACTURER shall design PACKAGE to withstand and operate in accordance with I-ET-3010.00-1350-960-P4X-001.

6.3 PACKAGE Requirements

6.3.1 PACKAGER / MANUFACTURER shall design PACKAGE for a 30-year life in a corrosive offshore environment without the need for replacement of any major component due to wear, corrosion, fatigue, or material failure.

6.3.2 Rotary parts, such as couplings, pulleys, and flywheels, shall feature rigid guards, made of non-sparking and non-flammable material in accordance with NR-12.

6.3.3 PACKAGER shall clearly define the utility consumption of the pump PACKAGE.

6.3.4 PACKAGER / MANUFACTURER shall include utility consumption in the technical proposal.

6.3.5 The consumption of utilities shall comply with the requirements of GENERAL SPECIFICATION FOR AVAILABLE UTILITIES report [document supplied by OWNER].

6.3.6 The pump PACKAGE, including all necessary auxiliary equipment, shall be assembled to the maximum extent possible, aligned and pre-checked in PACKAGER / MANUFACTURER's shop, allowing shipment to the integration yard with minimal fieldwork;

6.3.7 For foreign made equipment, PACKAGER / MANUFACTURER shall purchase the standard manufacturing parts (couplings, mechanical type seals, bearings) from Manufacturers with representative branches located in Brazil, with service parts and maintenance workshops.

6.3.8 PACKAGER / MANUFACTURER shall manufacture, inspect and verify PACKAGE(s) to comply with all specifications mentioned in Normative References and the Classification Society regulations.

6.3.9 PACKAGER / MANUFACTURER shall design pumps and components suitable for outdoor installation and operation.

6.3.10 Bearing housings shall be prepared for permanent accelerometer or vibration probes installation.


6.3.11 SUPPLIER shall ensure that the area around the pump PACKAGE has enough clearance for maintenance.

6.3.12 SUPPLIER shall create a reserved area on the 3D model to avoid installation of any other equipment or accessory in this area.

6.3.13 PACKAGE shall be designed in compliance with ISO 80079-36 and ISO 80079-37 requirements.

6.3.13.1 PACKAGER shall provide a certificate confirming that the equipment and components of the package is in conformity with both standards including as minimum:

- a) Ignition Hazard Assessment Report as per ISO 80079-36;
- b) Specific the requirements for the design and construction of nonelectrical and equipment type of protection as per ISO 80079-37;
- c) Equipment nameplate including ISO 80079-36 marking requirements.

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6.3.13.2 PACKAGER shall attest on his own responsibility that the equipment has been constructed in accordance with the applicable requirements of the relevant standards in safety matters.

6.4 Reciprocating Pumps

6.4.1 PACKAGER / MANUFACTURER shall design reciprocating pumps in accordance with API Std 674.

6.4.2 Reciprocating pumps that can operate with flammable or not stabilized fluid shall be sealed with non-flammable barrier to avoid flash of gas to surroundings.

6.4.3 Chevron rings shall not be used as a stuffing box sealing method.

6.5 Controlled Volume Pumps

6.5.1 PACKAGER / MANUFACTURER shall design controlled volume pumps in accordance with API Std 675.

6.5.2 Packed plunger design shall not be used.

6.5.3 Pumps shall be suitable for continuous operation at full load duty, unless otherwise stated in the process data sheets, without shutdown for normal maintenance, for a minimum period of one year.

6.5.4 MANUFACTURER shall design pumps with variable frequency drive to operate with minimum turndown without any restriction in operation range.

6.6 Rotary Pumps

6.6.1 PACKAGER / MANUFACTURER shall design rotary pumps in accordance with API Std 676.

6.6.2 Rotary pumps speed shall be limited to 1800 rpm.

6.6.3 PACKAGER / MANUFACTURER shall design mechanical seals in accordance with API Std 682.

6.7 Performance

6.7.1 PACKAGER / MANUFACTURER shall design the positive displacement pump PACKAGE(s) and all associated auxiliary systems for the full range of operational conditions listed in data sheets in accordance with the appropriate codes and documents.

6.7.2 Efficiency at the rated flow shall be at least 80% for pumps driven by electric motor with power above 150kW.

6.7.3 The NPSH required shall be at least 2.0 meters less than the NPSH available, considering acceleration head.


6.7.3.1 Correction factors shall not be allowed.

6.7.3.2 OWNER may accept differences between 1.0 and 2.0 meters, but a witnessed NPSH required test shall be performed.

6.8 Pressure Containing Parts and Pressure-Limiting Valves

6.8.1 With the exception of the Well Service Pumps, the maximum allowable working pressure (MAWP) of the pressure containing parts shall be, at least, 120% of the rated discharge pressure.

6.8.2 PACKAGER / MANUFACTURER shall design all positive displacement pumps to have a pressure-limiting valve according to API Std 526.

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6.8.3 Pressure-limiting valve setting shall be the lesser between the system MAWP and the pump MAWP.

6.8.4 Pressure-limiting valves integral with pump casing shall only be allowed diaphragm type positive displacement pumps.

6.9 Connections and Auxiliary Piping

6.9.1 PACKAGER / MANUFACTURER shall design, fabricate, and inspect piping in accordance with ASME B31.3.

6.9.2 Pipe flanges and flanged fittings shall be in accordance with ASME B16.5.

6.9.3 Suction and discharge nozzles shall be flanged.

6.9.4 Threaded connections may be used in suction and discharge nozzles only for controlled volume pumps connected to tubings, as indicated in the P&IDs.

6.9.5 Casing connections other than suction and discharge nozzles shall be at least DN 15 (NPS 1/2).

6.9.6 Threaded connections shall be tapered.

6.9.7 Drains and vents shall have flanged valves, unless otherwise stated in the pump data sheets.

6.9.8 Piping shall be suitably supported to the pump baseplate or mounting frame by PACKAGER / MANUFACTURER.

6.9.9 PACKAGER / MANUFACTURER shall provide pumps requiring auxiliary piping for sealing, cooling or lube oil systems with all necessary connections, plus shall provide all required piping and fittings, as defined on the data sheets.

6.9.10 Auxiliary piping in contact with the process fluid shall be made of the same material as the pump casing. All other auxiliary piping shall be made of SS 316 unless otherwise specified in pump data sheets.

6.9.11 PACKAGER / MANUFACTURER shall provide each pump with one pressure gauge on the suction side and one at the discharge side. Each pressure gauge shall be mounted with a valve.

6.9.12 PACKAGER / MANUFACTURER shall clearly mark the locations of all connections and identify them on the pump drawing.

6.9.13 All auxiliary interface connections shall terminate with block valves at the edge of the skid and shall be designed to allow easy disconnection.

6.9.14 Auxiliary connections welded to the pump casing shall be gusseted in two orthogonal planes.


6.10 Drivers, Couplings and Belt Drives

6.10.1 Pumps shall be driven by electrical motors, unless otherwise specified in the pump data sheets issued by OWNER.

6.10.2 MANUFACTURER shall submit to OWNER for approval the bearing housing for vertically mounted motors.

6.10.3 Couplings between the driver and pump shall be SS 316 flexible-element in accordance with ISO 14691.

6.10.4 Belt drives shall not be used.


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6.11 Gearbox

- 6.11.1 The minimum service factor shall be 1.6.
- 6.11.2 PACKAGER shall inform the gear ratio in the technical proposal.
- 6.11.3 PACKAGER shall provide satisfactory references of similar operations.
- 6.11.4 PACKAGER / MANUFACTURER shall design all gear bearings to minimize oil foaming.
- 6.11.5 PACKAGER / MANUFACTURER shall design the bearing to prevent oil whip or whirl at any operating speed.
- 6.11.6 PACKAGER / MANUFACTURER shall design bearings to be fully replaceable in the field and shall require no field fitting.

6.12 Baseplate

- 6.12.1 PACKAGER / MANUFACTURER shall install the pump and the driver on a combined steel baseplate (API Type), providing adequate clearance for safety and maintenance.
- 6.12.2 PACKAGER / MANUFACTURER shall design the baseplate to provide means to ensure that the deformation caused by the movement of the UNIT structure is not transmitted to the base of the rotary assembly.
- 6.12.3 PACKAGER / MANUFACTURER shall consider the stiffness of the assembly in the foundation design, aiming to prevent vibration transmission to the adjoining equipment, living quarters, control rooms, and other environments in the UNIT.
- 6.12.4 For pumps in corrosive duties, PACKAGER / MANUFACTURER shall make drain-pans of a corrosion-resistant material considering the pumped fluid properties.
- 6.12.5 PACKAGER / MANUFACTURER shall fully machine the mounting plates of the baseplate (plates of the pedestal where the equipment is fixed) for proper leveling and alignment of the pump and driver.
- 6.12.6 For pump PACKAGES with Low-Voltage motors, the baseplates shall be designed to be completely seal welded to the support structure. Intermittent welds are not allowed.
- 6.12.7 For pump PACKAGES with Low-Voltage motors, baseplates mounted with 3-point or multipoint mounting may be accepted under previous approval by BUYER.
- 6.12.8 For pump PACKAGES with Medium-Voltage motors, the baseplates shall be designed for 3-point or multipoint mounting.
- 6.12.9 PACKAGER / MANUFACTURER shall comply with the following about shims design:
 - 6.12.9.1 Shims shall be in SS 316 material of the same size of the mounting plate seating surface and shall minimize quantity used, i.e., thicker shims shall be used instead of several thinner shims.
 - 6.12.9.2 The use of multiple small sized shims shall not be acceptable.
 - 6.12.9.3 Alignment shall be done with shim plates of at least 3 mm thick at the driver side.
 - 6.12.9.4 Total height of shim stack shall not exceed 12 mm.
- 6.12.10 PACKAGER / MANUFACTURER shall analyze dynamic reactions of reciprocating pumps baseplate along structural design concerning vibration and resonance.

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6.13 Noise and Vibration Control

PACKAGER / MANUFACTURER shall perform noise and vibration control concerning human exposure according to I-ET-3010.00-1200-300-P4X-001 – Noise and Vibration Control Requirements.

6.14 Piping Pulsation and Vibration Control

6.14.1 PACKAGER / MANUFACTURER shall perform a pulsation and vibration analysis, according to API Std 674 Annex C (API Std 675 Annex F, or API Std 676 Annex F), with the following purposes:

- To verify that acoustic resonances in the suction and discharge piping do not occur within operational range;
- To take due consideration of cross-coupling influences from adjacent operating pumps;
- To establish the magnitude of the pressure pulsation at the suction and discharge nozzles of the pump and of the pulsation control devices.

6.14.2 Pulsation in the liquid flow entering and leaving the pump shall not exceed $\pm 1.5\%$ of the operating pressure in the suction or discharge manifold respectively.

6.14.3 PACKAGER / MANUFACTURER shall supply pulsation control devices if they are needed to meet the allowable pulsation levels. Complete descriptive data, calculation and drawings shall also be provided by PACKAGER / MANUFACTURER. Pulsation control devices shall be considered as pressure vessels, therefore subject to their requirements.

6.14.4 SUPPLIER shall modify the piping route and supports according to PACKAGER / MANUFACTURER recommendations, in order to reduce pulsation and vibration.

6.15 Pressure Vessels

6.15.1 PACKAGER / MANUFACTURER shall design pressure vessels within pump PACKAGE in accordance with I-ET-3010.00-1200-540-P4X-001 – Requirements for Pressure Vessels Design and Fabrication.

6.16 Special Tools and Spare Parts

6.16.1 PACKAGER / MANUFACTURER shall supply all special tools necessary for the installation, alignment, operation or maintenance of the equipment with the delivery of the PACKAGE.

6.16.2 PACKAGER / MANUFACTURER shall provide spare parts required for NR-13 tests and those recommended by the Classification Society.


6.16.3 PACKAGER / MANUFACTURER shall detail all special tools and spare parts in the packing list and these items shall be consistent with the lists issued for the engineering documentation.

6.16.4 All special tools and spare parts shall have an item number in the packing list, which shall match the item number fixed on the packing.

6.16.5 PACKAGER shall provide a list containing the part numbers of every spare part within the PACKAGE for BUYER's future reference.

7 MATERIALS

7.1 Materials shall be the MANUFACTURER's standard for the operating conditions specified, unless otherwise specified in pump data sheets issued by OWNER or in the respective standard (API Std 674, API Std 675 or API Std 676).

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7.2 PACKAGER / MANUFACTURER shall select all materials exposed to hydrocarbons containing hydrogen sulfide in accordance with ISO 15156 for the lowest anticipated pH and the highest H₂S partial pressure.

7.3 PACKAGER / MANUFACTURER shall isolate dissimilar materials in contact with an electrolyte to avoid galvanic corrosion.

7.4 Austenitic SS pumps shall use SS 316 (UNS S31600) or SS 316L (UNS S31603) for all parts subjected to pressure or other mechanical loads.

8 ELECTRICAL

8.1 PACKAGER / MANUFACTURER shall manufacture and test all electrical equipment in compliance with Classification Society and IEC requirements.

8.2 Electrical equipment and material shall comply with requirements of I-ET-3010.00-5140-700-P4X-002 - Specification for Electrical Material for Offshore Units, I-ET-3010.00-5140-700-P4X-007 - I-ET-3010.00-5140-700-P4X-007 - Specification for Generic Electrical Equipment for Offshore Units and I-ET-3010.00-5140-700-P4X-009 - General Requirements for Electrical Material and Equipment for Offshore Units.

8.3 Electrical induction motors shall comply with requirements of I-ET-3010.00-5140-712-P4X-001 – Low-Voltage Induction Motors for Offshore Units or I-ET-3010.00-5140-712-P4X-002 – Medium-Voltage Induction Motors for Offshore Units.

8.4 Concerning electrical system voltages and quantity of feeders for motors, panels and auxiliaries, pumps shall be fed according to definitions of I-ET-3010.00-5140-700-P4X-003 – Electrical Requirements for Packages for Offshore Units.

8.5 Grounding installations inside the PACKAGE shall comply with requirements of I-ET-3010.00-5140-700-P4X-001 – Specification for Electrical Design for Offshore Units and I-DE-3010.00-5140-700-P4X-003 – Grounding Installations Typical Details.

8.6 Medium-voltage VSDs shall comply with I-ET-3010.00-5140-772-P4X-001 – Medium-Voltage Frequency Converter for Offshore Units. Low-voltage VSDs shall comply with I-ET-3010.00-5140-772-P4X-002 – Specification For Low-Voltage Frequency Converters, Soft-Starters And Inverters For Offshore Units.

9 CONTROLS AND INSTRUMENTATION

9.1 General


9.1.1 PACKAGER / MANUFACTURER shall ensure that the equipment is properly certified for the specified classification. For further information see FIELD INSTRUMENTATION specification [document supplied by OWNER].

9.1.2 PACKAGE automation type classification shall be according to AUTOMATION INTERFACE OF PACKAGE UNITS specification [document supplied by OWNER].

9.1.3 The PACKAGE automation, control and instrumentation shall fully comply with I-ET-3010.00-1200-800-P4X-002 – Automation, Control and Instrumentation on Package Units and I-ET-3010.00-1350-940-P4X-001 – Systems Operation Philosophy.

9.1.4 PACKAGER / MANUFACTURER shall design all sensors suitable for prevailing temperatures.

9.1.5 When applicable, PACKAGER / MANUFACTURER shall install field amplifiers, transducers, etc., according to the area classification and to protect them against mechanical damage.

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9.2 Automation, Control and Instrumentation System Cabling

9.2.1 PACKAGER / MANUFACTURER shall clearly mark all wiring within the limits of the enclosure on the wire and at the terminal.

9.2.2 PACKAGER / MANUFACTURER shall furnish all cabling between the driver and the local gauge board. All cables and cable routes shall contain at least 20% of the extra capacity.

9.3 Alarms and Shutdown

PACKAGER / MANUFACTURER shall set the minimum alarm and shutdown functions as required on the P&IDs and matrix of cause and effect.

10 PAINTING AND COLOR

10.1 PACKAGER / MANUFACTURER paint system shall be according to I-ET-3010.00-1200-956-P4X-002 – General Painting.

10.2 Color code adopted shall be in accordance with DR-ENGP-I-1.15 – Color Coding.

11 NAMEPLATES

11.1 MANUFACTURER shall attach corrosion resistant SS 316 nameplates on main and auxiliary equipment in an accessible location, fastened with corrosion resistant pins.

11.2 The nameplate information shall include, as a minimum, the following items in Portuguese:

- Purchase order and item number;
- Manufacturer and year of build;
- Equipment serial number and type;
- Capacity, head, volume;
- Driver power rating and speed;
- Design code;
- Design temperature and pressure;
- Piston diameter (for piston pump);
- Tag number.

NOTE: The nameplate data for equipment, which handle hydrocarbons, shall have information that allows the lost emission calculation, according to established Standards from EPA AP-42 – Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources.

12 TAG NUMBERING


12.1 PACKAGER / MANUFACTURER shall tag all instrumentation, electrical, mechanical and piping items, including valves, in accordance with I-ET-3000.00-1200-940-P4X-001 – Tagging Procedure for Production Units Design.

12.2 PACKAGER / MANUFACTURER shall supply tag plates with number and description in Portuguese, unless otherwise stated in the technical data sheets.

12.3 All tag plates shall be made from SS 316 material.

12.4 PACKAGER / MANUFACTURER shall tag valves, instruments and orifices with the applicable number only.

12.5 PACKAGER / MANUFACTURER shall define tag numbers for remaining auxiliary equipment in detail design after approval of OWNER.

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13 CERTIFICATION REQUIREMENTS

13.1 Class Certification

PACKAGER / MANUFACTURER shall supply a Classification Society Certificate of compliance with Rules requirements for the pump PACKAGE.

13.2 Material Certification

13.2.1 PACKAGER / MANUFACTURER shall obtain all necessary certification of the equipment.

13.2.2 PACKAGER / MANUFACTURER, through the independent certifying authority shall supply all certificates related to the materials, inspections, tests and qualification activities detailed in the approved Quality Plan.

14 INSPECTION, TESTING AND COMMISSIONING

14.1 Inspection and Testing

14.1.1 PACKAGER shall submit the Inspection and Test Plan (ITP) based on the technical data sheet with witnessed inspections and tests identified.

14.1.2 PACKAGER shall ensure that all the witnessed inspection requirements by the Classification Society are fully accommodated and due notice requirements are satisfied.

14.2 Factory Acceptance Test (FAT)

14.2.1 SUPPLIER shall prepare a factory acceptance test / procedure (FAT) and submit for OWNER approval.

14.2.2 For the Factory Acceptance Test (FAT), the PACKAGER / MANUFACTURER shall make preliminary test to ensure that all parts of the equipment are operating satisfactorily prior to the arrival of the OWNER's representative.

14.2.3 SUPPLIER shall advise OWNER of the test schedule before the planned test dates.

14.2.4 When required, SUPPLIER shall arrange with the appointed Classification Society surveyor to witness FAT.

14.2.5 PACKAGER / MANUFACTURER shall carry out a performance test on each pump type.


NOTE: A pump type is defined as a group of pumps purchased for the same duty and designed either to operate in parallel or as standby units. An example of this would be where 3 x 50% units are supplied for a certain duty, therefore only one of these pumps shall be tested.

14.2.6 PACKAGER / MANUFACTURER shall test variable speed pumps at the speeds defined in the respective API Standard.

14.2.7 Acceptance of the FAT shall not be considered as the final acceptance test of the equipment.

14.2.8 If it is found necessary to dismantle any equipment after a test for repair or replacement of components, the test shall be invalidated and repeated.

14.2.9 Acceptance of shop tests shall not constitute a waiver of requirements to meet the field tests under specified operating conditions, nor shall inspection relieve the PACKAGER / MANUFACTURER of his responsibilities in any way whatsoever.

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14.3 Commissioning

14.3.1 PACKAGER / MANUFACTURER shall provide any necessary support for installation and commissioning of the equipment either at a shore-based fabrication yard or on the UNIT.

14.3.2 SUPPLIER shall inform PACKAGER / MANUFACTURER regarding any specific commissioning conditions for the equipment, i.e., conditions in which the equipment will have to operate temporarily, including environmental conditions such as extreme ambient temperatures, if they are different from the conditions defined in the data sheet. The PACKAGE shall be designed to withstand such conditions.

15 PREPARATION FOR SHIPMENT

15.1 Marking

15.1.1 PACKAGER / MANUFACTURER shall adequately mark all items supplied to this specification for identification against a certificate or relevant test documentation.

15.1.2 PACKAGER / MANUFACTURER shall mark such that it does not damage or impair the component. Marking shall be done on the item itself or on its packing or nameplate.

15.1.3 OWNER shall reject items that cannot be identified. Rejected items shall be recertified by carrying out all relevant testing, with prior approval of the OWNER.

15.1.4 As a minimum, the following identification shall be provided:

- Project number;
- Manufacturer's name;
- Purchase order number;
- Shipping weight;
- Item number;
- Classification Society surveyor's stamp.

15.2 Shipment Packing

15.2.1 PACKAGER / MANUFACTURER shall supply, test, flush, and preserve the PACKAGE and, if practical, already charge up with coolant and lubricants the equipment.

15.2.2 The preparation shall make the equipment suitable for 24 months outdoor storage from the time of shipment. The PACKAGE shall be protected from corrosion.

15.2.3 PACKAGER / MANUFACTURER shall treat and close off all open ends by plastic caps and taped.


15.2.4 PACKAGER shall submit the packing specification to the SUPPLIER for approval.

15.2.5 PACKAGER / MANUFACTURER shall pack in accordance with the requirements of the country to which the equipment is being shipped.

15.2.6 PACKAGER shall provide the procedures for unpacking, handling and installation, as well as repacking, and long-term storage requirements.

15.2.7 PACKAGER shall specify any limitations applicable to the transport and installation phase.

15.2.8 Unless otherwise advised, PACKAGER / MANUFACTURER shall check each item of equipment for its suitability to resist horizontal and vertical acceleration of 0.8g in any direction during sea transportation.

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16 REQUIRED DOCUMENTATION

16.1 PACKAGER / MANUFACTURER shall provide original documents in PDF format for all required documents.

16.2 Extracted figures from catalogue or manual, especially for the outline drawings of components such as couplings, mechanical seals and auxiliary equipment shall not be accepted.

16.3 Whenever required by OWNER, source files shall also be provided.

16.4 All documents required in this section shall be text searchable, including PDF files.

16.5 Before any document is issued by PACKAGER / MANUFACTURER, a document list shall be issued and approved by OWNER.

This is required in order to guarantee the correct document numbering.

16.6 Drawings and diagrams shall use the symbols defined on I-ET-3000.00-0000-940-P4X-002 – Symbols for Production Units Design.

16.7 Title of all documents to be issued by PACKAGER / MANUFACTURER shall have the following format:

- First part – tag number;
- Second part – service description;
- Third part – document description

EXAMPLE: B-5241501A/B – Inert gas seal pump – General Arrangement Drawing

16.8 If PACKAGER / MANUFACTURER issues documents which contain information valid for more than one pump tag, pump tag and service description shall be omitted and replaced by “Centrifugal Pumps”


EXAMPLE: Centrifugal pumps – Inspection and Test Plan.

16.9 The following documents shall be issued by PACKAGER / MANUFACTURER and approved by OWNER before FAT execution. Otherwise, OWNER will not attend the FAT and will not accept its execution:

- Piping and instrumentation diagram;
- General arrangement drawing;
- Cross section drawing with part list;
- Main and auxiliary equipment datasheets;
- Weight and center of gravity datasheet;
- Noise datasheet;
- Performance curves;
- Utility consumption list and heat dissipation;
- Inspection and Test Plan (ITP), including auxiliary equipment;
- Hydrostatic test procedure;
- Painting and insulation specification;
- Torsional analysis report;
- FAT procedure.

16.10 The following documents shall be issued by PACKAGER / MANUFACTURER and approved by OWNER before delivery of the PACKAGE. Otherwise, OWNER will not attend to the receiving inspection, and will not accept the PACKAGE:

- Nameplate drawings;
- Noise report;

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- FAT report;
- Handling drawing for installation;
- Installation manual;
- Instruments and instrumented valves datasheets;
- Packing list;

16.11 The following documents shall be issued by PACKAGER / MANUFACTURER and approved by OWNER before issuance of the Databook. Otherwise, OWNER will not accept the Databook:

- Mechanical seal drawing;
- Coupling drawing;
- Outline drawings of auxiliary equipment;
- Operation and maintenance manuals for main and auxiliary equipment;
- List of spare parts for commissioning and start up;
- List of recommended spare parts for two years of operation;
- List of special tools;
- List of instruments and instrumented valves;
- List of set points, alarms and shutdown;
- Logic diagrams;
- Cause and effect charts;
- Loop diagram;
- Electromechanical panel drawing;
- Memory maps;
- Automation architecture;
- Interconnection wiring diagram;
- Calculation notes of control valves, PSVs and flowmeters;
- I/O List;
- HMI screen layout;
- Calibration certificates of instruments;
- Fabrication procedures of pressure vessels classified in NR-13;
- NDT procedures of pressure vessels classified in NR-13;
- Hydrotest reports for pressure vessels classified in NR-13;
- Hydrotest report of pumps;
- NDT reports;
- Material certificates;
- Heat treatment records;
- Databook index.


16.12 All documents for electric motors shall be according to I-ET-3010.00-5140-712-P4X-001 – Low-Voltage Induction Motors for Offshore Units and I-ET-3010.00-5140-712-P4X-002 – Medium-Voltage Induction Motors for Offshore Units.

16.13 PACKAGER / MANUFACTURER shall issue installation, operation and maintenance manuals in Portuguese. PACKAGER / MANUFACTURER may choose to issue one single manual with installation, operation and maintenance instructions.

16.14 Installation manual shall contain all recommendations for preservation during storage on erection stage. If PACKAGER / MANUFACTURER fails to provide this information on the installation manual, any damages due to the lack of preservation shall be PACKAGER / MANUFACTURER's responsibility.

16.15 Installation manual shall contain a list of all consumables to be used for erection, commissioning and start up.

16.16 Maintenance manual shall contain the specification of lubricant fluids and periodicity of replacement.

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16.17 Maintenance manual shall contain instructions to assemble and disassemble each major piece of the equipment, such as mechanical seal, rotor and roller bearings. This information may be provided on a separate manual for the piece as well.

16.18 PACKAGER / MANUFACTURER shall choose to include specific commissioning instructions on the operation manual, or to issue a separate document, such as a procedure, for commissioning instructions.

16.19 PACKAGER / MANUFACTURER shall confirm in these instructions if the pump can operate with water, for services which the operation fluid is not water.

16.20 Operation manual shall contain, among other information, the control system description of the PACKAGE.

16.21 General arrangement drawings shall contain the connection list, i.e., a list with all connection tie-in points of the skids, which shall have the following minimum information:

- Connection identification number (which shall be represented in the drawing);
- connection description;
- tie-in connection specification, that is, pressure rating, manufacturing standard, flange face type, connection nominal diameter and fluid.

16.22 PACKAGER / MANUFACTURER shall indicate on the general arrangement drawing the distance required for removal of all internal parts, which shall be disassembled periodically for maintenance, in accordance with recommendations on the maintenance manual.

16.23 Mechanical seal drawings shall contain a list with all connections on the seal, including identification code (which shall be represented on the mechanical seal drawing), connection description and fluid.

16.24 Mechanical seal drawings shall also contain a part list with identification number of the part, description of the part and material of each part. Identification number of seal parts shall be different from the identification code of the connections.

NOTE: For example, identification codes can be letters and parts identified by numbers.

16.25 Each material certificate and NDT report provided by third parties shall be preceded by a PACKAGER / MANUFACTURER sheet, informing to which part of the equipment the document refers.

17 WELL SERVICE PUMP ADDITIONAL REQUIREMENTS

17.1 General

17.1.1 All requirements in this section/subsection shall be added to the other sections/subsections of this specification.

17.1.2 Well Service Pump couplings shall be designed and supplied in accordance with API Std 671.


17.2 Gear Units

17.2.1 The gear unit shall conform to API Std 677 and IOGP S-712.

17.2.2 The gear assembly shall have two embedded RTD's in each journal bearing of the gear. RTD leads shall be routed to a dedicated junction box mounted on the external side of the gear housing.

17.3 Pulsation and Vibration Analysis

17.3.1 PACKAGER / MANUFACTURER shall perform a pulsation and vibration analysis including the actual suction and discharge piping layout designed by SUPPLIER, according to API Std 674 Annex C, Design Approach 2 (Acoustical Simulation).

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17.3.2 PACKAGER / MANUFACTURER shall revise as many times as necessary the pulsation and vibration analysis, considering the feedback from SUPPLIER, until both pulsation and vibration analysis and flexibility analysis converge to a common piping run design.

17.3.3 PACKAGER / MANUFACTURER shall provide instructions on the piping design to reduce the effects of pulsation and vibration, in order to reach the limits established in this specification.

17.3.4 SUPPLIER shall follow the instructions from PACKAGER / MANUFACTURER regarding piping design and perform the flexibility analysis of the piping run, as many times as needed, until both pulsation and vibration analysis and flexibility analysis converge to a common piping run design.

17.3.5 If the Well Service Pump is driven by a Variable Frequency Drive (VFD), the Torsional Analysis Report shall consider its characteristic harmonics as possible torsional excitations, and the required separation margins apply.

17.3.6 If the Torsional Analysis shows that the required separation margins cannot be met, a fatigue analysis can be carried out to ensure all elements of the pump train are design for infinite life.

17.4 Monitoring System

17.4.1 Well Service Pumps, drivers and gearboxes shall be supplied with the following instrumentation as a minimum:

- a) Electric motor vibration – 2 accelerometers per bearing housing.
- b) Gearbox vibration – 1 accelerometer per shaft.
- c) Pump vibration – 2 accelerometers per crankshaft bearing.
- d) Shaft speed – 1 speed sensor for each different shaft speed.
- e) Bearing temperatures - 2 bearing metal temperature sensors (including driver, gearbox and pump).

17.4.2 Monitoring system shall comply with API Std 670.

17.4.3 Well Service Pumps lube oil systems shall have an online oil condition monitoring device to enable real-time indication of oil contamination with water and metallic residue.

17.4.3.1 The online oil condition monitoring device shall be compatible with and connected to the MMS.

17.5 Factory Acceptance Test (FAT)

17.5.1 Each pump shall undergo a continuous Mechanical Run Test at the rated operating conditions for four hours.

17.5.2 The mechanical run test shall not begin until oil temperatures have stabilized. During this run, MANUFACTURER shall record and approve records of vibration and temperature.


17.5.3 Each pump shall undergo a Performance Test in accordance with API Std 674.

NOTE: If MANUFACTURER does not define a limit for vibration in the FAT procedure, values defined in ISO 20816 shall be followed. MANUFACTURER shall define the bearing housing temperature limit in the FAT procedure.

17.5.4 Vibration and bearing housing temperature measurements are also required for the performance test and shall be recorded in the FAT report.

17.5.5 Vibration and temperature limits for the performance test shall be compatible with the limits defined for the mechanical run test.

17.5.6 OWNER shall witness all pump Factory Acceptance Tests carried out at the MANUFACTURER's facilities.

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17.5.7 When required by the design Data Sheets, one of the supplied pumps shall undergo a Complete Unit Test.

17.5.7.1 The following PACKAGE contract items shall be integrated and tested during the CUT:

- a) Pump skid: pump, driver, baseplate, gearbox, job coupling, lube oil system and sealing system.
- b) Variable Speed Drive, whenever applicable.
- c) Control Panel, whenever applicable.
- d) Vibration sensors and signal conditioning systems.
- e) Temperature and pressure sensors.

17.5.7.2 The pump unit shall be run at rated speed and pressure for a minimum 4 hours.

17.5.7.3 For pumps with VSDs, after the stabilization of the equipment's temperatures, the speed shall be varied across the entire allowable operating speed range.

17.5.7.4 The same vibration and temperature acceptance criteria from the pump Mechanical Running Test shall be applied to the CUT.

17.5.7.5 All monitored parameters shall be below the pre-defined design alarm levels during the entire duration of the CUT.

17.6 Materials

PACKAGER / MANUFACTURER shall select pump materials suitable for operation with sea water.

17.7 External Nozzle Forces and Moments

PACKAGER / MANUFACTURER shall design pump nozzles at battery limit to withstand two times the forces and moments defined in API Std 674.