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	AREA: BÚZIOS								
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1 INTRODUCTION

This specification covers the minimum technical requirements and criteria for the design, engineering, materials, fabrication, inspection, testing, preparation of shipment, installation, pre-commissioning and commissioning of all electric motor driven centrifugal pumps. These specification doesn't cover pumps from naval systems.

The pumps shall be provided with all necessary instrumentation to operate safely, adequately and without interruption in a tropical marine environment.

Details of design and construction shall be stated in the technical data sheet of each pump.

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

2 NORMATIVE REFERENCES

All equipment shall comply with the requirements of this technical specification, data sheets, documents as stated below and with those referred to herein.

2.1 Classification

PACKAGER/MANUFACTURER shall perform the work in accordance with the requirements of Classification Society. PACKAGER/MANUFACTURER is responsible for submitting to the Classification Society all documentation in compliance with stated Rules.

2.2 Codes and Standards

The following codes and standards include provisions, which, through reference in this text, constitute provisions of this specification. The latest issue of the references shall be used unless otherwise agreed. Other recognized standards may be used, provided it can be shown that they meet or exceed the requirements of the standards referenced below.

API RP 582	Welding Guidelines for the Chemical, Oil, and Gas Industries
API STD 610	Centrifugal Pumps for Petroleum, Petrochemical, and Natural Gas Industries
API STD 614	Lubrication, Shaft-sealing and Oil-control Systems and Auxiliaries
API STD 670	Machinery Protection Systems
API STD 671	Special-Purpose Couplings for Petroleum, Chemical, and Gas Industry Services
API STD 677	General-Purpose Gear Units for Petroleum, Chemicals and Gas Industry Services
API STD 682	Pumps - Shaft Sealing Systems for Centrifugal and Rotary Pumps
ASME B16.47	Large Diameter Steel Flanges NPS 26 Through NPS 60 Metric/Inch Standard

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ASME B16.5	Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B31.3	Process Piping
ASME B73.1	Specification for Horizontal End Suction Centrifugal Pumps for Chemical Process
ASME B73.2	Specification for Vertical In-Line Centrifugal Pumps for Chemical Process
ASME BPVC Sec. VIII-1	Rules For Construction of Pressure Vessels
ASME PTC 8.2	Centrifugal Pumps
AWS D1.1/D1.1M	Structural Welding Code - Steel
EPA AP-42	Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, of the USA Environment Protection Agency
HI	Hydraulic Institute Standard
IEC 60034	Rotating Electrical Machines
IEC 60092-502	Electrical Installation in Ships-Tankers-Special Features
IEC 61508/all parts	International Electrotechnical Commission - Functional safety of electrical/electronic/programmable electronic safety-related systems
IEC 61511/all parts	International Electrotechnical Commission - Functional safety - Safety instrumented systems for the process industry sector
IEC 61892-all parts	Mobile and Fixed Offshore Units – Electrical Installation
INMETRO	Resolution 89, February 23rd 2012
INMETRO	Resolution 179, May 18th 2010
ISO 14691	Petroleum, petrochemical and natural gas industries - Flexible couplings for mechanical power transmission - General-purpose applications
ISO 15156-all parts	Petroleum and Natural Gas Industries: Materials for Use in H ₂ S-Containing environments in Oil and Gas Production
ISO 12944-9	Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 9: Protective paint systems and laboratory performance test methods for offshore and related structures
NR-10	Brazilian Ministry of Labor (Ministério do Trabalho e Emprego – Norma Regulamentadora Nº 10, Segurança em Instalações e Serviços em Eletricidade)
NR-13	Brazilian Ministry of Labor (Ministério do Trabalho e Emprego – Norma Regulamentadora Nº 13, Caldeiras, Vasos de

NR-26	Pressão, Tubulações e Tanques Metálicos de Armazenamento)
NR-37	Brazilian Ministry of Labor (Ministério do Trabalho e Emprego – Norma Regulamentadora Nº 26, Sinalização de Segurança)
TEMA	Brazilian Ministry of Labor (Ministério do Trabalho e Emprego – Norma Regulamentadora Nº 37, Segurança e Saúde em Plataformas de Petróleo)
	Standards of Tubular Exchanger Manufactures Association Classification Society Rules for Offshore Facilities

Classification Society Rules for Offshore Facilities

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

2.3 Reference Documents

- 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-3010.00-1350-940-P4X-001	Systems Operation Philosophy
I-ET-3A36.00-1000-941-PPC-001	Metocean Data
I-LI-3010.1M-1200-940-P4X-002	Equipment List

- Mechanical**

I-ET-3010.00-1200-251-P4X-001	Bolt Material
I-ET-3010.00-1200-540-P4X-001	Requirements for Pressure Vessels Design
I-ET-3010.00-1200-540-P4X-002	Requirements for Pressure Vessel Fabrication
I-ET-3010.00-1200-955-P4X-001	Welding
I-ET-3010.00-1200-955-P4X-002	Requirements for Welding Inspection
I-ET-3010.00-1200-956-P4X-002	General Painting
I-ET-3010.00-5500-854-P4X-001	Machinery Monitoring System (MMS)
I-ET-3010.1M-1200-200-P4X-001	Piping Specification for Topside
I-ET-3010.1M-1200-300-P4X-001	Noise Control Requirements for Topside
DR-ENGP-I-1.15-R.3	Color Coding

- Process**

I-RL-3010.1M-1200-940-P4X-001	General Specification for Available Utilities
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- **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 and Equipment 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-3010.00-5140-797-P4X-001	Electrical System Automation Architecture

- **Automation**

I-ET-3010.00-1200-800-P4X-002	Automation, Control and Instrumentation on Package Units
I-ET-3010.1M-1200-800-P4X-005	Field Instrumentation
I-ET-3010.1M-1200-800-P4X-014	Automation Interface of Package Units
I-ET-3010.00-5520-888-P4X-001	CSS / SOS Panels
I-ET-3010.1M-1200-800-P4X-001	Instrumentation Additional Technical Requirements
I-ET-3010.1M-1200-800-P4X-005	Field Instrumentation
I-ET-3010.00-5500-854-P4X-001	Machinery Monitoring System

- **Naval**

I-RL-3010.1M-1350-960-P4X-009	Motion Analysis
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2.4 Conflicting Requirements

Pumps shall comply with the requirements of this technical specification and references stated below. All equipment parts and details not complying with any of these requirements shall be informed on a "Deviation List". Otherwise, they will be considered as "Agreed", and so required.

As a general guideline, in case of conflicting requirements between this technical specification and other cited references, the most stringent shall prevail. If necessary, the PACKAGER/MANUFACTURER may revert to PETROBRAS for clarification.

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3 DEFINITIONS AND ABBREVIATIONS

3.1 Definitions

Can: Can requirements are conditional and indicate a possibility open to the user of the standard.

May: May indicates a course of action that is permissible within the limits of the standard (a permission).

Shall: Shall is an absolute requirement, which shall be followed strictly in order to conform to the standard.

Unit: is defined as the FPSO (Floating Production Storage and Offloading), FSO (Floating Storage and Offloading), SS (Semi-Submersible) or Fixed Offshore Unit.

Package Unit or Package: is defined as an assembly of equipment supplied interconnected, tested and operating, requiring only the available utilities from the Unit for the Package operation.

Packager: is defined as the responsible for project, assembly, construction, fabrication, test and furnishing of the Package.

Manufacturer: is defined as the responsible by fabrication of equipment or components internal to the Package.

Bidder: is defined as the responsible for the lift, hook up, installation and integration of all Modules on the Unit Hull.

Module: is defined as the metallic structure suitable for lift and transport, where Packages and equipment will be installed, being supplied completely mounted and pre-commissioned.

Module Supplier: is defined as the responsible for project, assembly, erection, construction, fabrication, test and furnishing of the Module.

Hull Contractor: is defined as the responsible for all equipment, project, assembly, construction, fabrication, test, furnishing, installations and services related to Unit Hull.

3.2 Abbreviations:

FPSO:	Floating Production Storage and Offloading
g:	Gravitational acceleration
Giop:	“Gerenciamento Integrado de Operações”
mA:	Milliamps
PLC:	Programmable Logic Computer
RTD:	Resistance Temperature Detector
SS:	Stainless Steel
NPSH:	Net Positive Suction Head
Nss:	Specific Suction Speed



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MMS: Machine Monitoring System

4 GENERAL FUNCTIONAL REQUIREMENTS

4.1 Operation Environment / Motion Requirement

4.1.1 Operation Environment

The equipment supplied shall be suitable for the environment and range of ambient condition including, atmospheric pressure, relative humidity, rainfall, air temperature (dry bulb, see Obs.1), characteristic monthly values and wind motions defined in the document I-ET-3A36.00-1000-941-PPC-001revD- Metocean Data.

Obs.1: For air temperature (dry bulb) of electrical equipment, use the most critical conditions, among those defined by Classification Society and specific documentation of equipment.

4.1.2 Motion Requirements

The necessary design data and information on motion requirements are given I-RL-3010.1M-1350-960-P4X-009 - Motion Analysis.

BIDDER shall inform MANUFACTURER/PACKAGER any data from the model tests, which contradicts the specified data. Any action on the revised data will be subject to agreement with the BIDDER.

4.2 Design Conditions

MANUFACTURER/PACKAGER shall design the equipment for ongoing service (24h/d) considering the full range of operational conditions as specified in the data sheet.

All equipment shall be suitable for continuous operation in a classified area if established on the data sheets.

All electrical equipment shall be manufactured and tested in compliance with Classification Society and IEC requirements, unless otherwise stated.

4.3 Equipment Location

The pumps will be installed on the topsides of the facility and will be exposed to the marine environment, exception to submersible motor type pumps, which shall installed in a caisson.

Pumps shall be mounted on a common baseplate, providing adequate clearance for safety and maintenance.

4.4 Design Requirements

It is MANUFACTURER's/PACKAGER's responsibility to submit to the Classification Society the documentation in compliance with Rules in force.

All elements of the pump package, including sub-orders, shall be of "field proven" design and well within the manufacturer's actual experience.

For BIDDER, "field proven" equipment is defined as having a Reference List with at least 3 (three) operating packages (of similar rated capacity) installed in offshore production units. In addition, each one of those packages shall present:

- a) Availability over 98%
- b) Historical record according to Table 4-1

Table 4-1 Minimum Amount of Operation Hours Recorded for Mechanical Equipment

RATED POWER	OPERATION HOURS
UP TO 200 HP	8,000
BETWEEN 201 AND 600 HP	12,000
BETWEEN 601 AND 1200 HP	16,000
OVER 1200 HP	24,000

Deviations from the items above, related to the “field proven design”, may be accepted only for equipment which is part of research or development programs. In this case, their use shall be formally approved by PETROBRAS.

All pressure vessels shall comply with the requirements of NR-13.

4.5 Design Lifetime

PACKAGER shall design and fabricate the complete packages for a minimum service lifetime of 25 years.

4.6 Noise

Noise control analysis is a mandatory item to be carried-out. The I-ET-3010.1M-1200-300-P4X-001 - Noise Control Requirements for Toppide shall be followed.

This document establishes the minimum requirements for noise control to be observed and describes the basic procedures for the measurement and reporting of airborne sound levels of equipment.

4.7 Packager

PACKAGER shall be responsible for all co-ordination with manufacturers and collections of all details, drawings and data to achieve optimum design and full submission of all documents requested in the specification.

PACKAGER shall list into its tender the respective manufacturer for the following major items:

- Driver
- Gearbox (if applicable)
- Coupling
- Pump seals

5 EQUIPMENT SPECIFICATION

PACKAGER shall be responsible for supplying complete and fully operative systems in accordance with the requirements of this specification.

5.1 General Requirements

Pumps shall be designed for continuous operation at full load duty, unless otherwise stated in the process data sheets.



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The pump shall be MANUFACTURER'S/PACKAGER'S standard design, provided it covers the requirements of this specification. Prototypes are not acceptable.

No deviation from this specification and associated data sheets is permitted unless PETROBRAS gives approval in writing.

The complete unit of pump, driver and baseplate shall be provided with lugs, etc., to facilitate mechanical handling by means of a single point lift.

The structural design of pump skid shall provide means to ensure that the deformation caused by the movement of the platform or vessel structure is not transmitted to the base of the rotary assembly. Either by supporting the skid on three points or using other proper structures, particularly when such deformation is significant compared to limits allowed and specified by the equipment manufacturer. Foundation design shall take into account the stiffness of the assembly, aiming to prevent vibration transmission to the adjoining equipment, living quarters, control rooms, and other environments in the platform.

Pump materials, when not specified in this specification shall be in accordance with MANUFACTURER'S standards and submitted for PETROBRAS approval.

Multistage pump designs that require more than eight (8) impellers between the bearings or mounted on a single shaft shall be avoided. The use of such configuration requires PETROBRAS approval.

Pumps shall be preferably select to run at 1800 rpm. When a hydraulic selection cannot be matched at 1800 rpm, or there is an exceptional advantage in running at 3600 rpm, PETROBRAS design team shall be consulted for approval.

The rotary parts, such as couplings, pulleys, and flywheels, shall feature rigid guards, made of non-sparking and non-flammable material.

Pumps shall be designed to operate and withstand a saline atmosphere (seawater spray and mist).

5.2 Package

The complete package shall be designed, manufactured, tested, inspected and certified to conform to the requirements of this specification and shall be designed to meet the duty as stipulated on the project data sheets.

PACKAGER shall assume full unit responsibility for the complete package, including the driver and all ancillaries.

The utility requirements and consumption of the equipment shall be clearly defined by PACKAGER. This information shall also be included in the quotation.

No exceptions to the requirements of the regulation codes concerning the type of protection shall be allowed without a written approval of the BIDDER.

The pump packages, including all ancillary equipment, shall be assembled to the maximum extent possible, aligned and pre-checked in MANUFACTURER'S/PACKAGER'S shop, allowing shipment to the integration yard with minimal fieldwork.

For foreign made equipment, the standard manufacturing parts (couplings, mechanical type seals, anti-friction bearings) shall be purchased from Manufacturers with representative branches located in Brazil, with service parts and maintenance workshops.



Package(s) shall be manufactured, inspected and verified to comply with all specifications mentioned in chapter 2 and the Classification Society regulations.

Centrifugal pumps shall be driven by electrical motors, unless otherwise specified.

Dissimilar materials in contact with an electrolyte shall be isolated to avoid galvanic corrosion.

5.3 Performance

Pumps shall be suitable for continuous operation, without shutdown for normal maintenance, for a minimum period of one year and for intermittent service for a period of eighteen months, unless otherwise specified.

Pumps must have stable head / capacity curves with a continuous head rise to shutoff of at least 10% from rated head. When parallel operation is specified, the rise shall be at least 10% of the rated head, but not more than 20% of the head at BEP of rated impeller diameter, as confirmed during performance test. The use of orifice devices or other head modifiers situated in the pumped fluid discharge is not acceptable.

The efficiency at the specified duty point shall be the maximum value. Where it is below the maximum value, the maximum efficiency point should be achievable by increases in the flow rate. For pumps, which driver is medium voltage motor best efficiency point shall be at least 80%.

The pump shall normally be directly driven at standard electric motor speeds, unless otherwise stated in the data sheet or agreed by PETROBRAS.

Pumps with constant speed drivers shall be capable of providing a head increase of at least 5% at rated capacity by installing a larger diameter impeller.

MANUFACTURER/PACKAGER shall offer designs that minimize the number of required impeller stages.

Rated flow shall be within the region of 80 % to 110 % of best efficiency flow rate of the pump as furnished.

The NPSH required shall be at least 2 m less than the NPSH available. Correction factors are not allowed. BIDDER may accept differences between 1 and 2 m, but a witnessed NPSH test shall be performed.

5.4 Pump Casing

Casing wall thickness shall be suitable for the specified design and test pressures and temperatures. A corrosion allowance of at least 3 mm shall be included unless the material is stainless steel or other corrosion resistant alloy.

Where jackscrews are provided to assist in dismantling pump casing mating surfaces, the mating face shall be counter-bored to receive the jackscrew where damage to the face could lead to a leaky joint or improper fit. Mating surfaces shall be provided with taper dowel-pins or fitted bolts to ensure correct alignment on re-assembly.

The direction of rotation of the impeller(s) shall be clearly marked on the casing by permanent means.



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Drains and vents shall be flanged and valved unless otherwise stated in the pump data sheet. Screwed connections in the casing are not permitted. All BIDDER interface connections shall terminate at skid edge provided with a valve and a blind flange.

The drain and vent pipework shall be suitably secured to the pump baseplate or mounting frame by MANUFACTURER/PACKAGER as applicable.

The whole pump casing shall have a pressure rating allowing it to be tested at the hydrostatic test pressure of the discharge side by mounting blinds to the suction and discharge nozzle.

Threaded connections shall not be used.

The vertically-mounted, axially split-case pumps shall be provided with facilities (stud bolts or dowel pins), to simplify the upper casing cover assembly.

Horizontally-mounted axially split-case pumps shall be of the back-to-back or in line type.

5.5 Impellers

Impellers shall preferably be of one piece, fabricated, or cast construction, of closed type design, according to MANUFACTURER'S standard.

The pump rated impeller shall not be the maximum size impeller for the pump casing.

All pumps shall be designed and specified for maximum suction speed of 11000 (US Unit). If the available NPSH is not enough, the pump design shall be changed in order to comply with the maximum allowed Nss.

5.6 Wear Rings

Impellers shall be furnished with renewable wear rings, unless otherwise agreed by PETROBRAS.

In addition, where practicable, the pump casing shall be provided with renewable wear rings.

All wear rings shall be positively located and shall not rely on only shrink fits or welding, as a means of securing them.

5.7 Shaft and Shaft Sleeves

Shafts shall be of one-piece construction and ground all over, where practicable. A radius shall be provided at each shaft shoulder to reduce possibility of stress concentrations.

All pumps shall be furnished with shaft sleeves.

Shaft sleeves shall be manufactured from material having wearing properties suitable for the service and resistant to deterioration by the pumped fluid.

Shaft sleeves shall be machined concentric to the shaft, ground and polished over the full bearing or sealing length. The method of securing the sleeve to the shaft shall positively locate the sleeve to prevent slippage occurring. The sleeve surfaces shall not be distorted in any plane as a consequence of being secured to the shaft.

5.8 Mechanical Seals

Mechanical seal shall comply with the latest edition of API 610 and/or 682.



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Centrifugal pumps shall be provided with cartridge-type and balanced mechanical seals, with their sleeves independent from the pump's sleeves and shall not be used as centering element of the rotary set.

Seal flushing requirements shall be as specified on the pump data sheets.

Pumps in hydrocarbon service with a pumped fluid specific gravity of 0.60 or less at any operating point shall employ double or tandem seal arrangements and have provisions for cooling the flushing liquid, as required, to maintain a temperature at the seal face in accordance with the seal manufacturer's recommendation.

Pumps in service with temperature over 90°C shall have provisions for cooling the seal flush liquid where necessary, to ensure a temperature of no more than 90°C at the seal face. Seal materials shall be the seal manufacturer's recommendation for the service, with the exception that Ceramic seal face materials shall not be used.

BIDDER may also specify required materials on the data sheets. For services where the pumped product is in excess of 80°C, MANUFACTURER/PACKAGER shall evaluate the seal design to the BIDDER's acceptance.

Seal plates shall be provided with all necessary 1/2" NPT minimum connections (complete with solid plugs) for flushing, quench, drains and venting. Plugs shall be of the same material as the seal plate.

All mechanical seals shall be furnished with close clearance, non-sparking throttle bushes, pressed into the seal plate.

All sealing system elements shall be designed to withstand the maximum pressure for different arrangements (serial or in parallel) and for maximum pressure developed by the pump in case of seal failure.

5.9 Auxiliary Piping

All ancillary piping shall be designed, fabricated, and inspected in accordance with ASME B31.3.

All pipe flanges and pipe fittings shall be in accordance with ASME B16.5.

Pumps requiring auxiliary piping for cooling, flushing, etc., shall be provided with all necessary connections (1/2" NPT minimum), plus all required piping and fittings, as defined on the data sheets. All auxiliary piping shall be SS 316 unless otherwise specified.

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

All pump casings shall be provided with flanged vent and drain connections unless otherwise specified. Multistage pump casings shall include additional vent and drain sections to avoid gas pockets or residual liquids.

When barrier/buffer fluid is specified in the data sheet, a fluid reservoir shall be designed for mounting on the pump baseplate and shall be stripped loose separately. The reservoir shall include fluid circulation, tubing to and from the seal. Vent system shall be provided with a restriction orifice to control the rate of the product vaporized.

All auxiliaries piping carrying service shall terminate with block valves at the edge of the skid and shall be designed to permit ready disconnection of pipe work of the pump.



5.10 Bearings

Oil lubricated ball and roller bearings are preferred for all services unless otherwise specified.

Forced lubrication system shall be used in case energy density is higher or equal than limits established by API 610 for using hydrodynamic bearings.

Hydrodynamic bearing applications shall be designed for a pressure fed lubricating oil system. The hydrodynamic bearing lubrication system shall be in accordance with the latest edition of the API-614 standard specifications. The use of oil rings as the primary source of lubricant supply in these applications is unacceptable.

Sealed bearings filled with grease may only be offered with PETROBRAS approval.

The use of Polyamide or other synthetic materials in rolling contact bearings is forbidden.

Bearing housings serving as oil reservoirs shall be provided with constant level oilers. The recommended working oil level shall be accurately located and clearly marked on the outside of the bearing housing by permanent means.

Bearing housings shall be sealed against loss of lubricant and the entrance of water, steam, dust or other contaminants. Seals for bearing housings shall be of the hermetic labyrinth type, with static & dynamic effective sealing (liquid- and vapor-tight).

Cooling of bearing housings by means of water jackets shall be employed when handling fluids at a pumping temperature of 200°C or above, or when the lubricating oil temperature is likely to rise above 82°C, based on specified operating conditions and 34°C ambient.

Axially split case-type petroleum transfer pumps shall be provided with provisions for the installation of pressure gauges in the sealing box, for pressure monitoring.

5.11 Couplings

The preferred method of connecting the driver to the pump is by means of a flexible spacer type coupling.

The coupling guards shall be in non-sparking and non-flammable materials.

Flexible couplings with rubber parts shall not be used in classified area.

When required, as a result of the lateral analysis, reduced moment dry diaphragm type couplings may be used with the BIDDER'S written approval.

For pumps requiring power inputs greater than 500 kW, the coupling hubs shall be hydraulic taper fit, unless otherwise approved by PETROBRAS. All smaller sized units shall be in accordance with MANUFACTURER'S normal standard.

5.12 Baseplate

The pumps and drivers shall be installed on a combined baseplate unless otherwise specified. The baseplate shall be of the manufacturer's standard design, complete with a drain pans with valved drain connections. The design shall be such that the drain rim or baseplate shall be capable of containing 150% of the pump internal liquid volume, in the event that the drain connection becomes blocked.



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One 1½” NPT minimum drain connection shall be provided at the short side of the baseplate (normally drip pan slopes to one side). Larger drain sizes are preferred if practicable.

The baseplate shall be fully machined for proper alignment of the pump and driver. Leveling and alignment shall be done with shim plates of at least 3 mm thick at the driver side.

Pumps in corrosive duties shall be provided with suitable drained drip pans, manufactured in the same materials as the casing.

Design and fabrication welding shall be in accordance with Structural Welding Code, AWS D1.1 and classification society rules. Intermittent welds are not allowed.

The baseplate shall be designed such that there are no pockets or cavities that can collect or hold liquids. All such pockets and cavities shall connect to the main drain connection or be sealed.

For pump packages with LV motors, the baseplates shall be designed to be completely seal welded to the support structure. For pump packages with MV motors, the baseplates shall be designed to facilitate bolting to the support structure with either 3-point or multipoint mounting. LV motors with 3-point or multipoint mounting baseplate shall be advised by the vendors and introduced to PETROBRAS as exception.

Alignment blocks shall be provided for the driver if applicable. They shall be welded to the baseplate and provided with jackscrews for movement of the driver in both horizontal planes.

Shims shall be in stainless steel material of the same size of the baseplate resting surface and shall minimize quantity used. The use of multiple small sized shims is to be avoided.

5.13 Vibration and Balance

Major parts of the rotating element, such as impellers or balance drums, shall be individually statically balanced as a minimum.

In addition, if specified on the data sheets or required by the operating conditions and pump size, the impeller and complete rotating element shall be dynamically balanced.

Unless otherwise agreed, rotor balance of horizontal pumps shall be such that the amplitude of vibration does not exceed the limits as defined by API 610.

PACKAGER is responsible for the initial “Free Alignment” between the pump and the motor on the baseplate, which must be documented on relevant BIDDER check sheet.

For large pumps with 500kW and above, PACKAGER shall perform torsional analysis for the complete coupled train, including the driver.

Equipment subject to excessive vibration shall be provided with AVM (Anti Vibration Mounting) aiming that the vibration level does not exceed the values established by I-ET-3010.1M-1200-300-P4X-001 Noise Control Requirements for Topside.

5.14 Controls and Instrumentation

5.14.1 General

All instruments and controls, when applicable to the pump skid, shall be fitted for purpose, suitable for the climate, hazardous area and environment for which they are intended,

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according to the same standards and requirements applicable for this project. MANUFACTURER/PACKAGER shall ensure that the equipment is properly certified for the specified classification. For further information see I-ET-3010.1M-1200-800-P4X-005 - Field Instrumentation.

The package unit including control system shall be considered as a package, the type and all instrumentation equipment and interface with FPSO Automation and Control design shall fully comply with the document 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.

Bearing surfaces shall be prepared for accelerometer installation or proximity probes.

5.14.2 Vibration Detection Devices and Temperature Sensor

All vibration detection and temperature sensor devices on the equipment shall be suitable for prevailing temperatures. When applicable, field amplifiers, transducers, etc., shall be installed as per MANUFACTURER/ PACKAGER practices, according to the area classification to protect them against mechanical damage.

5.14.3 Automation, Control and Instrumentation System Cabling

All wiring within the limits of the enclosure shall be clearly marked on the wire and at the terminal.

The specification and cable supply must be according with the document I-ET-3010.00-1200-800-P4X-002 Automation, Control and Instrumentation on Package Units, item 4.8.

All cabling between the driver and the local gauge board shall be furnished.

All cables and cable routes shall contain at least 20% of the extra capacity.

5.14.4 Alarms and Shutdown

The minimum alarm and shutdown functions shall be as required in the technical data sheet.

5.14.5 Operation Mode

Pumps operation mode shall comply with requirements of I-ET-3010.00-1350-940-P4X-001 - Systems Operation Philosophy.

5.14.6 Monitoring – Requirements

For Centrifugal Pumps type, it will be applicable only to:

- B-1223001A/B - Pre-Oil Dehydrator Recirculation Water Pump
- B-1223002A/B - Oil Dehydrator Recirculation Water Pump
- B-1223003A/C - Oil Transfer Pump
- B-1223004A/B - Test Separator Pump
- B-1251001A/C – Booster Injection Water Pump
- B-1251002A/C – Main Injection Water Pump;
- B-5111001A/D – Sea Water Lift Pump;
- B-5111002 - Start-up Sea Water Lift Pump

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- B-5111003A/C - Injection Sea Water Lift Pump
- B-5124001A/C – Cooling Water Circulation Pump - Classified Area;
- B-5124002A/C - Cooling Water Circulation Pump - Non Classified Area;
- B-5124003 - Start-Up Cooling Water Pump - Non Classified Area;
- B-5125001A/C - Hot Water Circulation Pump
- B-5125002A/B - Utility Hot Water Circulation Pump

Note: In case of conflict between TAGs listed above and I-LI-3010.1M-1200-940-P4X-002, I-LI-3010.1M-1200-940-P4X-002 – Equipment List shall prevail.

The equipment shall be monitored according to I-ET-3010.00-5500-854-P4X-001 - Machinery Monitoring System (MMS).

All the sensors elements for monitoring shall be supplied by pump manufacturer with electric connection to the junction box supplied inside pump skid. Manufacturer must consider that sensors shall be connected to Machinery Monitoring System, so that, they must be specified for it.

Manufacturer shall provide all data and performance curve to be implemented by the MMS supplier for Monitoring System Configuration.

For package automation type classification see I-ET-3010.1M-1200-800-P4X-014 - Automation Interface of Packaged Units.

5.15 Pressure Vessels (Design and Fabrication)

5.15.1 Pressure Vessels Design

For pressure vessel design, see I-ET-3010.00-1200-540-P4X-001 - Requirements for Pressure Vessels Design.

5.15.2 Pressure Vessels Fabrication

For pressure vessel fabrication, see I-ET-3010.00-1200-540-P4X-002 - Requirements for Pressure Vessels Fabrication.

5.16 Heat Exchangers

On the lubricating oil and sealing oil heat exchangers, the oil pressure shall exceed the water pressure of the water circuit.

The Heat Exchangers for the lubricating oil and sealing oil system shall allow their switching with the equipment on-line

6 DRIVERS

The type of driver and transmission system to be supplied shall be as specified in the project data sheet.

In general, a direct drive is preferred; however, a gearbox may be used when the optimum pump speed is different from that of the driver and approved by PETROBRAS. The transmission unit, if provided, shall comply with the requirements of API Standard 677.

Unless otherwise specified on the data sheets, MANUFACTURER/PACKAGER shall supply and shop mount the driver and gearbox.

7 ELECTRICAL

All electrical equipment installed in hazardous areas (see Area Classification documentation) or installed outdoors and kept on during emergency condition (EDS) shall be certified according to IEC 61892, INMETRO Resolution 179, May 18th 2010 and INMETRO resolution 89, February 23rd 2012.

Electrical equipment and material shall comply with requirements of I-ET-3010.00-5140-700-P4X-002 – Specification for Electrical Material and Equipment for Offshore Units.

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.

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

Items 4.3.4, 4.3.5 and 8.2 per I-ET-3010.00-5140-712-P4X-002 - MEDIUM-VOLTAGE INDUCTION MOTORS FOR OFFSHORE UNITS shall not be considered for pumps, which have MMS for temperature bearings monitoring.

8 PAINTING AND COLOR

8.1 Painting

MANUFACTURER/PACKAGER paint system shall be according to PETROBRAS I-ET-3010.00-1200-956-P4X-002 General Painting. An external coating system may be pre-qualified in accordance with item 7 of respective I-ET. In that case PACKAGER must provide information, during the BID process, about the painting system regarding:

- Material Safety Data Sheet;
- Information data required by item 5.4 of ISO 12944-9: Paints and Varnishes – Performance Requirements for Protective Paint Systems for Offshore and Related Structures;
- Qualification tests reports.

8.2 Internal

Paint systems shall be according to MANUFACTURER /PACKAGER requirements, when not specified by BIDDER.

8.3 Color

Color code adopted shall be in accordance with DR-ENGP-I-1.15-R.3 Color Coding.

9 NAMEPLATES

MANUFACTURER shall attach corrosion resistant SS 316 nameplates on each item of equipment in an accessible location, fastened with corrosion resistant pins.

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

- Purchase order and item number
- Manufacturer and year of built
- Driver and ancillary equipment's serial number and type
- Capacity, head, volume etc.
- Driver power rating and speed etc.
- Design code
- Design temperature and pressure
- 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 AP-42 - Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources, of the USA Environment Protection Agency (EPA).

10 TAG NUMBERING

Tagging of all items including valves shall be carried out in accordance with I-ET-3000.00-1200-940-P4X-001 - Tagging Procedure for Production Units Design.

Tags shall be supplied with number and description in the Portuguese language.

All tag plates shall be made from 316 stainless steel material.

Valves shall be tagged with the applicable number only.

Tag numbers for remaining ancillary equipment shall be given after purchase order placement.

11 SPARE PARTS AND TOOLS

11.1 Spare Parts

PACKAGER shall include in the supply of equipment all spares required for commissioning, pre-operation and startup complete with spare part inventory.

Spare parts recommended by the Classification Society, if applicable, shall also be provided. Spare parts list recommended for 2 (two) years operation, including price and delivery time of each part, lay out and sectional drawings indicating the location of the part and TAG/Reference Identification (for BIDDER approval) shall be provided.

All spares shall be packed separately with clear identification and delivered with the main equipment in packing suitable for long-term storage.

11.2 Special Tools

All special tools necessary for the installation, alignment, operation or maintenance of the equipment shall be supplied with the delivery of the equipment. Special tools and



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CONTRACTOR personnel required for installation and/or commissioning shall be specified as a separate cost.

12 CERTIFICATION REQUIREMENTS

12.1 Class Certification

For the pump package, a Classification Society Certificate of compliance with Rules requirements shall be supplied.

12.2 Material Certification

MANUFACTURER/PACKAGER shall be responsible for obtaining all necessary certification of the equipment. MANUFACTURER/PACKAGER through the independent certifying authority shall supply all certificates related to the materials, inspections, tests and qualification activities detailed in the approved Quality Plan.

13 INSPECTION, TESTING AND COMMISSIONING

13.1 Inspection

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

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

The notification period for such inspections shall be informed in advance of 3 (three) weeks for foreign supplier and 2 (two) weeks for Brazilian supplier.

PETROBRAS shall witness hydrostatic test and performance test. Pump shall be tested at five points on the performance curve, including shut off.

13.2 Factory Acceptance Test (FAT)

CONTRACTOR shall prepare a factory acceptance test / procedure (FAT) and submit for PETROBRAS approval.

Factory Acceptance Testing (FAT) shall be carried out in accordance with the relevant code or standard of design, i.e., ASME / API / etc.

For the Factory Acceptance Test (FAT), the CONTRACTOR shall make preliminary test to ensure that all parts of the equipment are operating satisfactory prior to the arrival of the PETROBRAS's representative. CONTRACTOR shall advise PETROBRAS of the test schedule before the planned test dates.

At least one set of each following equipment shall be tested as a complete train (string test):

- B-1223001A/B – Pre-Oil Dehydrator Recirculation Water Pump
- B-1223002A/B – Oil Dehydrator Recirculation Water Pump
- B-1223003A/C – Oil Transfer Pump
- B-1223004A/B – Test Separator Pump



- B-1251001A/C – Booster Injection Water Pump
- B-1251002A/B – Main Injection Water Pump;
- B-5111001A/E – Sea Water Lift Pump;
- B-5111002 – Start-Up Sea Water Lift Pump.

As a minimum, each pump rotor, including spares if purchased, shall undergo a witnessed 4-hour continuous mechanical run at the duty point. During this run, MANUFACTURER shall record and approve records of vibration and temperature of mutually agreed parameters.

Additionally, a witnessed performance test shall be carried out on each pump type. 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.

This performance test shall include a minimum of three (3) test points for the pumps which operate with constant speed and five (5) test points for the pumps which operate with variable speed, one of which shall be at shut valve head; one at duty point; one at maximum flow rate before onset of stonewall; and two intermediate points.

If the developed head at the duty point is below the allowable margins as stated in the test procedure of the relevant standard, the test shall then be aborted and shall recommence at no further cost to PETROBRAS after mutually agreed design changes have been implemented. If the pump that fails test is part of a type (i.e. 3 x 50% units), all units shall be subject to witnessed performance test at no additional cost to PETROBRAS, following modification.

Where there is less than two (2) meters between NPSHA and NPSHR, a witnessed NPSH test shall be performed on each pump type. If the selected pump fails to meet the design NPSHR, all pumps of that type shall undergo witnessed NPSH testing and MANUFACTURER/PACKAGER shall provide acceptable means of correction. A correction factor is not acceptable.

The driver shall be subject to the required testing as defined in the Specification pertaining to it. PETROBRAS shall advise if the driver is to be included in the pump testing.

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

If it is found necessary to dismantle any equipment during a test, because of malfunction, the test may then be invalidated, and a full test shall be required after the repair of the fault.

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 CONTRACTOR of his responsibilities in any way whatsoever.

13.3 Commissioning

MANUFACTURER/PACKAGER shall be required to provide any necessary support for installation and commissioning of the equipment either at a shore based fabrication yard or on the FPSO.

MANUFACTURER/PACKAGER shall provide in the bid the estimated costs for travel and subsistence to and from the site location described in the inquiry. In addition,



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MANUFACTURER shall provide labor rates for 12-hours work days onshore and offshore, as well as standby rates for the site location.

MANUFACTURER/PACKAGER shall provide commissioning support as required by the BIDDER. Normally, this shall be a 72 hours test run.

BIDDER is responsible for assembly supervision of the equipment, including the assembly of components to be delivery loose (for example, some components of the pumps, like stuffing box, etc.).

BIDDER is responsible for pre-commissioning and commissioning supervision of the equipment/system. Final acceptance will be on satisfactory completion of commissioning tests as specified by PETROBRAS.

14 MANUFACTURER/PACKAGER RESPONSIBILITY

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

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

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

- Resolving all engineering questions and/or problems relating to design and manufacture.
- Providing details as requested of any vendors relating to design and manufacturing.
- Supervision by vendor will be required for the installation despite the service being done by others.
- Commissioning and training shall be packager responsibility.
- In all cases of conflict between this specification and applicable documents listed herein, the more stringent requirements shall prevail. In such cases, PACKAGER shall inform BIDDER of the conflict and seek clarification.

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

The technical proposal must, only and exclusively, have an explicit statement that meets the requirements of all items of the respective Material Requisition (number and revision quoted) and its annexes, complemented by the Technical Clarification Circular Letters (number quoted), including the scope of supply, without any technical deviation.

Any exclusion and/or alternative to what is specified in the Material Requisition and its annexes, including the use of the manufacturer/packager's standard and exclusive technology, shall be presented in a Deviation List, which only will be accepted by BIDDER during the clarification phase, preceding the proposal presentation.

BIDDER's acceptance of each item of the Deviation List will be through Technical Clarification Circular Letters that will be issued to all packagers.

The Deviation List mentioned above shall contain, at least, for each requirement that the packager intends to change:



- The document's description, code and section that contain the requirement;
- The reason for deviation, always indicating the requirements that are different to manufacturer/packager's standard and the costs, schedule and technical benefits/impacts of the change;
- The packager proposal.

15 PREPARATION FOR SHIPMENT

15.1 Marking

All items supplied to this specification shall be adequately marked for identification against a certificate or relevant test documentation. Marking shall be such that it shall not damage or impair the component.

Items that cannot be identified shall be rejected. Rejected items may be re-certified by carrying out all relevant testing, with prior approval of the BIDDER.

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

The equipment shall be supplied tested, flushed and preserved and, if practical, already charged up with coolant and lubricants.

The preparation shall make the equipment suitable for 12 months outdoor storage from the time of shipment.

The package shall be protected from corrosion.

PACKAGER shall submit the packing design to the BIDDER for approval.

PACKAGER shall package the equipment in accordance with the packaging requirements of the country to which the equipment is being shipped.

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

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

Unless otherwise advised, each item of equipment shall be checked for its suitability to resist horizontal and vertical acceleration of 0.8g in any direction during sea transportation.

16 PUMPS SPECIFIC REQUIREMENTS

TAG

IDENTIFICATION

All

B-1223001A/B	Pre-Oil Dehydrator Recirculation Water Pumps
B-1223002A/B	Oil Dehydrator Recirculation Water Pumps
B-1223003A/C	Oil Transfer Pumps
B-1223004A/B	Test Separator Pumps
B-1251001A/C	Booster Injection Water Pumps
B-1251002A/C	Main Injection Water Pumps
B-5111001A/D	Sea Water Lift Pumps
B-5111002	Emergency Sea Water Lift Pump
B-5111003A/B	Injection Sea Water Lift Pump
B-5125001A/C	Hot Water Circulation Pumps
B-5125002A/B	Utility Hot Water Circulation Pumps
B-5125003A/B	Hot Water Dump Cooler Pump
B-5133002A/B	Well Service Booster Pump
B-5331001A/C	Produced Water Booster Pump
B-5331002A/B	Stabilized Condensate Pump
B-5336502A/D	Oil Skimming Pump

specifications of this section/subsection shall be added to the other sections/subsections of this specification. If there are any conflicting requirements, section 16 shall prevail.

16.1 API 610 Pumps

16.1.1 Scope

The scope includes the following pumps:

16.1.2 General Requirements

All pumps shall be in accordance with API 610 Standard last edition and Hydraulic Institute standard, unless otherwise specified in the data sheet.

All materials, which are exposed to hydrocarbons containing hydrogen sulphide, must be in accordance with ISO 15156 for the lowest anticipated pH and the highest H₂S partial pressure.

Centrifugal pumps shall have dual mechanical seals or single seals depending on the application and shall be designed according to API 682. If the fluid is non-hazardous, not toxic and not vaporizing, a single seal will be selected. Shaft seal systems shall include seal leakage and failure detection features.

All pump bearings shall be provided with points for the installation of hand-held accelerometers flat machined surfaces.

16.1.3 General Specifications For Vertical Pumps

Coupling and impellers fixing device shall allow operation in reverse direction, without damage to main equipment.



Pump re-assembling after the motor or pump disassembly shall require alignment only at vertical plane. The motor base shall provide self-alignment at the horizontal plane. A driver's adjusting device for vertical alignment shall be provided.

Speed shall not exceed 1800 RPM.

Radial and thrust bearing shall be roller type.

16.1.4 Couplings

Couplings shall be furnished in accordance with API Standard 671.

16.1.5 Inspection and Testing

Inspection and testing are required as specified in the technical data sheet.

All pumps shall be tested in accordance with API 610, paragraph 7.3.

The pump performance test shall be carried out at the rated pump speed. The minimum running period is 4 hours continuously at duty point.

PACKAGER shall provide details for review and approval by the BIDDER.

16.1.6 Material

All pumps shall be in accordance with table H1 of API 610.

Booster and Main Injection Water Pumps for sea water service shall apply class material D2 of API-610, table H.1

Hot Water Circulation Pumps shall be in accordance with table H1 of API 610 except classes I-1, I-2, S-1, S-3 e S-4.

Materials for sea water lift pumps shall be in accordance with table H1 of API 610, D2 class or Br-Al-Ni alloy.

16.2 Non API Pumps

16.2.1 Scope

The scope includes the following pumps:

TAG	IDENTIFICATION
B-5115001A/B	Dilution Water Pump
B-5115002A/B	Cooling Water Make-up Pump Classified Area
B-5115503A/B	Distilled Water Pump
B-5124001A/C	Cooling Water Circulation Pump - Classified Area
B-5124002A/B	Cooling Water Circulation Pump - Non Classified Area
B-5124003	Start-up Cooling Water Pump - Non Classified Area

16.2.2 General Requirements

All pumps shall be in accordance with ASME/ANSI B73.1 Standard last edition, unless otherwise specified in the data sheet.



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Single Mechanical Seal API Plan 11/61 shall be advised by manufacturer. Pump single mechanical seal shall be subject to the process fluid.

16.2.3 Inspection and Testing

Inspection and testing are required as specified in the technical data sheet.

The pump performance test shall be carried out at the rated pump speed. The minimum running period is 4 hours continuously at duty point.

PACKAGER shall provide details for review and approval by PETROBRAS.

16.2.4 Material

The manufacturer shall follow Class S6 for this kind of pump as per API Standard 610.

Cooling Water Circulation Pumps for classified area shall be in accordance with table H1 of API 610 except classes I-1, I-2, S-1, S-3 e S-4.

16.3 Main Injection Water Pump

16.3.1 Scope

The scope includes the following pumps:

TAG	IDENTIFICATION
B-1251002A/C	Main Injection Water Pump

The Scope of Supply of the packages shall include, but not necessarily be limited to the following items. Two skid mounted Main Injection Water Pump Packages, each one comprising:

- Multistage Barrel type (BB5) Centrifugal Pump or High Speed Pump;
- Electric Motor Driver;
- Single mechanical seals, with if required a seal flushing and seal leakage monitoring system;
- Common baseplate with drip pans, lifting lugs, flanged drains with valves and grounding lugs in stainless steel AISI 316, welded to the saddles/skids;
- All necessary guards and couplings in non-sparking materials;
- Three-wire RTD's in all relevant bearing with installed spare elements (according to I-ET-3010.00-5500-854-P4X-001 - Machinery Monitoring System-MMS);
- In-skid common lube oil system for pump and electric motors;
- Condition monitoring system for each pump;
- Three-point resilient mounts and Anti Vibration Mounts (AVM's);
- All necessary instruments, ancillaries and instrument supports;
- Unit Control Panels (PN-B-1251002A/C – Main Injection Water Pump Control Panel);
- Electrical and instrumentation installation (including cable termination details, motor terminal box details, and grounding);
- Stainless steel (316), copper free aluminum or non-metallic junction boxes mounted at skid edge;
- All on skid piping for utilities such as lube oil, cooling medium and instrument/utility air;
- Lateral analysis of rotor systems;



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- Torsional analysis for the complete coupled train, including the driver;
- Complete design and fabrication of all equipment;
- Structural calculation;
- All raw materials and consumables;
- Transfer plates pack including both end plates;
- Frame consisting of fixed and movable covers, carrier and guide bars, support columns and mounting feet;
- Gaskets;
- Tightening bolts and nuts;
- Nameplates manufactured in SS 316 in Portuguese for all equipment and instruments;
- Surface preparation and painting proper for offshore installation;
- Maintenance lifting beams and hoists;
- Lugs, spreaders bars or slings for lifting;
- Handling devices and tightening tools;
- Special maintenance and alignment tools;
- Classification Society Certification;
- Inspection plan, testing and quality assurance of the equipment;
- Technical assistance during assembly, pre-commissioning, start-up and commissioning phases;
- Training, if applicable, and daily costs for mobilization/demobilization in Brazil (see Note 1);
- Safety signaling in Portuguese language;
- Proposal, Review and Technical documentation;
- Pre-commissioning at manufacturer's shop;
- Site supervision;
- Coupling, assembly and alignment;
- Preparation for shipment and preservation, including equipment handling conditioning and storage at job site;
- Anti-corrosive protection for storage for shipping and at jobsite;
- Packing, protection and marking proper for marine transportation
- Consumables and special tools for assembly, disassembly, maintenance, commissioning and start-up;
- Spare parts recommended for commissioning, pre-operation, start-up and by Classification Society;
- Spare parts list recommended for operation, including price and delivery time of each part, lay out and sectional drawings indicating the location of the part and TAG/Reference Identification (for BIDDER approval);
- Compliance with motion requirements and acceleration loads according to I-RL-3010.1M-1350-960-P4X-009 Motion Analysis;
- Start-up and commissioning, and operation procedures;
- Warranty period shall comprise 1 (one) year operation;
- Data books;
- Installation, operation and maintenance manuals in Portuguese language;
- Total process and mechanical guarantee;
- Field proven equipment list (reference list of similar installations);
- Postweld heat treatment, if applicable;



- The necessary studies as required by Classification Society;
- Nondestructive examination;
- Impact test according to ASME VIII, if necessary;
- Hydrostatic test;
- Thermal design performance and guarantee;
- Thermal insulation if necessary;
- Mechanical design performance and guarantee;
- Hazardous area certificates;
- NR-10 documentation;
- NR-13 test spare parts, if applicable.

Note 1: These costs shall include mobilization/demobilization, travel tickets, hotels and daily rates. The training location shall be defined later. For costs of printed copies of training material, a total number of 10 (ten) people of operation staff and 10 (ten) people of maintenance staff shall be foreseen. The training material shall be in Portuguese.

16.3.2 General Requirements

Sea water injection pump shall be driven by an electric motor through flexible coupling.

The respective standards and specifications for this driver shall be applied as appropriate.

All pumps in this service shall be in accordance with API 610 and Hydraulic Institute standards. The pumps shall be multi-stage barrel type (API 610 style BB5) or high speed type.

Main Injection Water Pumps for seawater service shall apply class material D2 of API-610, table H.1

All pumps shall feature a minimum flow valve.

The water injection pumps shall be installed side by side in parallel to the longitudinal axis of the vessel, unless otherwise stated.

Stiff shaft pump design is preferred, with no internal support bearing and with ample sized balancing drum and thrust bearing, but other designs shall be considered.

Vertical booster pumps are not allowed.

If booster pump head is less than 150m, maximum speed shall be 1800 rpm. Otherwise, if 3600 rpm is chosen, pump type shall be BB2 as per API 610.

The proposal shall include head/flow curves from zero flow to at least 120% with the continuous operating range clearly indicated. Power consumption and NPSHR shall be shown over the full-indicated head/flow range. The minimum continuous flow rate shall be clearly indicated on the curve.

All pressure vessels shall conform to the requirements of ASME BPVC Sec. VIII Div.1 and NR-13, if applicable. The materials of construction shall be such that all water wetted parts shall be suitable for continuous or intermittent seawater service, according to specification on technical data sheet.

Each package, including the driver, shall be mounted on one common baseplate, which will be fitted on the module deck by means of a three point mounting system.

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The baseplate shall be of rigid construction avoiding permanently distortion during lifting, shipping, and operation.

When lifting the baseplate with all equipment attached, beam deflection shall not exceed $1/400L$, where L is the length of the baseplate.

All bearings shall be supplied with individual temperature elements according to I-ET-3010.00-5500-854-P4X-001 - Machinery Monitoring System - MMS. Temperature indicators located in common housing sumps or common drain lines are not acceptable.

Bearing housings shall be provided with radial and axial probes for vibration monitoring according to I-ET-3010.00-5500-854-P4X-001 - Machinery Monitoring System – MMS .

Package unit equipment shall be provided with PACKAGER'S control system and the safeguarding incorporated. PACKAGER shall assume total responsibility for the instrumentation, design, engineering, operational philosophy, and the PLC based control and safeguarding systems.

These are parts of PACKAGER'S scope, unless otherwise specified.

16.3.3 Mineral Oil System

Integrated common lube oil system for pump and motor driver complete shall be provided for each pump set with: pumps, suction strainers, supply and return system, vents, drains, dual full-flow oil filters, lube oil cooler, electrical lube oil heater, all necessary valves and instruments. The oil system shall supply mineral and control oil to the respective users, and shall be mounted into the main pump baseplate. For pressure vessels and heat exchangers design and fabrication see item 5.15

Except as stated below, the system shall be in full compliance with API 610.

MANUFACTURER/PACKAGER shall take due consideration in the design of the equipment, such that oil return to the tank from each lubricated component, may be satisfactorily effected under all conditions of pitch, roll, and list of the FPSO. The vessel motion data and sea states are as defined I-RL-3010.1M-1350-960-P4X-009 Motion Analysis.

The preference for lubricating oil pumps is that the main oil pump is shaft driven. Back up lubrication requirements are satisfied by a single electrically driven (AC) oil pump. When no shaft driven pump is supplied, the use of 2 x AC driven pumps shall be provided.

Due consideration shall be given to the requirement (if any) to supply cooling oil to items of equipment, following a full load crash down during an emergency situation, that results in loss of all AC power.

Dual oil filters with 316 stainless steel bodies shall be provided, capable of on-line changeover without disruption to the main equipment operation.

All oil piping shall be manufactured from 316 Stainless Steel.

In order to minimize the footprint and still achieve maintainability, the use of tank mounted vertical oil pumps is acceptable. The preference for oil coolers is the plate and frame design, skid mounted. If a plate and frame type cooler cannot cope with the high cooling medium design pressure then a tubular type heat exchanger, designed in accordance with TEMA C, shall be considered for which BIDDER approval is required. The



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engineering, fabrication, inspection and testing shall be in accordance with ASME BPVC Section VIII, Div. 1.

An oil tank electric heater shall be provided, if specified, to maintain the lubricating and control oil at the minimum temperature requirements. If required, the heater shall be capable of on-line withdrawal without the necessity to drain down the oil tank. It shall be suitable for operation at the voltages stated in I-ET-3010.00-5140-700-P4X-003 Electrical Requirements for Packages for Offshore Units. The electric heaters shall be provided with 20% redundant heating elements.

All BIDDER auxiliary piping interfaces shall be at the skid edge. Flanges shall be in accordance with ANSI B16.5.

All piping shall be butt welded and at least 10% of the weld shall be X-rayed.

The oil tank vent shall be fitted with an oil mist eliminator and return oil pipe. PACKAGER shall supply a flame trap loose for installation by the BIDDER.

16.3.4 Auxiliary Piping

Each pump casing drain and vent shall be flanged, valved and manifolded to a single drain at the edge of the baseplate.

16.3.5 Couplings

Couplings shall be furnished in accordance with API Standard 671.

The preferred method of connecting the driver to the pump is by means of a dry all metal flexible coupling.

16.3.6 Baseplate

The achieved alignment tolerances shall be documented and submitted with the installation instructions.

16.3.7 Vibration and Balance

MANUFACTURER/PACKAGER is responsible for the lateral and torsional stability of the entire operating train (driver, coupling and pump) and the submission of verifying reports.

16.3.8 Electric Motor Drivers

All drivers shall be supplied and mounted by PACKAGER. See I-ET-3010.00-5140-712-P4X-002 – Medium-Voltage Induction Motors for Offshore Units and I-ET-3010.00-5140-712-P4X-001 – Low-Voltage Induction Motors for Offshore Units, for auxiliary motors.

16.3.9 Inspection and Testing

Inspection and testing are required as specified in the technical data sheet.

All pumps shall be tested in accordance with API 610.

The pump performance test shall be carried out at the rated pump speed; the minimum running period is 4 hours continuously at duty point.

PACKAGER shall provide details for review and approval by the BIDDER.

16.3.10 Factory Acceptance Testing (FAT)

All inspection and testing required in the project data sheet shall be mandatory to FAT.

If a spare rotor or complete inner assembly for multistage pump is purchased with the pump, it shall be subjected to the same running/performance tests in the main pump as the main rotor.

16.4 Sea Water Lift Pump

16.4.1 Scope

The scope includes the following pumps:

TAG	IDENTIFICATION
B-5111001A/D	Sea Water Lift Pump
B-5111002	Start-up Sea Water Lift Pump
B-5111003A/B	Injection Sea Water Lift Pump

The Scope of Supply of the packages shall include, but not necessarily be limited to the following items. Five Seawater Lift Pump Packages comprising:

- Submerged Centrifugal Pump/Motor with anodes;
- Flanged riser pipes with internal & external anodes, centralizers and external coating;
- Centralizers for pump and pipe stack;
- Pipe stacks accessories (bolts, nuts, washers, seals);
- Single Mechanical Seal;
- Pump top plate to interface with caisson top plate;
- Long radius discharge elbow with junction box;
- Air release valve and drain with valves;
- Pump suction strainer;
- Lifting lugs;
- Lubrication system;
- All necessary instruments, ancillaries and instrument supports;
- Electrical installation (including cable termination details, motor terminal box details, and earthing);
- All piping, valves and fittings, as applicable;
- Air release valve;
- Nameplates manufactured in SS 316 in Portuguese for all equipment and instruments;
- Surface preparation and painting proper for offshore installations;
- Special maintenance and alignment tools;
- Inspection plan, testing and the quality assurance;
- Technical assistance during assembly, pre-commissioning, start-up and commissioning phases;
- Training, if applicable, and daily costs for mobilization/ demobilization in Brazil (see Note 1);
- Technical documentation according to Material Requisition;

- Equipment handling conditioning and storage at MANUFACTURER's/ PACKAGER's premises;
- Pre-commissioning at manufacturer's shop;
- Site supervision;
- Coupling, assembly and alignment;
- Preparation for shipment and preservation;
- Consumables and special tools for assembly, disassembly, maintenance, commissioning and start-up;
- Spare parts recommended for commissioning, pre-operation, start-up and by Classification Society;
- Spare parts list recommended for operation, including price and delivery time of each part, lay out and sectional drawings indicating the location of the part and TAG/Reference Identification (for PETROBRAS approval);
- Grounding devices (see item 7.1);
- Safety signaling in Portuguese language;
- Installation, operation and maintenance manuals in Portuguese ;
- Anti-corrosive protection for storage, shipping and at jobsite;
- Preservation recommendation;
- Packing, protection and marking proper for marine transportation;
- Compliance with motion requirements and acceleration loads according to I-RL-3010.00-1350-960-P4X-008 – ACCELERATION DATA;
- Warranty period shall comprise 1 (one) year operation;
- Data books;
- Total process and mechanical guarantee;
- Field proven equipment list (reference list of similar installation).

Note 1: These costs shall include mobilization/demobilization, travel tickets, hotels and daily rates. The training location shall be defined later. For costs of printed copies of training material, a total number of 10 (ten) people of operation staff and 10 (ten) people of maintenance staff shall be foreseen. The training material shall be in Portuguese.

16.4.2 General Requirements

Sea water lift pumps shall be in accordance with Hydraulic Institute standards. Materials for sea water lift pumps shall be in accordance with table H1 of API 610, D2 class or Br-Al-Ni alloy.

Even though pump type is not foreseen in API Standard 610, pumps shall comply with this standard. MANUFACTURER shall submit deviations for PETROBRAS approval.

When finalizing the design, PACKAGER shall observe the requirement that all pumps be tested, and ex-works within the required delivery period.

Seawater Lift Pumps are Electrical Submersible Pump (ESP) type and shall be installed inside caisson, supplied and fitted by Hull Contractor. Pump suction shall consider survival draft value and sea wave height.

MANUFACTURER/PACKAGER shall supply check valve which shall be installed after the pump discharge, to guarantee that the pipe stack is full, for the pump start.



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Sodium hypochlorite shall be routed to the pump suction through the flange, along the pipe stack.

MANUFACTURER/PACKAGER shall provide a protection screen with suitable mesh in the inlet of the pump.

Due consideration shall be given to the sealing of the motor against the ingress of seawater or loss of the internal cooling medium. If this is by means of a conventional mechanical seal design, the seal employed shall be a double or tandem arrangement, and the chamber between the two seals shall be provided with suitable instrumentation to provide an alarm in the event of either seawater ingress or loss of motor cooling fluid (if applicable).

Coupling and impellers fixing device shall allow operation in reverse direction, without damage to main equipment.

Pump re-assembling after the motor or pump disassembly shall require alignment only at vertical plane. The motor base shall provide self-alignment at the horizontal plane. A driver's adjusting device for vertical alignment shall be provided.

Speed shall not exceed 1800 RPM.

Radial and thrust bearing shall be roller type.

MANUFACTURER/PACKAGER shall provide temperature-monitoring system for electric motor, bearings and signals shall be addressed for MMS (as per I-ET-3010.00-5500-854-P4X-001 - Machine Monitoring System). Manufacturer shall inform temperature level alarm and shut down actuation for pump protection.

16.4.3 Circulation System

Circulation system is a very important part of the electric submersible pump system and must meet the specification below. Main function is lubrication of bearings and shaft seal, and cooling of the main electric motor.

Circulation system may be oil-based or water-based.

For submerged centrifugal pumps with cooling and lubricating by oil, the internal pressure of this oil shall be always higher than the seawater back-pressure into the caisson, avoiding ingress of this seawater during the mounting and functioning. Mixing of different circulation oils should be avoided. If different circulation oils have to be mixed, a compatibility test shall be run to guarantee the compatibility prior to mixing.

For submerged centrifugal pumps with cooling and lubrication by water with additive, the pressure of this fluid shall be at least equal to or higher than the seawater back pressure into the caisson, avoiding ingress of this seawater during the mounting and functioning.

The type of sealing drawing must be submitted to PETROBRAS as standard document.

16.4.4 Couplings

Couplings shall be furnished in accordance with API Standard 671.



16.4.5 Electric Motors Drivers

See I-ET-3010.00-5140-712-P4X-002– Medium-Voltage Induction Motors for Offshore Units and I-ET-3010.00-5140-712-P4X-001 – Low-Voltage Induction Motors for Offshore Units.

16.4.6 Inspection and Testing

Inspection and testing are required as specified in the technical data sheet.

All pumps shall be tested in accordance with API 610, paragraph 7.3.

The pump performance test shall be carried out at the rated pump speed, the minimum running period is 4 hours continuously at duty point.

PACKAGER shall provide details for review and approval by the BIDDER.

16.5 Oil Transfer Pumps

Axially split case-type pumps shall be provided with provisions for the installation of pressure gauges in the sealing box, for pressure monitoring.

When sealing design requires the use of a cyclone, it shall be large sized and made of AISI 316 L.

The pumps shall feature a temperature sensor on the casing, near to the discharge side, with an alarm on the control panel. Drains shall be provided in the sealing boxes for the removal of solids.

Pumps shall have their own system for minimum flow protection. The use of self-operated valves will not be allowed.

Main exportation oil pumps shall be BB3 or BB5 type as per API 610.

Main exportation oil pumps velocity shall not exceed 3600 rpm in any case.