

	TECHNICAL SPECIFICATION				No. I-ET-3010.00-1200-310-P4X-001				
	CLIENT: SRGE				SHEET: 1 of 24				
	JOB: -				-				
	AREA: -								
SRGE	TITLE: API 610 CENTRIFUGAL PUMPS SPECIFICATION				INTERNAL				
ESUP									
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A	REVISED ITEMS 4.3.2, 6.13.1, 6.13.2, 6.13.4, AND INCLUDED ITEM 7.4								
B	INCLUDED ITEMS 6.6.7, 6.6.8 AND 18.3								
C	INCLUDED ITEMS 18.2.5, 18.2.15 AND 18.3, AND MODIFIED ITEM 18.5								
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	TECHNICAL SPECIFICATION	No. I-ET-3010.00-1200-310-P4X-001	REV. E
	-		SHEET: 2 of 24
	TITLE: API 610 CENTRIFUGAL PUMPS SPECIFICATION		INTERNAL
			ESUP

SUMMARY

1	OBJECTIVE.....	3
2	DEFINITIONS AND ABBREVIATIONS.....	3
3	SCOPE OF SUPPLY	3
4	NORMATIVE REFERENCES.....	4
5	PACKAGER RESPONSIBILITY	6
6	DESIGN REQUIREMENTS	6
7	MATERIALS	12
8	ELECTRICAL	12
9	CONTROLS AND INSTRUMENTATION	12
10	PAINTING AND COLOR	13
11	NAMEPLATES	14
12	TAG NUMBERING AND TAG PLATES.....	14
13	CERTIFICATION REQUIREMENTS	14
14	INSPECTION, TESTING AND COMMISSIONING	14
15	PREPARATION FOR SHIPMENT.....	16
16	REQUIRED DOCUMENTATION	17
17	COOLING AND HOT WATER CIRCULATION PUMPS ADDITIONAL REQUIREMENTS	19
18	INJECTION WATER AND SRU FEED PUMPS ADDITIONAL REQUIREMENTS	19
19	PRODUCED WATER PUMPS ADDITIONAL REQUIREMENTS.....	23
20	OIL TRANSFER PUMPS ADDITIONAL REQUIREMENTS	24
21	ANNEXES.....	24

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-1200-310-P4X-001	REV. E
	-	SHEET: 3 of 24	
	TITLE: API 610 CENTRIFUGAL PUMPS SPECIFICATION	INTERNAL	
		ESUP	

1 OBJECTIVE

1.1 This technical specification covers the minimum technical requirements for the design, materials, fabrication, assembly, inspection, testing, preparation for shipment, installation, pre-commissioning and commissioning of all electric motor driven API Std 610 centrifugal 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 are established in the latest revision of I-ET-3010.00-1200-940-P4X-002 – General Technical Terms.


2.2 Abbreviations

AVM: Anti-Vibration Mounting
DAM: Dynamic Acquisition Module
g: Gravitational acceleration
HSVD: Hydraulic Variable Speed Drive
ITP: Inspection and Test Plan
MFCV: Minimum Flow Control Valve
MMS: Machinery Monitoring System
MPS: Machinery Protection System
NPSH: Net Positive Suction Head
RTD: Resistance Temperature Detector
SAT: Site Acceptance Test
SS: Stainless Steel
UCP: Unit Control Panel (Package Control Panel)

3 SCOPE OF SUPPLY

PACKAGER scope of supply shall include the following:

- Centrifugal pump;
- Electric motor driver;
- Mechanical seals;
- Baseplate with drain pans, lifting lugs, grounding lugs, and drains with valves;
- Couplings and coupling guards;
- Automatic Recirculation Valve (ARV) or Minimum Flow Control Valve (MFCV), if specified;
- In-skid common lube oil system for pump and electric motors, as specified on pump data sheet;
- Monitoring system, according to I-ET-3010.00-5500-854-P4X-001 – Machinery Monitoring System (MMS) and definitions in this technical specification;
- Three-point resilient mounts and AVMs, according to definitions in this technical specification and pump data sheets issued by OWNER;
- 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;

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-1200-310-P4X-001	REV. E
	-	SHEET: 4 of 24	
	TITLE: API 610 CENTRIFUGAL PUMPS SPECIFICATION	INTERNAL	
		ESUP	

- Nameplates made of SS 316 in Portuguese for all equipment and instruments;
- Surface preparation and painting proper for offshore installation, 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;
- All required tests at MANUFACTURER's shop;
- 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;
- 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

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

4.1 Applicable Codes and Standards

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

IOGP S-615	Supplementary specification to ANSI/API Standard 610 for Centrifugal Pumps
IOGP S-615L	Information requirements for Centrifugal Pumps
IOGP S-615Q	Quality requirements for Centrifugal Pumps
IOGP S-615D	Data sheets for Centrifugal Pumps
API Std 610	Centrifugal Pumps for Petroleum, Petrochemical, and Natural Gas Industries
API Std 613	Special-purpose Gears for Petroleum, Chemical, and Gas Industry Services
API Std 614	Lubrication, Shaft-sealing and Oil-control Systems and Auxiliaries
API Std 670	Machinery Protection Systems
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 B16.5	Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Metric/Inch Standard
ASME B16.47	Large Diameter Steel Flanges NPS 26 Through NPS 60 Metric/Inch Standard
ASME B31.3	Process Piping
ASME BPVC Sec. VIII-1	Rules for Construction of Pressure Vessels
ASME PTC 8.2	Centrifugal Pumps
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

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-1200-310-P4X-001	REV. E
	-		SHEET: 5 of 24
	TITLE: API 610 CENTRIFUGAL PUMPS SPECIFICATION		INTERNAL
		ESUP	

Brazilian Government regulations are mandatory and shall prevail, if more stringent, over the requirements of this specification and other references herein. PACKAGER/MANUFACTURER shall comply with any other government regulations stated in the Contract and not listed above.

4.2 Reference Codes and Standards

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

ANSI/HI 14.6	Rotodynamic Pumps - Hydraulic Performance Acceptance Tests
API Std 671	Special-Purpose Couplings for Petroleum, Chemical, and Gas Industry Services
API RP 691	Risk-based Machinery Management
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 21940/all parts	Mechanical Vibration – Rotor Balancing
ISO 7146-1	Plain bearings — Appearance and characterization of damage to metallic hydrodynamic bearings
TEMA	Standards of Tubular Exchanger Manufacturers Association

4.3 Applicable Documents

4.3.1 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 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-3010.00-5500-854-P4X-001	Machinery Monitoring System (MMS)
I-ET-3010.00-5520-888-P4X-001	Automation Panels

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-1200-310-P4X-001	REV. E
	-		SHEET: 6 of 24
	TITLE: API 610 CENTRIFUGAL PUMPS SPECIFICATION		INTERNAL

Naval

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

4.3.2 Specific Project Documents

The following project documents, supplied by OWNER, 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. Project's DOCUMENT LIST shall be consulted to verify the correct document number and title.

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

5 PACKAGER RESPONSIBILITY

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

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

5.3 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.

5.4 PACKAGER is responsible for all coordination with MANUFACTURERS and gathering of all details, drawings and data to achieve optimum design and full submission of all documents requested in this 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].


6.2 Motion Requirements

6.2.1 The necessary design data and information on motion requirements are given by MOTION ANALYSIS report [document supplied by OWNER].

6.2.2 PACKAGE shall be able to withstand and operate in accordance with I-ET-3010.00-1350-960-P4X-001.

6.3 PACKAGE Requirements

6.3.1 PACKAGE shall be designed 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.

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-1200-310-P4X-001	REV. E
	-		SHEET: 7 of 24
	TITLE: API 610 CENTRIFUGAL PUMPS SPECIFICATION		INTERNAL
<p>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.</p> <p>6.3.3 The utility consumption of the equipment shall be clearly defined by PACKAGER. This information shall also be included in the technical proposal. The consumption of utilities shall comply with the requirements of GENERAL SPECIFICATION FOR AVAILABLE UTILITIES report [document supplied by OWNER].</p> <p>6.3.4 The pump PACKAGE, including all 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.</p> <p>6.3.5 For foreign made equipment, the standard manufacturing parts (couplings, mechanical seals, bearings) shall be purchased from MANUFACTURERS with representative branches located in Brazil, with service parts and maintenance workshops.</p> <p>6.3.6 SUPPLIER shall ensure that the area around the pump PACKAGE has enough clearance for maintenance. SUPPLIER shall create a reserved area on the 3D model to avoid installation of any other equipment or accessory in this area.</p> <p>6.3.7 The following pumps configurations shall not be furnished unless approved by OWNER for the specific application:</p> <ul style="list-style-type: none"> - Rigidly or close coupled; - Two-stage overhung; - Double suction overhung; - Multistage ring-section single casing; - Vertical (other than in-line) above 1800 rpm; - OH1 construction. <p>6.4 Performance</p> <p>6.4.1 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.</p> <p>6.4.2 For pumps with intermittent service, the preventive maintenance shall only be required after a period of 18 months, unless otherwise specified.</p> <p>6.4.3 Constant speed pumps shall be limited to 1800 rpm. When a hydraulic selection cannot be matched at 1800 rpm, or there is an exceptional advantage in running at 3600 rpm, OWNER design team shall be consulted for approval.</p> <p>6.4.4 Pumps driven by electric motor with power above 150kW shall have efficiency at the rated flow above 80% for $n_s > 1500$ ($n_s > 29.1$ metric units) and above 75% for $n_s < 1500$ ($n_s < 29.1$ metric units). The pump's specific speed – n_s – shall be calculated according to API Std 610.</p> <p>6.4.5 The NPSH required shall be at least 2.0 meters less than the NPSH available. Correction factors are not allowed. OWNER may accept differences between 1.0 and 2.0 meters, but a witnessed NPSH required test shall be performed.</p> <p>6.5 Vertical Pumps Requirements</p> <p>6.5.1 Coupling and impellers fixing devices shall allow reverse rotation, without damage to the main equipment.</p> <p>6.5.2 Unless required per API Std 610, radial and thrust bearings shall be rolling-element type.</p>			

6.6 Pressure Casings

- 6.6.1 The direction of rotation of the impeller(s) shall be clearly marked on the casing by permanent means.
- 6.6.2 Maximum discharge pressure shall consider the additional differential pressure developed during operation with maximum specified fluid relative density and driver maximum speed.
- 6.6.3 Vertically mounted, axially split-case pumps shall be provided with facilities (stud bolts or dowel pins), to simplify the upper casing cover assembly.
- 6.6.4 Casing connections other than suction and discharge nozzles shall be at least DN 15 (NPS 1/2).
- 6.6.5 Threaded connections shall not be used.
- 6.6.6 Steel and steel alloy pumps with nozzle diameters lower than 16", the pump casing and baseplates shall be designed for satisfactory performance if subjected to the external nozzle forces and moments from API Std 610 Table 5 multiplied by a factor defined in Table 1 below. For nozzles diameter greater than 16" these load values shall be linearly extrapolated, and the agreement of the manufacturer is required.
- 6.6.7 If any of the applied load components on any of the pump's nozzles (suction or discharge) exceeds the limits defined on item 6.6.6, both nozzles shall be verified using Annex F of API Std 610. In this case, allowable loads to be considered in the equations of Annex F will be replaced by the values defined in Table 1 below.

Table 1 - Allowable nozzle loads.


Pressure rating	≤ 300# - 900#	1500# - 2500#
Nozzle load	2 * API 610	4 * API 610

6.7 Impellers

- 6.7.1 Impellers shall be furnished with renewable wear rings, unless otherwise agreed by OWNER. Renewable wear rings shall be held in place by a press fit with at least three axial screws, equally spaced.
- 6.7.2 Impellers shall be fully enclosed type. Open impellers are not acceptable. Semi-open impellers are acceptable for low-flow, high-head pump design.
- 6.7.3 Impellers shall be single-piece casting or forging.

6.8 Mechanical Seals

- 6.8.1 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.
- 6.8.2 Unless otherwise specified, but not limited to, double seal arrangements shall be used with:
- Hydrocarbon services with vapor pressure above 400 kPa (abs) at maximum operational temperature;
 - Services with H₂S, under the following conditions:
 - Concentrations above 10 ppm (mass) for pumps located indoors;

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-1200-310-P4X-001	REV. E
	-	SHEET: 9 of 24	
	TITLE: API 610 CENTRIFUGAL PUMPS SPECIFICATION	INTERNAL	
		ESUP	

— Concentrations above 500 ppm (mass) for pumps located outdoors. Double seal shall be non-pressurized from 500 ppm (mass) up to 5 000 ppm (mass). Double seal shall be pressurized above 5 000 ppm (mass);

c) Hydrocarbons at temperatures above their auto-ignition limit.

6.8.3 Pumps with hydrocarbon services and single seal arrangement shall be supplied with auxiliary seal piping plan 65B (API Std 682) for leakage collection.

6.8.4 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.

6.8.5 Seal materials shall be the seal MANUFACTURER's recommendation for the service, with the exception that Sintered Silicon Carbide (SSiC) seal face materials shall not be used. SUPPLIER may also specify required materials on the data sheets. However, seal MANUFACTURER shall validate this material specification.

6.8.6 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.

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

6.8.8 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 failure in other sealing components, such as the **throat** bushing.

6.8.9 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.

6.9 Auxiliary Piping

6.9.1 Drains and vents shall have flanged valves. Piping shall be suitably supported to the pump baseplate or mounting frame by PACKAGER / MANUFACTURER.

6.9.2 Pumps requiring auxiliary piping for balancing line, sealing, cooling or lube oil systems shall be provided with all necessary connections, plus all required piping and fittings, as defined on the data sheets.

6.9.3 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.

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


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

6.10 Bearings and Bearing Housings

6.10.1 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 Std 614 specifications.

6.10.2 Sealed bearings filled with grease are not acceptable.

6.10.3 The use of Polyamide or other non-metallic materials in rolling contact bearings is forbidden.

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-1200-310-P4X-001	REV. E
	-	SHEET: 10 of 24	
	TITLE: API 610 CENTRIFUGAL PUMPS SPECIFICATION	INTERNAL	
		ESUP	

6.10.4 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 outer surface of the bearing housing by permanent means.

6.10.5 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 "U" type labyrinth.

NOTE The sealing element referred to as "U" type labyrinth is a sealing element with two deflectors (internal and external) that obstruct air movement through the bearing housing.

6.10.6 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 temperature.

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

6.10.8 Bearing housings shall have a flat surface at least 1 in. (25 mm) in diameter for the location of magnetic-based vibration-measuring equipment.

6.11 Drivers

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

6.11.2 A direct driver shall be used. However, a gearbox may be used when the optimum pump speed is different from the nominal driver speed, under previous approval by OWNER. The transmission unit, if provided, shall comply with the requirements of API Std 677.

6.12 Couplings

6.12.1 Pumps shall be connected to the driver by means of a flexible spacer type coupling.

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

6.12.3 For pumps requiring power inputs greater than 500 kW, the coupling hubs shall be hydraulic taper fit. All smaller sized units shall be in accordance with MANUFACTURER's normal standard.

6.12.4 Unless otherwise specified in pump data sheets issued by OWNER, couplings and coupling mountings shall be according to:

- ISO 14691 for pumps with rolling-element thrust bearings;
- API Std 671 for pumps with hydrodynamic thrust bearings.


6.12.5 For pumps with hydraulic taper fitted coupling hubs, the MANUFACTURER shall provide a detailed procedure for coupling hubs assembly as part of the pump's maintenance manual. The MANUFACTURER shall also provide a quality control report of the factory assembly with evidence that the hubs were assembled in accordance with the correct procedures and drawings.

6.12.6 Flexible disk couplings furnished in accordance with API Std 671 shall be made of Inconel 625 flexible disks.

6.12.7 Coupling hubs and spacers shall be supplied with corrosion resistant coating. Bolts and nuts shall be made of appropriate material considering design conditions and corrosion resistance.

6.12.8 The coupling guard shall be made of a solid sheet of metallic, spark-resistant material.

NOTE Coupling guard according to PETROBRAS' patented design is preferable.

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-1200-310-P4X-001	REV. E
	-	SHEET: 11 of 24	
	TITLE: API 610 CENTRIFUGAL PUMPS SPECIFICATION	INTERNAL	
		ESUP	

6.13 Baseplate

- 6.13.1 The baseplate shall have a drain-pan with a valved drain opening. Drain-pans may be bolted to the baseplate.
- 6.13.2 For pumps in corrosive duties, drain-pans shall be made of a corrosion-resistant material considering the pumped fluid properties.
- 6.13.3 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. Baseplates mounted with 3-point or multipoint mounting may be accepted under previous approval by OWNER.
- 6.13.4 For pump PACKAGES with Medium Voltage motors, the baseplates shall be designed for 3-point or multipoint mounting.

6.14 Balancing, Noise and Vibration Control

- 6.14.1 Major rotating parts, such as impellers, balance drums, and couplings, shall be dynamically balanced according to ISO 21940-11, grade G2.5. In addition, if specified on the data sheets, required by the operating conditions and pump size or if the pump's maximum speed is above 3600 rpm, the complete rotor shall be dynamically balanced.
- 6.14.2 Noise and vibration control concerning human exposure shall be performed according to I-ET-3010.00-1200-300-P4X-001 – Noise and Vibration Control Requirements.
- 6.14.3 OWNER data sheets define which pumps shall be mounted on AVMs. SUPPLIER shall define if other pumps need to be mounted on AVMs, based on vibration and structure-borne noise studies.
- 6.14.4 Impeller balancing correction shall always be performed by means of mass removal. The reduction of wall thickness shall not exceed 30 % (at actual impeller tip), or the impeller shall otherwise be replaced.

6.15 Pressure Vessels


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

6.16 Heat Exchangers

- 6.16.1 The oil pressure shall exceed the cooling water pressure on lubricating oil and sealing oil Heat Exchangers.
- 6.16.2 Pump PACKAGES with pressurized Lube Oil Systems shall be equipped with twin Oil Coolers arrangement as per API 614. It shall be possible to switch between Heat Exchangers with the pumps in operation.
- 6.16.3 Shell & tube type heat exchangers shall be considered as pressure vessels and are therefore subject to their requirements.

6.17 Special Tools and Spare Parts

- 6.17.1 Spare parts required for NR-13 tests and those recommended by Classification Society shall be provided.
- 6.17.2 All special tools and spare parts shall be detailed in the packing list and shall be consistent with the lists issued for the engineering documentation. These items shall have an item number in the packing list, which shall match the item number fixed on the packing.

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-1200-310-P4X-001	REV. E
	-	SHEET: 12 of 24	
	TITLE: API 610 CENTRIFUGAL PUMPS SPECIFICATION	INTERNAL	
		ESUP	

7 MATERIALS

7.1 Material selection shall be according to API Std 610 Annexes G and H, unless otherwise specified in pump data sheets issued by OWNER. Additional requirements for specific pumps on this specification shall be followed.

7.2 All materials exposed to hydrocarbons containing hydrogen sulfide shall be in accordance with ISO 15156 (all parts) for the lowest anticipated pH and the highest H₂S partial pressure.

7.3 Dissimilar materials in contact with an electrolyte shall be electrically isolated 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 All electrical equipment shall be manufactured and tested 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 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, centrifugal 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.

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

9.2 Automation, Control and Instrumentation System Cabling

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

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-1200-310-P4X-001	REV. E
	-	SHEET: 13 of 24	
	TITLE: API 610 CENTRIFUGAL PUMPS SPECIFICATION	INTERNAL	
		ESUP	

9.2.2 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.

9.3 Alarms and Shutdown

The minimum alarm and shutdown functions shall be as required on the P&IDs and matrix of cause and effect.

9.4 Monitoring Requirements

9.4.1 The equipment that shall be monitored and the monitoring requirements shall be according to I-ET-3010.00-5500-854-P4X-001 – Machinery Monitoring System (MMS).

9.4.2 Monitoring sensors for motors shall be in accordance with 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.

9.4.3 All monitoring sensors shall be compatible with MPS/DAM, as described in I-ET-3010.00-5500-854-P4X-001 – Machinery Monitoring System (MMS).

9.4.4 All monitoring sensors shall be supplied installed, configured, and connected to a junction box located on the pump skid. MANUFACTURER shall provide complete documentation of the sensors installed in the equipment.

9.4.5 All monitoring sensors of P0 type PACKAGE UNITS shall be interconnected to the MPS/DAM (supplied by others), while all machinery monitoring sensors of P2 type PACKAGE UNITS shall be interconnected to the MPS/DAM (supplied by PACKAGER) inside the UCP (supplied by PACKAGER). All MPS and DAM shall be interconnected to the MMS of the UNIT.

9.4.6 PACKAGER / MANUFACTURER shall provide all data and performance curves to be implemented by the MMS supplier for Monitoring System Configuration.

9.4.7 For equipment with rolling-element bearings, one accelerometer for each bearing housing shall be supplied, installed and tested in accordance with API Std 670.

9.4.8 For equipment with hydrodynamic bearings (including drivers, gearboxes and HVSDs), vibration probes including their mounting and calibration shall be supplied, installed and tested in accordance with API Std 670. Two radial-vibration probes in each bearing housing, two axial-position probes at the thrust end of each machine, and one phase reference transducer for each different shaft speed shall be supplied for each machine.


9.4.9 Hydrodynamic thrust and radial bearings shall be fitted with bearing metal temperature detectors. Detectors shall be platinum resistance RTDs, three-wire, 100Ω at 0°C.

9.4.10 All pumps provided with a pressurized lube oil system shall be equipped with an online oil condition monitoring device to enable real-time indication of oil contamination with water and metallic residue. This device shall be compatible with and connected to the MMS.

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.

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-1200-310-P4X-001	REV. E
	-		SHEET: 14 of 24
	TITLE: API 610 CENTRIFUGAL PUMPS SPECIFICATION		INTERNAL

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;
- Rated flow;
- Rated head;
- Casing hydrostatic test pressure;
- Maximum allowable working pressure (MAWP);
- Temperature basis for MAWP;
- Driver power rating and speed;
- Design code;
- Design temperature and pressure;
- Tag number.

12 TAG NUMBERING AND TAG PLATES

12.1 Tagging of all instrumentation, electrical, mechanical and piping items, including valves, shall be according to I-ET-3000.00-1200-940-P4X-001 – Tagging Procedure for Production Units Design.

12.2 Tag plates shall be supplied with number and description in Portuguese.

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

12.4 Tag numbers for remaining auxiliary equipment shall be defined in detail design after approval of OWNER.

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.

13.2.3 Certificates for pressure-containing parts, impellers and shafts shall include chemical analysis and mechanical properties of the materials.

14 INSPECTION, TESTING AND COMMISSIONING

14.1 Inspection and Testing

14.1.1 Inspection and testing throughout the manufacturing process shall be in accordance with the quality requirements of IOGP S-615Q. The conformity assessment system (CAS) is letter B.

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-1200-310-P4X-001	REV. E
	-	SHEET: 15 of 24	
	TITLE: API 610 CENTRIFUGAL PUMPS SPECIFICATION	INTERNAL	
		ESUP	

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

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

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

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

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

14.2.4 Motors tests shall be in accordance with 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.

14.2.5 Monitoring systems of P2 type PACKAGE UNITS and monitoring sensors of P0 type PACKAGE UNITS shall be tested on the FAT.

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

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

14.2.8 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.

14.2.9 The pump shall be mechanically run at the rated flow for 4 h if, at least, one of the criteria below is met. The parameters shall be calculated as defined in API Std 610.

- nd_m factor $\geq 350\,000$.
- Energy density $> 4,0 \times 10^6$ kW/min.


14.2.10 For higher power pumps (drivers ≥ 1 MW), pump efficiency at rated flow inferred during the performance test shall not be less than the predicted efficiency on the proposal.

NOTE The vendor shall include any cost and delivery impact during the proposal.

14.2.11 Hydrodynamic bearings shall be removed, inspected by the purchaser or his representative, and reassembled after the mechanical and performance tests are completed. An inspection report shall be included in the documentation.

14.2.12 If replacement or modification of the bearings are needed after the inspections, the original test shall not be acceptable, and the machine shall be retested. If minor scratches occur, manual cosmetic repairs of these parts are not a cause for retest.

NOTE ISO 7146-1 may be used for guidance and bearing damage characterization.

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-1200-310-P4X-001	REV. E
	-		SHEET: 16 of 24
	TITLE: API 610 CENTRIFUGAL PUMPS SPECIFICATION		INTERNAL

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, including monitoring systems of P0 and P2 type PACKAGE UNITS.
- 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.
- 14.3.3 For services in which the operation fluid is not water, PACKAGER / MANUFACTURER shall confirm if the pump and driver system can operate with water during commissioning activities.


15 PREPARATION FOR SHIPMENT

15.1 Marking

- 15.1.1 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 does not damage or impair the component. Marking may be done on the item itself or on its packing or nameplate.
- 15.1.2 Items that cannot be identified shall be rejected. Rejected items may be recertified by carrying out all relevant testing, with prior approval of the OWNER.
- 15.1.3 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 The equipment shall be supplied tested, flushed and preserved and, if practical, already charged up with coolant and lubricants.
- 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 All open ends of piping shall be treated and closed off by plastic caps and taped.
- 15.2.4 PACKAGER shall submit the packing specification to the SUPPLIER for approval.
- 15.2.5 Packing shall be 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, 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.

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-1200-310-P4X-001	REV. E
	-	SHEET: 17 of 24	
	TITLE: API 610 CENTRIFUGAL PUMPS SPECIFICATION	INTERNAL	
		ESUP	

16 REQUIRED DOCUMENTATION

16.1 PACKAGER / MANUFACTURER shall provide original documents in PDF format for all required documents. Extracted figures from catalogue or manual, especially for the outline drawings of components such as couplings, mechanical seals and auxiliary equipment will not be accepted. Whenever required by OWNER, source files shall also be provided.

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

16.3 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.

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

16.5 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

16.6 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.

16.7 The following documents shall be issued and approved 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;
- Rotor dynamics analysis report (according to requirements of API Std 610);
- FAT procedure.

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

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

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-1200-310-P4X-001	REV. E
	-	SHEET: 18 of 24	
	TITLE: API 610 CENTRIFUGAL PUMPS SPECIFICATION	INTERNAL	
		ESUP	

16.9 The following documents shall be issued and approved 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.

16.10 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.

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

16.12 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 will be PACKAGER / MANUFACTURER's responsibility.


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

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

16.15 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.

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

16.17 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

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-1200-310-P4X-001	REV. E
	-		SHEET: 19 of 24
	TITLE: API 610 CENTRIFUGAL PUMPS SPECIFICATION		INTERNAL

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

16.18 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.

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

16.20 PACKAGER / MANUFACTURER shall inform either in the datasheet or in the performance curve the flow rates defining the preferred operation region and the allowable operation region of the equipment. For pumps with variable speed drives, the performance curve shall inform the preferred and allowable operating region for the pump's entire speed range, with all design operating conditions indicated in it.

16.21 PACKAGER / MANUFACTURER shall inform the number of impeller and diffuser vanes either in the datasheet or in the cross section drawing with part list.

16.22 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 COOLING AND HOT WATER CIRCULATION PUMPS ADDITIONAL REQUIREMENTS

17.1 General

Requirements in this section shall be added to sections 1-17 of this specification.

17.2 Materials

Material class shall be S-6, as per API Std 610, Table H.1.

17.3 Testing

PACKAGER / MANUFACTURER shall perform NPSH required test for one pump type of Hot Water Circulation Pumps. The test shall conform to HI 14.6 or ISO 9906 with API Std 610 additional requirements.

18 INJECTION WATER AND SRU FEED PUMPS ADDITIONAL REQUIREMENTS

18.1 General


18.1.1 Requirements in this section apply to SRU (Sulphate Removal Unit) Feed Pumps, Injection Water Booster Pumps and Main Water Injection Pumps. These requirements shall be added to the sections 1-17 of this specification.

18.1.2 Although IOGP S-615 scope may not include pumps for this service, its requirements shall be fulfilled to the most extent possible. Requirements that cannot be fulfilled shall be presented in writing for OWNER's resolution.

18.1.3 Main Pumps shall be deemed as Special Purpose Pumps as per API Std 610 and, as such, a DFMEA according to API Std 691 shall be performed and presented by the PACKAGER / MANUFACTURER.

18.2 Design Requirements

18.2.1 Main Pumps shall be of one of these types:

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-1200-310-P4X-001	REV. E
	-		SHEET: 20 of 24
	TITLE: API 610 CENTRIFUGAL PUMPS SPECIFICATION		INTERNAL

- High-speed integrally geared pumps;
- Multistage BB3 or BB5 pumps.

18.2.2 Booster and SRU feed pumps with rated shaft power greater than 150 kW and rated speed above 1800 rpm shall be between bearing type.

18.2.3 Booster and SRU feed pumps with rated shaft power greater than 300kW shall be between bearing type.

18.2.4 Main pumps rated speed may be higher than 1800 rpm.

18.2.5 Vertical booster pumps are not allowed.

18.2.6 Pumps shall be installed side by side in parallel to the longitudinal axis of the UNIT, unless otherwise stated in pump data sheets issued by OWNER.

18.2.7 Main pumps mechanical seals shall be suitable for operation with produced water. Springs shall be located on the quench side.

18.2.8 Main pumps sealing system shall be according to Piping Plans 11/62 of API Std 682.

18.2.9 MANUFACTURER shall inform the pump minimum flow requirements – including its dependence on rotation speed, if applicable – to enable the flow control system design and configuration. If an Automatic Recirculation Valve (ARV) is specified for minimum flow assurance, this valve shall be designed and supplied by the pump PACKAGER.

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

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


18.2.12 Impellers, balancing drums and similar major rotating components of Main Injection Water Pump shall be dynamically balanced to ISO 21940-11, grade G1.

18.2.13 Main Pumps shall have a visual reference (e.g., zebra tape) in a visible section of the rotating assembly to allow direct visual identification of the driver shaft rotation.

18.2.14 If head per stage of Main Pumps is above 275 m, the structural design of the pumps' impellers and diffusers shall include the following analyses, the results of which shall be made available for the OWNER in a dedicated technical report:

- a) Structural analysis to determine shroud natural frequencies, wet mode shapes, and potential for resonance. Separation on interference diagram shall be $\geq 10\%$.
- b) Impellers and diffusers hydraulic loading calculation by a Computational Fluid Dynamics (CFD) transient simulation. The simulation shall consider the actual impeller to collector vane tip clearance and the whole allowable operating range. The calculated hydraulic loading shall be applied to the components' structural model to verify fatigue life at maximum speed. The design shall consider infinite fatigue life for this analysis.

18.2.15 Main Pumps hydraulic selection shall consider the following constraints: efficiency shall be 80% or higher, suction specific speed below 11,000 (USC units) and head rise from BEP to shutoff above 15%.

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-1200-310-P4X-001	REV. E
	-	SHEET: 21 of 24	
	TITLE: API 610 CENTRIFUGAL PUMPS SPECIFICATION	INTERNAL	
		ESUP	

18.2.16 Main Pumps with direct startup shall be designed considering the transient loads of high flow startup. Baseplate and hold down bolts design, for both pump and driver, shall consider the higher torque loads resulting from startup at higher flow.

18.2.17 Main Pump's Minimum Flow Control Valves (MFCVs) and respective orifice plates shall be specified and supplied by the Pump PACKAGER. These valves shall comply with the requirements 18.2.17.1 to 18.2.17.4.

18.2.17.1 Main Pump's MFCV shall be sized to perform their function in all operating conditions, including transients. The valve's opening/closing stroke times shall be defined by the Pump PACKAGER considering the typical transient events such as pump startup and Injection Well Shutdown.

18.2.17.2 Main Pump's MFCV shall be open at failure type with body material according to recycle line material specification.

18.2.17.3 MFCV's positioner shall be contactless, smart and with 4-20 mA with HART protocol.

18.2.17.4 At least one of the MFCVs shall be tested during the Complete Unit Test.

18.3 Factory Acceptance Test (FAT) – Main Injection Water Pumps

18.3.1 Main Injection Water pump FAT shall be performed at rated speed.

18.3.2 Vibration and bearing temperature data shall be continuously monitored and recorded during the shop Performance Test. The acceptance limits specified in API Std 610 are applicable to the whole duration of the test.

18.3.3 The vibration and temperatures shall be continuously monitored and recorded during the 4-h Mechanical Running Test (MRT).

18.3.4 The same vibration and bearing temperature limits applicable to the Performance Test shall be applied for the MRT.

18.3.5 The original files containing all data recorded during the FAT shall be made available for Petrobras after the tests.

18.3.6 Disassembly of the pump for any head adjustment (including less than 5 % diameter change) after test shall be cause for retest.

18.3.7 A Shop Verification of Rotor Dynamic Characteristics as per API Std 610, Annex I shall be carried out during Factory Acceptance Tests of the Main Injection Water Pumps.

18.4 Materials


18.4.1 Main and booster pump materials shall be of class D2 of API Std 610, Table H.1.

18.4.2 Wetted parts materials shall be suitable for continuous or intermittent seawater and produced water service, including the requirements of ISO 15156 (all parts), according to specifications on data sheets issued by OWNER.

18.5 Lateral Analysis – Main Injection Water Pumps

18.5.1 The Lateral Analysis of Main Injection Water Pumps shall include a Damped Unbalance Response Analysis as per API Std 610, Annex I regardless of the calculated damping factor and critical speed ratio.

18.5.2 The peak-to-peak major axis displacement of the unbalanced rotor shall not exceed 35 % of the diametral running clearance at each close clearance location.

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-1200-310-P4X-001	REV. E
	-		SHEET: 22 of 24
	TITLE: API 610 CENTRIFUGAL PUMPS SPECIFICATION		INTERNAL

18.5.3 In addition to the conditions described in API Std 610, the Separation Margin, Damping Ratio and Allowable Displacement criteria shall be applied considering minimum and maximum bearing clearance conditions.

18.5.4 The Lateral Analysis Report shall include model data in sufficient detail to allow independent audit of the results.

18.6 Lube Oil System

18.6.1 Integrated common lube oil system for pump and motor driver shall be provided for each pump set with: pumps, suction strainers, supply and return system, vents, drains, dual full-flow oil filters, twin lube oil cooler, electrical lube oil heater, all necessary valves and instruments. The oil system shall supply mineral oil to the respective users and shall be mounted into the main pump baseplate.

18.6.2 Except as stated below, the system shall be in full compliance with API Std 614 as a General-Purpose Lube Oil System.

18.6.3 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. The use of tank mounted vertical oil pumps is acceptable.

18.6.4 In case of an emergency, that results in loss of all AC power, supply cooling oil shall be sustained.

18.6.5 Dual oil filters of SS 316L material capable of on-line changeover without disruption to the main equipment operation shall be provided.

18.6.6 Oil coolers shall be plate heat exchangers skid mounted. Shell and tube heat exchangers can only be used with OWNER's approval.

18.6.7 An oil tank electric heater shall be provided to maintain the lubricating and control oil at the minimum temperature requirements. The heater shall be capable of on-line withdrawal without the necessity to drain down the oil tank. The electric heater shall be in accordance with 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.

18.6.8 All piping shall be butt welded and at least 10% of the welds shall be radiographic tested.

18.6.9 The oil tank vent shall be fitted with an oil mist eliminator and return oil pipe. PACKAGER shall supply a flame arrestor (loose item) for installation by the SUPPLIER.

18.6.10 The Lube Oil System shall have a dedicated pressure control valve (PCV) with by-pass and block valve.


18.6.11 The Lube Oil System shall have a dedicated thermostatic valve for oil temperature control.

18.7 Monitoring System

18.7.1 All bearings shall be supplied with individual temperature elements. Spare elements shall be installed in each bearing.

18.7.2 In addition to the shaft vibration probes, Main Pumps shall be supplied with at least one accelerometer per bearing housing and one accelerometer installed on the pressure casing. The pressure casing accelerometer shall be located close to the annular seal element with the highest radial stiffness.

18.7.3 Main Pumps and SRU Feed Pumps shall have continuous monitoring of rotation speed and direction integrated to the MMS. Indication of reverse rotation condition shall inhibit the equipment's startup and cause automatic blockage of the pump's discharge valve.

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-1200-310-P4X-001	REV. E
	-		SHEET: 23 of 24
	TITLE: API 610 CENTRIFUGAL PUMPS SPECIFICATION		INTERNAL

18.7.4 Main Pumps shall be provided with a casing temperature sensor located on the pressure casing surface as close as possible to the discharge nozzle. Alarm (TAH) and trip (TAHH) values shall be configured for this parameter.

18.7.5 Main Pumps, when BB5 type, shall have a differential pressure transmitter between the balancing chamber (non-drive end side) and the pump's suction nozzle. A high level alarm shall be associated with this measurement. The instrument shall be suitable for the system's expected transient events.

18.8 Gear Units

18.8.1 Hydraulic Variable Speed Drive (HVSD)

18.8.1.1 When required on the Basic Design datasheets HVSDs shall be supplied to allow the pump's speed variation. It shall be furnished according to API 613 wherever applicable.

18.8.1.2 HVSDs shall be designed as a "stand-alone" unit, whereby no external thrust loads shall be imposed upon the HVSD by other equipment.

18.8.1.3 HVSD shall be designed for all operating cases defined in the pump datasheet. The hydraulic variable speed driver shall be designed to operate continuously and for a long period at any point in the speed and torque range.

18.8.1.4 The equipment shall have a Nitrogen purge connection for preservation purpose.

18.8.1.5 Each HSVDs shall undergo a Mechanical Running Test in accordance with API 613 and it shall be witnessed by the OWNER. All real-time vibration data shall be recorded, and a copy provided to the OWNER.

18.8.2 Gearbox

18.8.2.1 When required, the gearbox shall be double helical, single stage designed in accordance with API 613 last edition. A device to allow manual rotation of the shafts shall be included for maintenance purpose (such as shaft mechanical alignment or borescope inspection).

18.8.2.2 Gearbox shall be designed as a "stand-alone" unit, whereby no external thrust loads shall be imposed upon the gearbox by other equipment.

18.8.2.3 Shaft oil seal shall be easily accessible for removal and re-installation without removing couplings.

18.8.2.4 All bearings shall be pressure lubricated and fully replaceable at field.

18.8.2.5 Each gearbox Mechanical Running Test shall be witnessed by the OWNER. All real-time vibration data shall be recorded, and a copy provided to the OWNER.

18.9 Commissioning


Main and booster pump PACKAGES shall undergo a Site Acceptance Test (SAT) in accordance with the requirements of Annex A – Rotating Equipment Reliability Test.

19 PRODUCED WATER PUMPS ADDITIONAL REQUIREMENTS

19.1 General

19.1.1 Requirements in this section shall be added to sections 1-17 of this specification.

19.1.2 Produced water pumps used to feed injection water main pumps shall also conform to the requirements of injection water booster pumps.

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-1200-310-P4X-001	REV. E
	-		SHEET: 24 of 24
	TITLE: API 610 CENTRIFUGAL PUMPS SPECIFICATION		INTERNAL

19.2 Design Requirements

19.2.1 Mechanical seals shall be suitable for operation with produced water. Springs shall be located on the quench side.

19.2.2 Pumps sealing system shall be according to Piping Plans 11/62 of API Std 682.

20 OIL TRANSFER PUMPS ADDITIONAL REQUIREMENTS

20.1 General

20.1.1 Requirements in this section shall be added to the sections 1-17 of this specification.

20.1.2 Requirements in this section are applicable to pumps that transfer crude oil from the oil treatment system to the cargo tanks of the UNIT.

20.2 Design Requirements

SUPPLIER shall calculate the NPSH available considering transient pressure variations at the oil treatment system.

20.3 Testing

PACKAGER / MANUFACTURER shall perform NPSH required test for one of each pump type.

21 ANNEXES

Annex A – Rotating Equipment Reliability Test.



ANNEX A -
ROTATING EQUIPME