	<b>TECHNICAL SPECIFICATION</b>		Nº I-ET-3010.1M-1200-310-P4X-001							
	CLIENT:	SRGE	SHEET					1	of	54
	JOB:	REFERENCE BASIC DESIGN					1001056398 0010			
	AREA:	BÚZIOS								
DP&T-SRGE	TITLE:		<b>API 610 CENTRIFUGAL PUMPS SPECIFICATION</b>					NP-1		
ESUP										
MICROSOFT WORD / V. 2013 / I-ET-3010.1M-1200-310-P4X-001_B.DOCX										
<b>INDEX OF REVISIONS</b>										
<b>REV.</b>	<b>DESCRIPTION AND/OR REVISED SHEETS</b>									
0	ORIGINAL ISSUE									
A	REVISED ITEMS 2.3, 5.3, 5.14.1, 5.14.6, 7 and 16.4.2 (WHERE INDICATED)									
B	GENERAL REVISION									
	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H	
DATE	JUL/15/19	AUG/16/19	NOV/25/19							
DESIGN	ESUP	ESUP	ESUP							
EXECUTION	ERNANI	PESSOA	MMARROIG							
CHECK	GONZALEZ	FABIANA	PESSOA							
APPROVAL	TMCAMPOS	TMCAMPOS	TMCAMPOS							
INFORMATION IN THIS DOCUMENT IS PROPERTY OF PETROBRAS, BEING PROHIBITED OUTSIDE OF THEIR PURPOSE.										
FORM OWNED TO PETROBRAS N-0381 REV.L.										



## SUMARY

<b>SECTION I – GENERAL INFORMATION</b> .....	<b>4</b>
<b>1 INTRODUCTION</b> .....	<b>4</b>
<b>2 DEFINITIONS AND ABBREVIATIONS</b> .....	<b>4</b>
<b>3 SCOPE OF SUPPLY</b> .....	<b>5</b>
<b>4 CERTIFICATION REQUIREMENTS</b> .....	<b>5</b>
<b>5 SPARE PARTS AND TOOLS</b> .....	<b>6</b>
<b>6 MANUFACTURER/PACKAGER RESPONSIBILITY</b> .....	<b>6</b>
<b>7 NORMATIVE REFERENCES</b> .....	<b>7</b>
<b>8 GENERAL TECHNICAL REQUIREMENTS</b> .....	<b>10</b>
<b>9 PUMP DESIGN CONDITIONS</b> .....	<b>11</b>
<b>10 PERFORMANCE</b> .....	<b>13</b>
<b>11 VIBRATION, BALANCE AND NOISE CONTROL</b> .....	<b>14</b>
<b>12 CONTROLS AND INSTRUMENTATION</b> .....	<b>14</b>
<b>13 PRESSURE VESSELS AND HEAT EXCHANGERS</b> .....	<b>14</b>
<b>14 DRIVERS</b> .....	<b>15</b>
<b>15 ELECTRICAL</b> .....	<b>15</b>
<b>16 PAINTING AND COLOR</b> .....	<b>15</b>
<b>17 INSPECTION, TESTING AND COMMISSIONING</b> .....	<b>15</b>
<b>18 PREPARATION FOR SHIPMENT</b> .....	<b>16</b>
<b>SECTION II – IOGP S-617 SUPPLEMENTARY SPECIFICATION</b> .....	<b>18</b>
<b>1 SCOPE</b> .....	<b>19</b>
<b>2 NORMATIVE REFERENCES</b> .....	<b>19</b>
<b>3 TERMS AND DEFINITIONS</b> .....	<b>20</b>
<b>5 REQUIREMENTS</b> .....	<b>20</b>
<b>6 BASIC DESIGN</b> .....	<b>20</b>



<b>TECHNICAL SPECIFICATION</b>	Nº	I-ET-3010.1M-1200-310-P4X-001	REV.	B
BÚZIOS		SHEET	3	of 54
TITLE:		<b>API 610 CENTRIFUGAL PUMPS SPECIFICATION</b>		
		<b>NP-1</b>		
		<b>ESUP</b>		

<b>7 ACCESSORIES .....</b>	<b>28</b>
<b>8 INSPECTION, TESTING AND PREPARATION FOR SHIPMENT .....</b>	<b>31</b>
<b>ANNEX L .....</b>	<b>38</b>
<b>(INFORMATIVE).....</b>	<b>38</b>
<b>VENDOR DRAWING AND DATA REQUIREMENTS .....</b>	<b>38</b>
<b>SECTION III - IOGP S-617Q QUALITY REQUIREMENTS .....</b>	<b>40</b>
<b>1 SCOPE.....</b>	<b>40</b>
<b>2 NORMATIVE REFERENCES.....</b>	<b>40</b>
<b>3 TERMS AND DEFINITIONS.....</b>	<b>40</b>
<b>4 SYMBOLS AND ABBREVIATIONS.....</b>	<b>41</b>
<b>5 QUALITY REQUIREMENTS .....</b>	<b>41</b>
<b>6 TRACEABILITY .....</b>	<b>42</b>
<b>7 CONTROL OF NONCONFORMING PRODUCTS AND SERVICES .....</b>	<b>42</b>
<b>8 EVIDENCE (RECORDS).....</b>	<b>42</b>
<b>ANNEX A PURCHASER CONFORMITY ASSESSMENT REQUIREMENTS .....</b>	<b>43</b>
<b>ANNEX B - MATERIAL TRACEABILITY AND CERTIFICATION REQUIREMENTS .....</b>	<b>46</b>
<b>SECTION IV - IOGP S-617L MODIFIED INFORMATION REQUIREMENTS FOR CENTRIFUGAL PUMPS .....</b>	<b>47</b>
<b>1 SCOPE.....</b>	<b>47</b>
<b>2 ABBREVIATIONS AND DEFINITIONS.....</b>	<b>47</b>
<b>3 LIST OF DOCUMENTS.....</b>	<b>47</b>
<b>SECTION V - PUMPS SPECIFIC REQUIREMENTS .....</b>	<b>50</b>
<b>1 SCOPE.....</b>	<b>50</b>
<b>2 GENERAL REQUIREMENTS .....</b>	<b>50</b>
<b>3 MAIN INJECTION WATER PUMP .....</b>	<b>52</b>
<b>4 SEA WATER LIFT PUMP .....</b>	<b>53</b>
<b>5 OIL TRANSFER PUMPS .....</b>	<b>54</b>



<b>TECHNICAL SPECIFICATION</b>	Nº	I-ET-3010.1M-1200-310-P4X-001	REV.	B
BÚZIOS			SHEET	4 of 54
TITLE:			<b>NP-1</b>	
<b>API 610 CENTRIFUGAL PUMPS SPECIFICATION</b>			<b>ESUP</b>	

## SECTION I – GENERAL INFORMATION

### 1 INTRODUCTION

1.1 This technical specification covers the minimum technical requirements for the design, materials, fabrication, inspection, testing, preparation of shipment, installation, pre-commissioning and commissioning of all electric motor driven API 610 centrifugal pumps.

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

### 2 DEFINITIONS AND ABBREVIATIONS

#### 2.1 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. For the purpose of this specification HULL CONTRACTOR and BIDDER may be the same organization, thus, unless otherwise specified HULL CONTRACTOR will be herein called as BIDDER.

#### 2.2 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



**MMS:** Machine Monitoring System

### 3 SCOPE OF SUPPLY

#### 3.1 General Requirements

3.1.1 MANUFACTURER scope of supply shall include the following:

- Centrifugal pump
- Electric Motor Driver;
- Mechanical seals;
- Baseplate;
- All necessary guards and couplings in non-sparking materials;
- In-skid common lube oil system for pump and electric motors, as applicable;
- Monitoring system (as applicable);
- Three-point resilient mounts and Anti Vibration Mounts (AVM's), as applicable;
- All necessary instruments, ancillaries and instrument supports;
- Unit Control Panels (as applicable)
- 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 piping and their respective utilities skids, such as lube oil, cooling medium and instrument/utility air;
- All raw materials and consumables;
- Gaskets;
- Tightening bolts and nuts;
- Nameplates manufactured in SS 316 in Portuguese for all equipment and instruments;
- Surface preparation and painting proper for offshore installation;
- Maintenance lifting beams and hoists;
- Lugs, spreaders bars or slings for lifting;
- Handling devices and tightening tools;
- Special maintenance and alignment tools;
- Technical assistance during assembly, pre-commissioning, start-up and commissioning phases;
- Safety signaling in Portuguese language;
- 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;
- 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;
- Warranty;
- Thermal insulation if necessary;
- A complete engineering package including design, fabrication, inspection, testing, commissioning as well as all documents and data required.
- Certification requirements
- Assembly and commissioning supervision.

3.1.2 All equipment, including sub-orders, shall be of field proven design within the MANUFACTURER's experience.

#### 3.2 CERTIFICATION REQUIREMENTS

##### 3.2.1 Class Certification



<b>TECHNICAL SPECIFICATION</b>	Nº	I-ET-3010.1M-1200-310-P4X-001	REV.	B
BÚZIOS			SHEET	6 of 54
TITLE: <b>API 610 CENTRIFUGAL PUMPS SPECIFICATION</b>			<b>NP-1</b>	
			<b>ESUP</b>	

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

### 3.2.2 Material Certification

3.2.2.1 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.

## 3.3 SPARE PARTS AND TOOLS

### 3.3.1 Spare Parts

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

3.3.1.2 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 parts shall be provided.

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

### 3.3.2 Special Tools (non commodities tools)

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

## 4 MANUFACTURER/PACKAGER RESPONSIBILITY

4.1 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.

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

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

4.4 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.

4.5 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.

4.6 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.



4.7 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.

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

4.9 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.

4.10 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.

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

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

## 5 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.

### 5.1 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.

### 5.2 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.

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 RP 582	Welding Guidelines for the Chemical, Oil, and Gas Industries



<b>TECHNICAL SPECIFICATION</b> Nº I-ET-3010.1M-1200-310-P4X-001 REV. B	BÚZIOS		SHEET 8 of 54
	TITLE: <b>API 610 CENTRIFUGAL PUMPS SPECIFICATION</b>		NP-1
			ESUP

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
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 <sub>2</sub> 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





<b>TECHNICAL SPECIFICATION</b> Nº I-ET-3010.1M-1200-310-P4X-001	REV. B	
	BÚZIOS	
	SHEET 9 of 54	
	<b>API 610 CENTRIFUGAL PUMPS SPECIFICATION</b>	

TITLE:	NP-1
	ESUP

NR-10	Brazilian Ministry of Labor (Ministério do Trabalho e Emprego – Norma Regulamentadora Nº 10, Segurança em Instalações e Serviços em Eletricidade)
NR-12	Brazilian Ministry of Labor (Ministério do Trabalho e Emprego – Norma Regulamentadora Nº 12, Segurança em Instalações e Serviços em Máquinas e Equipamentos)
NR-13	Brazilian Ministry of Labor (Ministério do Trabalho e Emprego – Norma Regulamentadora Nº 13, Caldeiras, Vasos de Pressão, Tubulações e Tanques Metálicos de Armazenamento)
NR-26	Brazilian Ministry of Labor (Ministério do Trabalho e Emprego – Norma Regulamentadora Nº 26, Sinalização de Segurança)
NR-37	Brazilian Ministry of Labor (Ministério do Trabalho e Emprego – Norma Regulamentadora Nº 37, Segurança e Saúde em Plataformas de Petróleo)
TEMA	Standards of Tubular Exchanger Manufactures Association 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.

### 5.3 Reference Documents

#### 5.3.1 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

#### 5.3.2 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

#### 5.3.3 Process

I-RL-3010.1M-1200-940-P4X-001	General Specification for Available Utilities
-------------------------------	---

#### 5.3.4 Electrical



TITLE:

**API 610 CENTRIFUGAL PUMPS SPECIFICATION**

NP-1

ESUP

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
5.3.5 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
5.3.6 Naval	
I-RL-3010.1M-1350-960-P4X-009	Motion Analysis

**5.4 Conflicting Requirements**

5.4.1 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.

5.4.2 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.

**6 GENERAL TECHNICAL REQUIREMENTS**

**6.1 DESIGN LIFETIME**

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

**6.2 GENERAL REQUIREMENTS OF PACKAGE**

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

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

6.2.3 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



<b>TECHNICAL SPECIFICATION</b>	Nº	I-ET-3010.1M-1200-310-P4X-001	REV.	B
BÚZIOS			SHEET	11 of 54
TITLE:			<b>NP-1</b>	
<b>API 610 CENTRIFUGAL PUMPS SPECIFICATION</b>			<b>ESUP</b>	

integration yard with minimal fieldwork.

6.2.4 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.

6.2.5 Package(s) shall be manufactured, inspected and verified to comply with all specifications mentioned in chapter 5 and the Classification Society regulations.

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

### **6.3 EQUIPMENT LOCATION AND LAYOUT CONSIDERATIONS**

6.3.1 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.

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

### **6.4 OPERATION ENVIRONMENT / MOTION REQUIREMENT**

#### **6.4.1 Operation Environment**

6.4.1.1 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.

6.4.1.2 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.

#### **6.4.2 Motion Requirements**

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

6.4.2.2 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.

## **7 PUMP DESIGN CONDITIONS**

### **7.1 General requirements**

7.1.1 All equipment shall be suitable for continuous operation in a classified area / non classified area as established on the data sheets.

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

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

7.1.4 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.

7.1.5 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.

7.1.6 The rotary parts, such as couplings, pulleys, and flywheels, shall feature rigid guards, made of non-sparking and non-flammable material according to NR-12.

### **7.2 Pump Casing**

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



<b>TECHNICAL SPECIFICATION</b>	Nº	I-ET-3010.1M-1200-310-P4X-001	REV.	B
	BÚZIOS		SHEET	12 of 54
	TITLE: <b>API 610 CENTRIFUGAL PUMPS SPECIFICATION</b>		<b>NP-1</b>	
		<b>ESUP</b>		

7.2.2 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.

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

7.2.4 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.

7.2.5 Threaded connections shall not be used.

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

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

### 7.3 Impellers

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

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

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

### 7.4 Mechanical Seals

7.4.1 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.

7.4.2 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. 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.

7.4.3 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.

7.4.4 Seal plates shall be provided with all necessary ½" NPT minimum connections (complete with solid plugs) for flushing, quench, drains and venting. Plugs shall be of the same material as the seal plate.

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

7.4.6 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.

### 7.5 Auxiliary Piping

7.5.1 Pumps requiring auxiliary piping for cooling, flushing, etc., shall be provided with all necessary connections (½" NPT minimum), plus all required piping and fittings, as defined on the data sheets. All auxiliary piping shall be SS 316 unless otherwise specified.

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

7.5.3 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.

### 7.6 Bearings

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



<b>TECHNICAL SPECIFICATION</b>	Nº	I-ET-3010.1M-1200-310-P4X-001	REV.	B
	BÚZIOS		SHEET	13 of 54
	TITLE: <b>API 610 CENTRIFUGAL PUMPS SPECIFICATION</b>		<b>NP-1</b>	
		<b>ESUP</b>		

7.6.2 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.

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

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

7.6.5 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.

7.6.6 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).

7.6.7 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.

7.6.8 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.

## 7.7 Couplings

7.7.1 The preferred method of connecting the driver to the pump is by means of a flexible spacer type coupling. Flexible couplings with rubber parts shall not be used in classified area.

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

7.7.3 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.

## 7.8 Baseplate

7.8.1 The pumps and drivers shall be installed on a combined baseplate unless otherwise specified. The baseplate shall be of the API 610 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.

7.8.2 For pump packages with Low Voltage motors, the baseplates shall be designed to be completely seal welded to the support structure. For pump packages with Medium Voltage motors, the baseplates shall be designed to facilitate bolting to the support structure with either 3-point or multipoint mounting. Pumps driven by Low Voltage motors with 3-point or multipoint mounting baseplate may be accepted under previous approval by PETROBRAS.

7.8.3 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 shall be avoided.

## 8 PERFORMANCE

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

8.2 Where it is below the maximum value, the maximum efficiency point should be achievable by increases in the flow rate. It shall be at least 80% of efficiency at BEP (Best Efficiency Point) for pumps which have voltage electric motor main driver with power more over 150kW.

8.3 The NPSH required shall be at least 2 m less than the NPSH available. Correction factors are not allowed.



<b>TECHNICAL SPECIFICATION</b>	Nº	I-ET-3010.1M-1200-310-P4X-001	REV.	B
BÚZIOS			SHEET	14 of 54
TITLE:			<b>NP-1</b>	
<b>API 610 CENTRIFUGAL PUMPS SPECIFICATION</b>			<b>ESUP</b>	

## 9 VIBRATION, BALANCE AND NOISE CONTROL

9.1 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.

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

9.3 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.

## 10 CONTROLS AND INSTRUMENTATION

### 10.1 General

10.1.1 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.

10.1.2 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.

### 10.2 Vibration Detection Devices and Temperature Sensor

10.2.1 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. For submerged motor, temperature probes may be installed within insulation and barrier fluid, hence fluid temperature can be used for motor temperature monitoring.

### 10.3 Automation, Control and Instrumentation System Cabling

10.3.1 All wiring within the limits of the enclosure shall be clearly marked on the wire and at the terminal. All cabling between the driver and the local gauge board shall be furnished.

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

### 10.4 Alarms and Shutdown

10.4.1 The minimum alarm and shutdown functions shall be as required in the matrix of cause and effect.

## 11 PRESSURE VESSELS AND HEAT EXCHANGERS

### 11.1 Pressure Vessels

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

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

### 11.2 Heat Exchangers

11.2.1 On the lubricating oil and sealing oil heat exchangers, the oil pressure shall exceed the water pressure



<b>TECHNICAL SPECIFICATION</b>	Nº	I-ET-3010.1M-1200-310-P4X-001	REV.	B
BÚZIOS			SHEET	15 of 54
TITLE: <b>API 610 CENTRIFUGAL PUMPS SPECIFICATION</b>			<b>NP-1</b>	
			<b>ESUP</b>	

of the water circuit.

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

## 12 DRIVERS

12.1 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 PETROBRAS. The transmission unit, if provided, shall comply with the requirements of API Standard 677.

## 13 ELECTRICAL

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

13.2 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.

13.3 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.

13.4 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.

13.5 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.

## 14 PAINTING AND COLOR

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

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

## 15 INSPECTION, TESTING AND COMMISSIONING

### 15.1 Inspection

15.1.1 Inspection and testing throughout the manufacturing process shall be in accordance with the quality requirements of IOGP S-615Q reproduced at Section III of this technical specification. The conformity assessment system (CAS) is letter B.

15.1.2

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

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

15.1.5 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.



<b>TECHNICAL SPECIFICATION</b>	Nº	I-ET-3010.1M-1200-310-P4X-001	REV.	B
BÚZIOS			SHEET	16 of 54
TITLE: <b>API 610 CENTRIFUGAL PUMPS SPECIFICATION</b>			<b>NP-1</b>	
			<b>ESUP</b>	

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

## 15.2 Commissioning

15.2.1 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.

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

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

15.2.4 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.).

15.2.5 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.

## 16 PREPARATION FOR SHIPMENT

### 16.1 Marking

16.1.1 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 shall not damage or impair the component.

16.1.2 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.

16.1.3 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

### 16.2 Shipment Packing

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

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

16.2.3 The package shall be protected from corrosion.

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

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

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

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

16.2.8 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.

### 16.3 NAMEPLATES

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

16.3.2 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).

### 16.4 TAG NUMBERING

16.4.1 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.

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

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

16.4.4 Valves shall be tagged with the applicable number only.

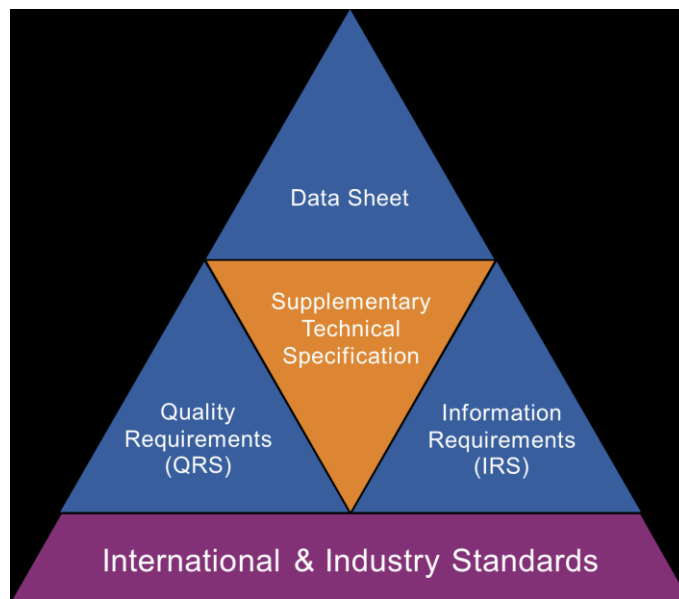
16.4.5 Tag numbers for remaining ancillary equipment shall be given after purchase order placement.

## SECTION II – IOGP S-617 SUPPLEMENTARY SPECIFICATION

### INTRODUCTION

The purpose of this specification is to define a minimum common set of supplementary requirements for procurement of centrifugal pumps in accordance with ANSI/API Standard 610 11th Edition September 2010 Centrifugal Pumps, which is an identical adoption of ISO 13709:2009 with the same title, for application in the petroleum and natural gas industries.

This JIP33 standardized procurement specification follows a common document structure comprising the four documents as shown below, which together with the purchase order define the overall technical specification for procurement.



**Figure 1 - JIP33 Specification for Procurement Documents Supplementary Technical Specification**

It is required to use all of these documents in conjunction with each other when applying this specification, as follows:

#### **S-615: Supplementary specification to ANSI/API Standard 610 for Centrifugal Pumps**

This specification is written as an overlay to ANSI/API Std 610, following the clause structure of the parent standard, to assist in cross-referencing the requirements. Where clauses from the parent standard (ANSI/API Std 610) are not covered in this specification, there are no supplementary requirements or modifications to the respective clause. The terminology used within this specification follows that of the parent standard and otherwise is in accordance with ISO/IEC Directives, Part 2.

Modifications to the parent standard defined in this specification are identified as Add (add to clause or add new clause), Replace (part of or entire clause) or Delete.

#### **S-615D: Data sheets for Centrifugal Pumps**

This document provides project specific requirements where the supplementary specification and its parent standard require the purchaser to define an application specific requirement. It also includes information required by the purchaser for technical evaluation. Additional purchaser supplied documents are also listed on the data sheets, to define scope and technical requirements for enquiry and purchase of the equipment.

#### **S-615L: Information requirements for Centrifugal Pumps**

This document defines the information requirements, including format, timing and purpose, for

information to be provided by the vendor. It also defines the specific conditions which must be met for conditional information requirements to become mandatory. The information requirements listed on the IRS have references to the source of the requirement..

### S-615Q: Quality requirements for Centrifugal Pumps

This document includes a conformity assessment system (CAS) which specifies standardized user interventions against quality management activities at four different levels. The applicable CAS level is specified by the purchaser on the data sheets.

The data sheets and IRS are published as editable documents for the user to specify application specific requirements. The supplementary specification and QRS are fixed documents.

Unless defined otherwise in the purchase order, the order of precedence (highest authority listed first) of the documents shall be:

- a) regulatory requirements;
- b) contract documentation (e.g. Section I and Section V);
- c) purchaser defined requirements (data sheets, IRS, QRS);
- d) this specification;
- e) the parent standard.

## 1 SCOPE

### Add after second paragraph

This specification does not apply to all pumps and services within the scope of ANSI/API Std 610.

The scope excludes the following:

- a) types:
  - OH4, BB4 and BB5 pumps;
  - single volute overhung pumps requiring a driver rated in excess of 112 kW (150 HP);
  - overhung pumps with two or more stages;
  - double suction overhung pumps;
- b) services:
  - pumps in cryogenic services [ $< -100\text{ °C}$  ( $-148\text{ °F}$ )];
  - pumps in multi-phase service.
- c) auxiliaries:
  - pumps with drivers  $> 1\ 000\text{kW}$  (1 340 HP);

## 2 NORMATIVE REFERENCES

### Delete from clause

ISO 1940-1 Mechanical vibration — Balance quality requirements for rotors in a constant (rigid) state — Part 1: Specification and verification of balance tolerances

ISO 9906 Rotodynamic pumps — Hydraulic performance acceptance tests

ISO 21049:2004 Pumps — Shaft sealing systems for centrifugal and rotary pumps



ANSI/HI 1.6

Add to clause Centrifugal Tests

ISO 9906 Rotodynamic pumps — Hydraulic performance acceptance tests - Grades 1, 2 and 3 - Second Edition

ISO 21940-11 Mechanical vibration — Rotor balancing — Part 11: Procedures and tolerances for rotors with rigid behaviour

ANSI/API Std 682 Pumps — Shaft sealing systems for centrifugal and rotary pumps

ANSI/HI 14.6 Rotodynamic Pumps for Hydraulic Performance Acceptance Tests

### 3 TERMS AND DEFINITIONS

#### 3.22 maximum discharge pressure

Replace subclause with

maximum discharge pressure is the maximum suction pressure plus the maximum differential pressure that the pump is capable of developing at shut-off when operating with the maximum specified relative density (specific gravity) with:

- the maximum impeller diameter at the rated speed for constant speed applications;
- the rated impeller diameter at the trip speed for variable speed applications

#### 3.23 maximum dynamic sealing pressure

Replace fifth sentence of note with

See ANSI/API Std 682.

#### 3.24 maximum operating temperature

Replace second sentence of note with

See ANSI/API Std 682.

#### 3.43 pressure casing

Replace subclause with

composite of all stationary pressure-containing parts of the pump, including all nozzles, seal glands, seal chambers and all auxiliary process fluid containing piping permanently attached to the pump casing but excluding the stationary and rotating members of mechanical seals

## 5 REQUIREMENTS

### 5.1 Units

Replace subclause with

The units required for all vendor's documentation shall be as per the data sheet units. However, piping dimensions shall be in accordance with ANSI.

## 6 BASIC DESIGN

### 6.1 General

#### 6.1.1



Add to subclause

Only equipment of proven reliability with equivalent design features to the units proposed and operating in similar service conditions shall be included in the vendor's proposal. Prototypes shall not be proposed. The vendor shall confirm that the quoted equipment (including pump, driver and gear) design is proven and demonstrate experience of 24 000 operating hours with the same equipment in at least three similar installations by providing the related necessary evidence.

**6.1.4**

Add to subclause

For fixed speed pumps, the proposed rated impeller diameter for pumps with constant speed drivers shall be not be greater than 95 % or less than 80 % of the maximum impeller diameter that can be installed in the pump casing.

For pumps with variable speed drives, the impeller diameter giving the maximum efficiency shall be selected. If this results in the selected impeller diameter being the maximum for the chosen casing, then the driver and pump shall be capable of the speed increase necessary to give a 5 % increase in head (per subclause 6.1.4 of ANSI/API Std 610) and to correct any head shortfall during testing, including the -3 % tolerance allowed by Table 16 of ANSI/API Std 610.

**6.1.7**

Replace second sentence of second paragraph with

During operation, the seal chamber pressure shall be at least a gauge pressure of 35 kPa (0,35 bar; 5 psi); see ANSI/API Std 682.

**6.1.9**

Replace subclause with

The pump suction-specific speed shall be calculated in accordance with Annex A of ANSI/API Std 610. With the exception of OH6 type pumps, suction-specific speed values shall not exceed 213 m<sup>3</sup>/s, rpm, m (11 000 gpm, rpm, ft). Suction-specific speed values higher than 213 m<sup>3</sup>/s, rpm, m (11 000 gpm, rpm, ft) may be accepted if the vendor can demonstrate proven experience of at least 3 years of operation at similar operating conditions such as NPSH margins and percentage of operating point to BEP.

Pumps with suction inducers may be considered if approved by purchaser. In which case the vendor shall:

- clearly indicate that the proposed pump includes a suction inducer;
- state the suction-specific speed for the impeller only;
- clearly show the allowable operating region on the pump curve.

**6.1.10**

Add to subclause at end of first paragraph

The proposal and final test curves for pumps in viscous service shall also include:

- the expected performance curves with specified viscous product;
- the maximum expected absorbed powers based on a cold viscous start up and normal viscous operation.

**6.1.11**

Replace subclause with

Pumps that have stable head versus flowrate curves (continuous head rise to shutoff) are required for all applications. The head rise from rated point to shutoff shall be at least 10 %. If a discharge orifice is required as a means of providing a continuous rise to shutoff, this shall be subject to purchaser's approval. Where offered, the vendor shall furnish full performance curves for the pump with and without the orifice installed.



A pump suction side restriction ring, commonly known as a "Bull Ring" is not allowed.

#### 6.1.24

Add to subclause

Any non-rotating maintenance part weighing more than 25 kg shall be supplied with an appropriately located tapped hole to fit a removable lifting eye.

#### 6.1.28

Add to subclause

For floating applications, the vendor shall state the maximum inclination and time period of oscillation at which the pump can operate.

#### 6.1.29 Bolting and threads

##### 6.1.29.1

Replace first sentence with

The details of threading shall conform to ISO 261, ISO 262, ISO 724, ISO 965 (all parts), ANSI/ASME B1.1 or other internationally standardized threading.

Add new subclause

##### 6.1.35

Any requirement for instantaneous start-up shall be specified on the data sheet.

Add new subclause

##### 6.1.36 Warm up and cool down

The vendor shall specify on the data sheet details of a separate warm-up (or cool-down) line, if required, to achieve instantaneous start-up of the pump with the pumping temperatures indicated on the data sheet. If an instantaneous start-up is not possible under any circumstances, the vendor shall make provisions to ensure that rapid heat-up does not damage the pump, accessories, or seals. The vendor shall submit the warm-up (or cool-down) procedure.

Add new subclause heading

##### 6.1.37 Insulation and heat tracing

Add new subclause

##### 6.1.37.1

If specified, personnel protection hot insulation shall be applied to all parts that are exposed to contact with persons during control and routine maintenance operations.

Add new subclause

##### 6.1.37.2

If specified, frost protection or wax formation protection heat tracing and insulation shall be applied to all necessary parts to maintain all the equipment in its normal operating state when the pump is on standby.

Add new subclause

##### 6.1.37.3

Where such insulation is required, insulation shall comply with the requirements specified on the data sheet. The vendor shall provide sufficient stand-offs and clearance from the insulated surface throughout for pipe flanges, valves and all instrument equipment to allow the fitment of the insulation and access for



maintenance. Surface coatings under insulation shall comply with the requirements specified on the data sheet.

Add new subclause

6.1.38

All equipment installed in a hazardous area shall be certified for use in explosive atmospheres in accordance with applicable regulatory requirements.

### 6.3 Pressure casings

#### 6.3.1

Replace subclause with

The maximum discharge pressure is defined in 3.22.

NOTE The basis of determining maximum discharge pressure is an application issue.

#### 6.3.5

Replace paragraph after note 2 with

The pump-seal chamber and seal gland shall have a pressure-temperature rating at least equal to the maximum allowable working pressure and temperature of the pump casing to which it is attached, in accordance with subclause 3.1.52 of ANSI/API Std 682:2014.

#### 6.3.6

Replace subclause with

All parts referred to in the definition of pressure casing shall have the same MAWP.

#### 6.3.10

Replace third sentence of note with

ANSI/API Std 682 specifically requires O-ring gaskets on low temperature [ $< 175\text{ °C}$  ( $350\text{ °F}$ )] pressure-seal gland plates. 6.3.11

Add to subclause

Centreline or near centreline supported pumps operating above  $204\text{ °C}$  ( $400\text{ °F}$ ) shall have a casing guide or key slot along the centreline and at each support pedestal. For pumps with four centreline or near centreline mounting feet, the key guides shall be on the non-drive end pedestals guiding thermal expansion away from the coupling end of the pump.

### 6.4 Nozzles and pressure casing connections

#### 6.4.1 Casing opening sizes

##### 6.4.1.2

Add to subclause

Drain connections of pumps handling fluids with a viscosity  $\geq 400\text{ cP}$ , or products with higher than ambient pour point temperature, or slurries shall be DN25 (NPS 1) minimum and shall be free draining. 6.4.2 Suction and discharge nozzles

##### 6.4.2.1

Replace second sentence with

All pumps shall have suction and discharge flanges of equal rating.



### 6.4.3 Auxiliary connections

#### 6.4.3.1

Add to subclause

Socket welded connections shall not be used when:

- a) the pump nozzles are Class 900 or above, or;
- b) the minimum pumping temperature is 0 °C (32 °F) or below, or;
- c) the pump is for hazardous service, or;
- d) NACE MR0175 or NACE MR0103 is applicable.

#### 6.4.3.10

Replace first sentence with

Piping less than DN50 (NPS 2) shall be gusseted in two orthogonal planes to increase the rigidity of the piped connection, in accordance with the following stipulations.

Replace item e) with

- e) Gussets shall not be bolted to the casing.

#### 6.4.3.11

Add to subclause after fifth sentence

Plugs that may require subsequent removal or plugs in cast iron casings shall be 316 stainless steel.

### 6.6 Rotors

#### 6.6.3

Replace third sentence with

Collets shall not be used in vertical pumps.

Add new subclause

#### 6.6.15

Impellers with four vanes shall not be provided in double volute pumps.

Add new subclause

#### 6.6.16

Repairs to correct machining errors shall be subject to approval by the purchaser. Metal plating shall not be used for shaft or impeller repairs. Weld repair of shaft shall not be permitted.

### 6.7 Wear rings and running clearances

#### 6.7.3

Replace subclause with

Renewable wear rings, if used, shall be held in place by a press fit with three axial screws or by tack welding in at least three places.

#### 6.7.4

Replace first sentence with

Running clearances shall meet the requirements of 6.7.4 a) to 6.7.4 c). Quoted pump performance and curve shall be based on the clearances used by the vendor after making allowances for any added





clearance based on temperature, viscosity and galling tendencies.

Add new subclause

6.7.5

Run-out of casing wear rings and casing-to-cover area shall not exceed 50 µm (0,002 in) TIR.

## 6.8 Mechanical shaft seals

### 6.8.1

Replace subclause with

Pumps shall be equipped with mechanical seals and sealing systems in accordance with ANSI/API Std 682. Pump and seal interface dimensions shall be in accordance with Table 7 and Figure 26 of ANSI/API Std 610. The purchaser shall specify the category of seal required. The purchaser should use the datasheets in ANSI/API Std 682 for this purpose.

The pump vendor shall be responsible for the engineering co-ordination, installation and performance of the mechanical seal and its auxiliary facilities such as circulation, injection, quenching and cooling.

### 6.8.2

Replace subclause with

The seal cartridge shall be removable without disturbing the driver, except for vertical pumps types OH5 and OH6.

### 6.8.7

Replace second sentence with

Symbols shall be in accordance with those specified in ANSI/API Std 682.

### 6.8.11

Replace first sentence with

If specified, or deemed to be required by the vendor, jackets shall be provided on seal chambers for heating.

## 6.9 Dynamics

### 6.9.2 Torsional analysis

#### 6.9.2.1

Add to end of item c)

Transient conditions include short circuit between two phases, start-up and, if specified, re-acceleration. A stress analysis shall be performed for the transient conditions to ensure that shaft-end, coupling and drivecomponent ratings are not exceeded.

#### 6.9.2.10

Replace first sentence with

If either a steady-state, damped-response analysis or a transient torsional analysis is performed, the vendor shall furnish a detailed report of the torsional analysis.

### 6.9.3 Vibration

#### 6.9.3.3

Replace second sentence with

The plotted spectra shall be included with the pump test results.



## 6.9.4 Balancing

### 6.9.4.1

Replace first sentence with

Impellers, balancing drums and similar major rotating components shall be dynamically balanced to ISO 21940-11, grade G2.5.

### 6.9.4.4

Replace first sentence of first paragraph with

If specified, impellers, balancing drums and similar major rotating components shall be dynamically balanced to ISO 21940-11, grade G1 (equivalent to 4WIn in USC terminology).

Replace second sentence of third paragraph with

In international standards, unbalance is expressed as a balance quality grade of ISO 21940-11.

## 6.10 Bearings and bearing housings

### 6.10.1 Bearings

#### 6.10.1.1

Replace second paragraph with

The bearing type and arrangement shall be selected in accordance with the limitations in Table 10 of ANSI/API Std 610.

#### 6.10.1.4

Replace third sentence with

Pressed steel cages shall not be used.

### 6.10.2 Bearing housings

#### 6.10.2.4

Replace first sentence with

Cooling, including an allowance for fouling, shall be provided to maintain oil and bearing temperatures as follows, based on the operating conditions and the lubrication system design ambient temperature specified on the data sheet: Replace item a) with

a) for pressurized systems, unless otherwise specified on the datasheet, oil outlet temperature below 70 °C

(160 °F) and bearing metal temperatures (if bearing-temperature sensors are supplied) less than 93 °C (200 °F); during shop testing, and under the most adverse specified operating conditions, the bearing-oil temperature rise shall not exceed 28 K (50 °R);

Replace item b) with

b) for ring-oiled or splash systems, unless otherwise specified on the datasheet, an oil-sump temperature below 82 °C (180 °F); during shop testing, the sump oil temperature rise shall not exceed 40 K (70 °R) above the ambient temperature in the test cell measured at the time of each reading and (if bearing temperature sensors are supplied) outer ring temperatures shall not exceed 93 °C (200 °F).

## 6.11 Lubrication

### 6.11.4

Replace subclause with

Grease lubrication shall not be used except for VS4 and VS5 pumps as per subclause 9.3.12.4 of ANSI/API

Std 610. Grease lubrication may be used for OH3 pumps subject to approval by the purchaser.

## 6.12 Materials

### 6.12.1 General

#### 6.12.1.3

Replace second sentence with

O-rings shall be selected and their application limited in accordance with ANSI/API Std 682.

#### 6.12.1.8

Replace subclause with

The vendor shall furnish material certificates that include chemical analysis and mechanical properties for the heats from which the material is supplied for the items listed below. Items (excluding lifting points) in sour service shall be supplied with material certificates containing a declaration of conformity to NACE MR0175 (all parts) or NACE MR0103 as specified on the data sheet.

- all process pressure-containing components, including any material welded directly to them;
- all process pressure retaining components;
- impellers;
- shafts;
- lifting points.

### 6.12.2 Castings

#### 6.12.2.3

Add to item a)

Weld repairs shall be defined as major when the depth of the cavity after preparation for repair exceeds 20 % of the actual wall thickness, or 25 mm (1 in), whichever is smaller, or when the extent of the cavity exceeds approximately 65 cm<sup>2</sup> (10 in<sup>2</sup>). All other weld repairs shall be considered minor.

Major weld repairs shall be documented.

Castings shall be heat-treated after major weld repairs according to the applicable material standard. Heat treatment after minor weld repairs is not required except where specified in the applicable material standard or upon agreement between the vendor and the purchaser.

#### 6.12.2.5

Replace subclause with

For casting repairs made in the vendor's shop, these shall be carried out in accordance with a weld repair procedure compliant with the component ASTM material specification. For major repairs as defined in 6.12.2.3, the vendor shall prepare documentation including weld repair maps showing the location and dimensions of weld repair cavities, qualification records, drawings, photographs, heat treatment detail, non-destructive examination requirements and other specified documents shall be submitted for purchaser's approval. The purchaser shall specify if approval is required before proceeding with repair. Repairs made at the foundry level shall be controlled by the casting material specification ("producing specification").

### 6.12.3 Welding

#### 6.12.3.4

Delete from item e)

The purchaser shall specify if the following additional examinations shall be performed:

- 1) magnetic-particle or liquid-penetrant examination of auxiliary connection welds;



2) ultrasonic or radiographic examination of any casing welds.

### 6.13 Nameplates and rotation arrows

#### 6.13.1

Replace subclause with

A nameplate shall be securely attached at a readily visible location on the equipment (including after any insulation is fitted) and on any other major piece of auxiliary equipment.

#### 6.13.2

Replace first sentence with

The nameplate shall be stamped with characters of 5 mm (0,2 in) minimum size, and in the language specified by the purchaser with the following information, in units consistent with the data sheet:

Add to list

- k) year of manufacture;
- l) shaft lift (for vertical pumps).

#### 6.13.3

Replace subclause with

In addition to being stamped on the nameplate, the pump serial number shall be plainly and permanently marked on the pump casing main constituents: casing, casing cover, lower and upper half casings, discharge head and suction can.

## 7 ACCESSORIES

### 7.1 Drivers

#### 7.1.3

Replace subclause with

For drive-train components that have a mass greater than 100 kg (220 lb), the equipment feet shall be provided with vertical jackscrews. The vendor shall allow a minimum clearance of 50 mm (2 in) under the driver to enable the use of a hydraulic jack when there are no jackscrews fitted.

#### 7.1.4

Replace second sentence with

On pumps where it is only possible to carry out shop testing with the contract motor, the motor rating shall be sufficient to permit shop testing with water. An overload of 10 % above the motor rated power at the pump rated duty point may be allowed during the test period subject to approval of the motor manufacturer.

#### 7.1.6

Replace subclause with

For which ever type of pump starting method is specified (for example against closed discharge valve, open system, bypass) the motor driver starting torque capability at 80 % voltage shall exceed the speed-torque requirements of the driven equipment by 10 % minimum of the required torque, along all points on the driven equipment speed-torque curve.

#### 7.1.7

Replace subclause with



Vertical suspended pumps and vertical in-line pumps shall have motors designed for vertical service. Unless otherwise specified on the data sheet, motors for vertical pumps shall have solid shafts. If the pump thrust bearing is in the motor, the motor shall meet the shaft and base tolerances shown in Figure 36 of ANSI/API Std 610. For all vertical pumps, the vendor shall shop mount, align, and match mark the motor. Specific motor requirements will be incorporated on the motor data sheet.

## 7.2 Couplings and guards

### 7.2.3

Replace subclause with

Couplings shall be balanced to ISO 21940-11, grade G6.3 or a more stringent balance grade.

### 7.2.14

Replace subclause with

Coupling guards shall be constructed of an agreed spark-resistant material (see subclause 6.10.2.6 and note of ANSI/API Std 610).

## 7.3 Baseplates

### 7.3.5

Replace first sentence of second paragraph with

This requirement shall be demonstrated in the pump-vendor's shop prior to mounting of the equipment and with the baseplate supported at the foundation bolt holes only.

### 7.3.6

Replace first paragraph third sentence with

Shim packs shall not be thicker than 13 mm (0,5 in) nor contain more than 3 shims.

### 7.3.10

Replace sixth sentence with

Vent holes at least 13 mm (0,5 in) in diameter shall be provided at each of the corners in each bulkhead section of the baseplate.

### 7.3.13

Replace subclause with

For pump baseplates required to be un-grouted, the baseplate and pedestal support assembly shall maintain alignment and the deflection criteria defined in Table 13 of ANSI/API Std 610 when the pump is subjected to the nozzle loads defined in Table 5 of ANSI/API Std 610.

### 7.3.17

Replace first sentence with

Transverse and axial alignment positioning jackscrews shall be provided for drive-train components having a mass greater than 100 kg (220 lb) to facilitate transverse horizontal and longitudinal adjustments.

Add new subclause

### 7.3.22

Two grounding lugs shall be provided on each baseplate, located at diagonal opposite corners, with 13 mm (1/2 in) brass studs, nuts and washers.

## 7.4 Instrumentation

## 7.4.2 Vibration, position and temperature detectors

### 7.4.2.2

Replace first sentence with

For equipment with hydrodynamic bearings, provision shall be made for mounting two radial-vibration probes in each housing, two axial-position probes at the thrust end of each machine. Provision for mounting a one-event-per-revolution probe in each driver shall be made.

Add to subclause after first sentence

Probes shall be located so that any spill is avoided during probe change out.

### 7.4.2.3

Replace first sentence with

Hydrodynamic thrust and radial bearings shall be fitted with bearing metal temperature detectors.

Add new sub-clause

#### 7.4.2.5

A complete instrument list and individual instrument data sheets shall be submitted to the purchaser for all instruments supplied by the vendor.

## 7.5 Piping and appurtenances

### 7.5.1 General

#### 7.5.1.4

Replace subclause with

Barrier or buffer fluid reservoirs shall be designed for mounting on the pump baseplate or motor support stand (vertical pumps). These reservoirs and the fluid-circulation tubing shall be fully installed and supported.

#### 7.5.1.6

Replace subclause with

Each piping system shall be manifolded to a single purchaser's inlet or outlet flanged connection to the edge and within the boundary of the baseplate.

NOTE The datasheet allows selection of this option for vent, cooling and drain connections.

Add new subclause

#### 7.5.1.9

Other than for seal plans, tubing shall not be used for any process wetted systems.

Add new subclause

#### 7.5.1.10

Brackets and supports welded on the mechanical equipment or on the baseplate shall have full length welds. Stitch welding is unacceptable.

### 7.5.2 Auxiliary process liquid piping

#### 7.5.2.4

Add to subclause

The orifice shall be a removable, flat orifice plate mounted between flanges. Restriction orifices shall have

the size and orifice tag number stamped on the upstream side of the orifice tab.

#### 7.5.2.6

Replace subclause with

Except for connections to cast iron, threaded vent and drain connections are not permitted.

#### 7.5.2.8

Replace subclause with

Unions shall not be used.

### 7.6 Special tools

Add new subclause

#### 7.6.3

Operating procedures for special tools, if any, shall be included in the installation, operating and maintenance manual.

## 8 INSPECTION, TESTING AND PREPARATION FOR SHIPMENT

### 8.1 General

#### 8.1.5

Replace subclause with

Prior to release for shipment, the purchaser's and the vendor's representative shall mutually agree compliance in accordance with an inspector's checklist such as that provided in ANSI/API Std 610 Annex E by initialling and dating the completed checklist.

### 8.2 Inspection

#### 8.2.2 Pressure-casing materials inspection

##### 8.2.2.1

Add to sub-clause

The vendor shall submit to the purchaser the detailed pertinent non-destructive examination procedures.

**Table 14 – Pressure casing material inspection requirements** Add rows to Table 14

Fabricated casing welds	VI	VI, plus MT or PT	VI, plus MT or RT (100 %)
Casing attachment welds	VI	VI, plus MT or PT	VI, plus MT or PT

##### 8.2.2.7

Replace first sentence with

When sour service is specified, the hardness of parts, welds and heat-affected zones shall be verified as being within allowable values by testing.

##### 8.2.2.8

Replace first sentence with



Pressure boundary parts of alloy materials, including overlays shall be subject to positive material identification (PMI) using recognized testing methods, instrumentation and standards.

### 8.3 Testing

#### 8.3.1 General

##### 8.3.1.1

Replace first sentence with

The vendor shall submit to the purchaser detailed procedures for all running tests and all specified optional tests (subclause 8.3.4 of ANSI/API Std 610).

##### 8.3.1.2

Replace first sentence with

Performance and NPSH test shall be conducted using the methods and uncertainty requirements of ISO 9906 Grade 1, ANSI/HI 14.6 (for centrifugal pumps) or ANSI/HI 2.6 (for vertical pumps).

#### 8.3.2 Hydrostatic test

##### 8.3.2.1

Add to sub-clause

The vendor shall submit to the purchaser the detailed hydrostatic test procedure.

##### 8.3.2.2

Add to subclause after first sentence

The test shall be conducted after completion of case machining except when subclause 8.3.2.10 of ANSI/API Std 610 applies.

##### 8.3.2.9

Replace third sentence with

Gland plates and removable seal chambers shall be tested as specified in ANSI/API Std 682.

Delete NOTE from subclause

##### 8.3.2.10

Replace second paragraph with

Any areas that are to be machined after hydrostatic testing shall be identified on the hydrotest report that shall be submitted to the purchaser prior to start of post hydrostatic test machining.

##### 8.3.2.12

Replace subclause with

All pumps pressure containing parts shall be tested to the same pressure. Segmental testing shall not be allowed.

Add new subclause

##### 8.3.2.17

Any repairs required after the hydrostatic test shall be subject to approval by the purchaser.

#### 8.3.3 Performance test

##### 8.3.3.1



Add to subclause

Spare rotor purchased with the main equipment shall undergo the same performance test and mechanical running tests as the main equipment. The vendor shall provide all necessary spares (gaskets, O-rings, etc.) associated with the test.

**8.3.3.2**Replace first sentence with

The following requirements of a) through j) shall be met while the pump is operating on the test stand and before the performance test is performed.

Replace item b) with

b) Substitute seals may be used during the performance test if needed to prevent damage to the contract seals or if the contract seals are not compatible with the test liquid. See subclause 10.3.6 of ANSI/API Std 682:2014. Shop buffer or barrier liquid systems may be used during bare-shaft pump performance test.

Replace item c) first paragraph first sentence with

Containment seal and quench drains shall be left open or unplugged during the performance test. The seal (or seals) shall not have a leakage rate during any phase of the pump performance test that is in excess of that specified in subclause A.1.3 of ANSI/API Std 682:2014, or as otherwise agreed by the vendor and the purchaser.

Replace item c) second paragraph second sentence with

Subclause A.1.3 of ANSI/API Std 682:2014, should be reviewed to confirm that a zero-visible-leakage criterion is appropriate for the seals being tested.

Delete NOTE from item c)Replace item d) with

d) If leakage during test is over limit specified in the test procedure, the assembled pump and seal shall be re-tested to demonstrate satisfactory seal performance.

Add to list

j) Pumps specified for oil mist lubrication shall have running tests performed whilst using the vendor's oil mist supply system.

**8.3.3.3**Replace item a) with

a) The vendor shall record test data, including head, flowrate, power and vibration at a minimum of six points:

- 1) shut off (vibration for information only);
- 2) minimum continuous stable flow (beginning of allowable operating region);
- 3) midway between minimum continuous flow and rated flow;
- 4) within  $\pm 2\%$  of rated flow;
- 5) approximately the best efficiency flow (if rated flow is not within 5% of best efficiency flowrate); 6) end of allowable operating region.

Add to end of item b)

Pumps that are specified to operate in parallel shall:

- 1) have the same shut off head (within a tolerance of  $\pm 3\%$ ), which shall be confirmed at the performance



test;

2) between 80 % and 110 % of best efficiency point, the tested head of the second pump shall be less than 101,5 % and greater than 98,5 % of the tested head of the first pump at the same flow. This does not allow the second pump to be outside the contractual performance limits.

Replace item e) with

e) In addition to formal submittal of final data in accordance with 10.3.2.2 of ANSI/API Std 610, curves and test data (corrected for speed, specific gravity, clearances and viscosity) shall be submitted within 24 h after completion of performance testing for the purchaser's review and acceptance prior to shipment.

**8.3.3.5**

Replace item b) with

b) If applicable, the bearing temperatures and bearing oil temperatures shall be measured and recorded throughout the test. Where supplied, the contract resistance temperature detectors shall be used during the test.

**8.3.3.6**

Replace subclause with

If specified, the performance test shall be conducted with:

- a) test stand NPSHA controlled to no more than 110 % of the NPSHA specified on the data sheet;
- b) vertical submerged pumps operated at minimum submergence.

NOTE It is the purpose of this test to evaluate pump performance with the specified NPSHA at pump suction.

**8.3.3.7**

Add to item a)

The impeller(s) shall not be modified after the performance test to correct hydraulic performance by under filing, over filing, V-cutting or any other such technique, unless approved by the purchaser. If approved, the vendor shall submit a drawing showing the details of the modification.

Replace item b) with

b) If specified, disassembly of multistage pumps for any head adjustment (including less than 5 % diameter change) after test shall require the rotor to be rebalanced in accordance with this specification and shall be cause for retest.

**8.3.4 Optional tests**

**8.3.4.2 Mechanical run test**

**8.3.4.2.1**

Replace subclause with

After oil temperature stabilisation (subclause 6.10.2.4 of ANSI/API Std 610), the pump shall be run on the test stand at the rated flow for 2 hours. Oil temperature stabilisation is achieved when the rise is not greater than 1 °C (2 °F) over a 10 minute period.

**8.3.4.2.2**

Replace subclause with

During the mechanical run test, pump flow rates, pressures, power, speed, filtered and unfiltered vibration, lube oil flow, temperature, and pressure and bearing temperature, shall be recorded at intervals of 15 minutes or less during the first hour of testing, and at 30 minute intervals thereafter for the rest of the test



duration. The parameters measured shall conform to the requirements specified by the purchaser for the performance test.

### 8.3.4.3 NPSH required test

#### 8.3.4.3.1

Replace subclause with

If specified, NPSH3 or submergence test (vertical submerged type pumps) shall be determined at each test point identified in 8.3.3.3 a), except shut-off. Refer to the data sheet for the type of NPSH3 test required and the acceptance criteria.

#### 8.3.4.3.3

Replace seventh sentence with

These NPSH3 curves shall be developed and submitted in accordance with hydraulic institute standards ANSI/HI 14.6 or ISO 9906, as specified.

## 8.4 Preparation for shipment

### 8.4.2.1

Replace first sentence with

Axial movement of rotors with no thrust bearings shall be blocked. Axial and radial movement of rotors with hydrodynamic bearings shall be blocked.

### 8.4.2.4

Replace first sentence with

Refer to the data sheet for the applicable painting specification. If the vendor's standard is acceptable to purchaser, then exterior surfaces, except for machined surfaces, shall be given at least one coat of the vendor's standard paint. The vendor shall submit to the purchaser the detailed painting procedure. 8.4.2.7

Add to subclause

Threaded openings which are normally plugged during service shall be fitted with stainless steel plugs in accordance with ASME B16.11.

## 9 Specific pump types

### 9.1 Single-stage overhung pumps

#### 9.1.3 Integral gear-driven (type OH6) pumps

##### 9.1.3.7

Replace first sentence with

Inducers, impellers and similar major rotating components shall be dynamically balanced to ISO 21940-11, grade G2.5, or to a residual unbalance of 7 g·mm (0,01 oz·in), whichever is greater.

### 9.2 Between-bearings pumps (types BB1, BB2, BB3 and BB5)

#### 9.2.1 Pressure casings

##### 9.2.1.2

Replace subclause with

Pumps for service temperatures below 120 °C (248 °F) may be foot-mounted.

#### 9.2.4 Dynamics

##### 9.2.4.2 Rotor balancing

**9.2.4.2.2**

Replace second paragraph first sentence with

Table 19 of ANSI/API Std 610 shows ISO 21940-11, grade G2.5 for all interference fit rotors to speeds of 3 800 r/min.

**9.2.5 Bearings and bearing housings**

Add new subclause

**9.2.5.5**

On multi-stage pumps, bearing housings shall be doweled after verification of stuffing box runout.

**9.2.6 Lubrication****9.2.6.4**

Replace subclause with

Pressure-lubrication systems shall be as specified on the data sheet.

**9.2.7 Testing****9.2.7.5**

Replace subclause with

Hydrodynamic bearings shall be removed, inspected by the purchaser or the purchaser's representative, and reassembled after the performance test is completed.

**9.3 Vertically suspended pumps (types VS1 through VS7)****9.3.3 Rotors****9.3.3.2**

Add to subclause

The shaft of vertical pumps shall be 25 mm (1 in) in diameter (minimum). Shaft length shall not exceed 6 000 mm (236 in).

**9.3.5 Dynamics**

Replace subclause with

The vendor is not required to furnish a dynamic analysis of the pump and its support structure to confirm acceptability of the design.

**9.3.6 Bushings and bearings****9.3.6.1**

Add to subclause

If specified that VS pumps shall operate for short periods with no lubrication (dry column during start up) or shall be subject to periods of standby, the bushings shall not shrink or swell.

**9.3.8 Accessories****9.3.8.3 Mounting plates****9.3.8.3.1**

Add to subclause after first sentence

This mounting plate shall be continuously welded to the can (outer casing) on both sides and machined on its bottom surface to align with the sole plate. No shims shall be used between the bottom of the mounting



plate and the top of the sole plate.

#### 9.3.8.3.2

Replace subclause with

A minimum of four alignment-position screws shall be provided for each drive-train component that has a mass greater than 100 kg (225 lb) to facilitate horizontal adjustment.

#### 9.3.8.3.3

Replace subclause with

Pumps shall be provided with a separate sole plate for bolting and grouting to the foundation (see Figure 38 of ANSI/API Std 610). The bottom of the sole plate shall be blasted and prepared for epoxy grout. This plate shall be machined on its top surface for mounting of the discharge head, can or motor support and shall have four levelling screws, one adjacent to each holding down bolt hole.

### 9.3.9 Testing

#### 9.3.9.1

Replace subclause with

Pumps shall be tested as complete assemblies unless otherwise agreed by the purchaser and subsequently specified on the data sheet. Any length of vertical pump tested shall include at least two lineshaft bearings. Suction cans, if supplied, are not required for performance testing.

### 9.3.13 Double-casing diffuser (VS6) and volute (VS7) pumps

#### 9.3.13.3

Replace subclause with

Complete outer-case venting shall be ensured by means of a DN25 (NPS 1) minimum flanged high-point vent connection.

#### 9.3.13.4

Replace subclause with

Complete venting of the inner assembly within the seal chamber or associated auxiliary process piping shall be ensured by means of a DN15 (NPS 1/2) minimum flanged high-point vent connection.

#### 9.3.13.5

Replace subclause with

The suction can shall be supplied with an internal drain piped to the surface and terminating with a DN 25 (NPS 1) minimum flanged connection. The internal drain pipe shall be affixed to bowl assembly and column bolting to avoid vibration. The internal drain pipe shall have means for removal from the underside of the discharge head.

Add new subclause

#### 9.3.13.7

Bowls shall be flanged and shall have metal-to-metal rabbeted fits.

## 10 Vendor's data

### 10.2 Proposals

#### 10.2.3 Technical data

Replace item I) with



l) a list of similar machines installed and operating under similar conditions;

Replace item n) with

n) calculated specific speed and suction-specific speed;

Add to list

q) test procedure for vertical pumps that cannot be tested completely assembled.

### 10.2.5 Options

Replace subclause with

The vendor shall furnish an outline of the procedures used for each of the special or optional tests that have been specified by the purchaser or proposed by the vendor.

### 10.3 Contract data

#### 10.3.2 Drawings and technical data

##### 10.3.2.2

Replace first sentence with

Certified test curves and data (see example in Annex M) and valid calibration certificates for all test instrumentation shall be submitted after testing in accordance with the IRS and shall include head, power recalculated to the proper specific gravity and efficiency plotted against flowrate.

#### 10.3.4 Parts lists and recommended spares

Add new subclause

##### 10.3.4.3

For antifriction bearings, the spare parts list shall include full bearing designation number with appropriate suffixes that clearly indicate bearing type, size, cage type, and the selected internal clearance or pre-load.

#### 10.3.5 Data manuals

Add new sub-clause

##### 10.3.5.4 Manufacturing record book

A manual containing all manufacturing records, personnel qualifications, certification and inspection and test reports. As a minimum, the manufacturing record book shall include all as built and verifying documentation detailed in the inspection and test plan.

## ANNEX L

(INFORMATIVE)

### VENDOR DRAWING AND DATA REQUIREMENTS

#### L.1 General

Replace sub-clause and Figure L.1 with

Refer to S-615L for proposal and contract document requirements. The document content requirements are given in S-615L and ANSI/API Std 610 6.9.2.10, 8.3, 10.2, 10.3, L.2, I.1.4 and I.3 as amended by S-615L.



**PETROBRAS**

**TECHNICAL SPECIFICATION**

Nº

I-ET-3010.1M-1200-310-P4X-001

REV.

B

BÚZIOS

SHEET

39

of

54

TITLE:

**API 610 CENTRIFUGAL PUMPS SPECIFICATION**

**NP-1**

**ESUP**



<b>TECHNICAL SPECIFICATION</b>	Nº	I-ET-3010.1M-1200-310-P4X-001	REV.	B
BÚZIOS			SHEET	40 of 54
TITLE:			<b>NP-1</b>	
<b>API 610 CENTRIFUGAL PUMPS SPECIFICATION</b>			<b>ESUP</b>	

## SECTION III - IOGP S-617Q QUALITY REQUIREMENTS

### 1 SCOPE

1.1 To specify quality management requirements for the supply of centrifugal pumps to IOGP S-615 Supplementary Specification to ANSI/API Standard 610 Centrifugal Pumps including:

- a) vendor quality management system requirements;
- b) purchaser conformity assessment (surveillance and inspection) activities;
- c) traceability requirements;
- d) evidence of conformity.

### 2 NORMATIVE REFERENCES

For the purpose of this document, the documents referenced in IOGP S-615 and those listed below, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9001:2015 Quality management systems - Requirements

API Specification Q1 Specification for Quality Management System Requirements for Manufacturing Organisations for the Petroleum and Natural Gas Industry

ANSI/API Std 610 11<sup>th</sup> Edition Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries

IOGP S-615 Supplementary Specification to ANSI/API Standard 610 Centrifugal Pumps

### 3 TERMS AND DEFINITIONS

For the purpose of this document, the terms and definitions given in ISO 9000:2015 (normative to ISO 9001:2015) and the following shall apply. To align with the definitions used in ANSI/API Std 610 the term “purchaser” is used in place of “customer” and the term “vendor” in place of “supplier”.

#### 3.1 Conformity assessment

Demonstration that requirements relating to a product, process, system, person or body are fulfilled.

NOTE 1 Conformity assessment (or assessment) includes but is not limited to review, inspection, verification and validation activities.

NOTE 2 Assessment activities may be undertaken at a vendor or sub-vendor's premises, virtually by video link, desktop sharing etc. or by review of information formally submitted for acceptance or for information.

#### 3.2 Conformity assessment system (CAS)

Systems providing different levels of assessment of the vendor's control activities by the purchaser (second party) or independent body (third party) based on evaluation of the vendor's capability to conform to the product or service specification and obligatory requirements. The applicable CAS level is specified by the purchaser in the data sheet.

NOTE CAS A reflects the highest risk and associated extent of verification. CAS D is the lowest.

#### 3.3 Conformity assessment – witness point (W)





<b>TECHNICAL SPECIFICATION</b>	Nº	I-ET-3010.1M-1200-310-P4X-001	REV.	B
BÚZIOS			SHEET	41 of 54
TITLE: <b>API 610 CENTRIFUGAL PUMPS SPECIFICATION</b>			<b>NP-1</b>	
			<b>ESUP</b>	

Inspection or test where the purchaser is notified of the timing of the inspection or test and a hold is placed on the inspection and test until the purchaser or purchaser's representative is in attendance (ANSI/API Std 610, 3.64)

### **3.4 Conformity assessment – observed (O)**

Inspection or test where the purchaser is notified of the timing of the inspection or test and it is performed as scheduled regardless of whether the purchaser or purchaser's representative is present (ANSI/API Std 610, 3.38).

### **3.5 Conformity assessment – surveillance (S)**

Observation, monitoring or review by the purchaser or purchaser's representative of an activity, operation, process, product or associated information.

### **3.6 Conformity assessment – review (R)**

Review of the vendor's information by the purchaser or purchaser's representative to determine conformity to requirements.

NOTE Information review requirements are managed on a surveillance basis, and as such do not impose schedule constraints, unless specified as hold points in Annex A, or as conditions specified in the associated IRS.

## **4 SYMBOLS AND ABBREVIATIONS**

For purposes of this document, the following abbreviation applies:

- CAS Conformity assessment system
- IRS Information requirements specification
- QRS Quality requirements specification (this document)

## **5 QUALITY REQUIREMENTS**

### **5.1 Quality management system**

The vendor shall demonstrate that the quality management arrangements established for the supply of products or services conform to ISO 9001, API Specification Q1 or equivalent quality management system standard agreed with the purchaser.

### **5.2 Conformance assessment**

5.2.1 Quality plans or inspection and test plans developed as outputs to operational planning and control for the products or services shall define the specific controls to be implemented by the vendor and when applicable, sub-vendors, to ensure conformity with the specified requirements.

5.2.2 Controls will address both internally and externally sourced processes, products and services

5.2.3 Quality plans and inspection and test plans shall include provisions for the purchaser CAS; see Annex A, as specified in the data sheet or purchase order.

5.2.4 Vendor performance in meeting the requirements will be routinely assessed during execution of the scope and where appropriate, corrective action requested and conformity assessment activities increased or decreased consistent with criticality and risk.

NOTE 1 For industrial well proven solutions CAS level D is specified unless risk assessment indicates that a more stringent CAS-level is required.



<b>TECHNICAL SPECIFICATION</b>	Nº I-ET-3010.1M-1200-310-P4X-001	REV. B
BÚZIOS		SHEET 42 of 54
TITLE: <b>API 610 CENTRIFUGAL PUMPS SPECIFICATION</b>		<b>NP-1</b>
		<b>ESUP</b>

NOTE 2 Irrespective of the CAS level defined by the purchaser, either, by reference to standard and specification requirements or in the scope, the vendor remains responsible for operational planning and control and demonstration of the conformity of products and services with the requirements (see ISO 9001, 8.1, 8.2).

## 6 TRACEABILITY

Material certification and traceability shall be provided in accordance with Annex B.

## 7 CONTROL OF NONCONFORMING PRODUCTS AND SERVICES

Nonconformance with specified requirements identified by or to the vendor prior to or during the delivery of the products and services shall be corrected such that the specified requirements are satisfied or the purchaser's acceptance of the nonconformance agreed in accordance with purchase order conditions. See ISO 9001, 8.2.3, 8.2.4, 8.5.6, 8.7

## 8 EVIDENCE (RECORDS)

Plans, procedures, methods, resultant records shall be provided in accordance with the associated IRS.



<b>TECHNICAL SPECIFICATION</b> Nº I-ET-3010.1M-1200-310-P4X-001 REV. B	BÚZIOS			SHEET 43 of 54
	TITLE: <b>API 610 CENTRIFUGAL PUMPS SPECIFICATION</b>			NP-1
				ESUP

## ANNEX A PURCHASER CONFORMITY ASSESSMENT REQUIREMENTS

This annex defines four conformity assessment systems (CAS) or levels of purchaser assessment.

The vendor shall provide for the specified CAS when developing quality plans and inspection and test plans in accordance with Clause 5.

	PURCHASER ASSESSMENT ACTIVITIES	CAS			
		A	B	C	D
<b>1</b>	<b>Planning and Control Activities</b>				
1.1	Quality plan (ISO 9001, 8.1 and ISO 10005)	R	R	R	
1.2	Inspection and test plan ( ISO 9001, 8.1 and ISO 10005)	R	R	R	R
1.3	Kick-off, pre-production and pre-inspection meeting	W	O		
<b>2</b>	<b>Design and Development Activities</b>				
2.1	Design verification review as required (ISO 9001, 8.3). Review that manufacture is against accepted revision of documents.	R	R	R	
2.2	Weld procedure specification and procedure qualification records (ANSI/API Std 610, Table 11) or as specified in IOGP S-615D	R	R	R	
2.3	Non-destructive examination procedures (ASME BPVC V, Non-destructive examination and ANSI/API Std 610, Table 15) or as specified in IOGP S-615D	R	R	R	
2.4	Raw materials used in the construction of pump parts comply with requirements of (ANSI/API Std 610, Annex H) or as specified in IOGP S-615D	R	R	R	
<b>3</b>	<b>Control of External Supply</b>				
3.1	External supply scope, risk assessment and controls (ISO 9001, 8.4)	R	R	R	
<b>4</b>	<b>Materials and Component Manufacturing</b>				
4.1	Material certification and traceability (ANSI/API Std 610, 6.12.1.8, 6.12.4.3 and 8.2.2.7, Tables H.2 and H.4 and IOGP S-615, 6.12.1.8 and 8.2.2.7 when specified in IOGP S-615D)	S	R	R	R
4.2	Surfaces of castings (ANSI/API Std 610, 6.12.2.1)	O	S		
4.3	Compliance of welding materials (ASME BPVC.II Part C)	S	S		
4.4	Fabrication				
4.4.1	Baseplate manufacture (ANSI/API 610, 7.3 and IOGP S-615, 7.3) flatness and coplanarity of baseplate equipment mounting pads	O	S	R	
4.5	Inspection, testing and verification activities (ANSI/API Std 610, 8.2 and 8.3 and IOGP S-615, 8.2 and 8.3)				
4.5.1	All welders have been qualified on approved welding procedures (ANSI/API Std 610, Table 11) or as specified in IOGP S-615D	R	R	R	
4.5.2	Weld repair procedure (excluding major weld repairs) (ANSI/API Std 610, 6.12.2 and IOGP S-615, 6.12.2)	R	R	R	R
4.5.3	Weld repair procedure (major) maps and other specified documentation (ANSI/API Std 610, 6.12.2.5 and IOGP S-615, 6.12.2.5) if specified in IOGP S-615D	W	W	R	R
4.5.4	Inspection of major weld repairs (ANSI/API Std 610, 6.12.2.3 and IOGP S-615, 6.12.2.3, 6.12.2.5)	O	O	S	R



**TECHNICAL SPECIFICATION**

Nº I-ET-3010.1M-1200-310-P4X-001

REV. B

BÚZIOS

SHEET 44 of 54

TITLE:

**API 610 CENTRIFUGAL PUMPS SPECIFICATION**

NP-1

ESUP

	PURCHASER ASSESSMENT ACTIVITIES	CAS			
		A	B	C	D
4.5.5	Non-destructive examination personnel performing non-destructive examinations are qualified and certified in accordance with the requirements of Article 1, Section V of ASME BPVC	R	R	R	
4.5.6	Pressure casing inspection including all welds associated with the casing (ANSI/API Std 610 Table 14 and IOGP S-615, Table 14) or as specified in IOGP S-615D. Inspection timing (ANSI/API Std 610, 8.2.2.3)	O	S	R	
4.6	Non-destructive examinations of component parts (ANSI/API Std 610, 6.12.1.5 and 8.2.1.3) if specified in IOGP S-615D	O	R	R	
4.7	Positive material identification ( ANSI/API Std 610, 8.2.2.8 and IOGP S-615, 8.2.2.8) and other parts specified in IOGP S-615D	O	S	R	
4.8	Verify that the heat treatments, including PWHT, have been performed (ANSI/API Std 610, Table 11) or as specified in IOGP S-615D	R	R	R	
4.9	Shaft and rotors (ANSI/API Std 610, 6.6, 9.3.3.1 and 9.3.12.2 d, Tables 17 and 19)	O	O	R	
4.10	Rotating component balancing (ANSI/API Std 610, 6.9.4, 9.1.3.7 and 9.2.4 and IOGP S-615, 6.9.4, 9.1.3.7 and 9.2.4) or as specified in IOGP S-615D	R	R		
4.11	Wear rings and running clearance verification (ANSI/API Std 610, Table 6 and IOGP S-615, 6.7.4)	R	R	R	
4.12	Cleanliness check prior to final assembly (ANSI/API Std 610, 8.2.2.6) if specified in IOGP S-615D	O	S	S	
4.13	Inspection and test equipment calibration certificates	R	R	R	
4.14	Hydrostatic testing activities (ANSI/API Std 610, 8.3.2 and IOGP S-615, 8.3.2)	W	W	O	R
4.15	Performance testing (ANSI/API Std 610, 8.3.3 and IOGP S-615, 8.3.3) or as specified in IOGP S-615D	W	W	O	R
4.16	NPSH or submergence testing (ANSI/API Std 610, 8.3.4.3 and IOGP S-615, 8.3.4.3) if specified in IOGP S-615D	W	O	O	R
4.17	Mechanical run testing (ANSI/API Std 610, 8.3.4.2 and IOGP S-615, 8.3.4.2)	W	O	O	R
4.18	Sound level testing (ANSI/API Std 610, 8.3.4.5) if specified in IOGP S-615D	W	O	S	R
4.19	Complete unit testing (ANSI/API Std 610, 8.3.4.4) if specified in IOGP S-615D	W	W	O	R
4.20	Auxiliary equipment testing (ANSI/API Std 610, 8.3.4.6) if and as specified in IOGP S 615D	O	S	R	R
4.21	Bearing housing resonance test (ANSI/API Std 610, 8.3.4.7) if specified in IOGP S-615D	W	O	R	R
4.22	Structural resonance test (ANSI/API Std 610, 9.3.9.2) if specified in IOGP S-615D	W	O	R	R
4.23	Disassembly after testing (ANSI/API Std 610, 8.3.3.8) if specified in IOGP S-615D	W	O	S	R
4.24	Hydrodynamic bearing inspection after testing (ANSI/API Std 610, 9.2.7.5 and IOGP S-615, 9.2.7.5)	W	O	S	
4.25	Surface preparation and painting (ANSI/API Std 610, 6.12.2.1, 7.3.12, 8.4.2.4 and IOGP S-615, 6.1.37.3, 8.4.2.4, 9.3.8.3.3) or as specified in IOGP S-615D	W	O	R	



TITLE:

**API 610 CENTRIFUGAL PUMPS SPECIFICATION**

NP-1

ESUP

	PURCHASER ASSESSMENT ACTIVITIES	CAS			
		A	B	C	D
<b>5</b>	<b>Release of Product or Service</b>				
	Verify conformity to PO including as applicable				
5.1	Final Inspection				
5.1.1	Complete skid overall dimensions including holding down bolt hole and connection locations	W	W	O	O
5.1.2	Couplings and guards (ANSI/API Std 610, 9.3.8.2.1, 7.2.1.3 and 7.2.3 and IOGP S-615, 7.2.3)	W	W	O	O
5.1.3	Pump nameplate and rotation arrows (ANSI/API Std 610, 6.13 and IOGPS-615, 6.13)	W	W	O	O
5.2	Loose ship items, spares and special tools as applicable	W	W	O	O
5.3	Nozzle force and moments testing (ANSI/API Std 610, 7.3.21 ) if specified in IOGP S-615D	W	O	R	R
5.4	Preparation of preservation, packing and storage (ANSI/API Std 610, 8.4 and IOGP S-615, 8.4.2) or as specified IOGP S-615D	W	O	S	
5.5	Final documentation review as per IOGP S-615L	R	R	R	R
5.6	Inspection release note	W	W	W	W
	W is witness point, O is observed point, S is surveillance and R is review of documentation. Definitions are provided in Clause 3.				



TITLE:

**API 610 CENTRIFUGAL PUMPS SPECIFICATION**

NP-1

ESUP

**ANNEX B - MATERIAL TRACEABILITY AND CERTIFICATION REQUIREMENTS**

Item		Certificate Type	Material Traceability level	Additional Requirements
Centrifugal Pump	Metallic Components ANSI/API Std 610, Annex H or as specified in IOGP S-615D	3.1	Level II	NACE MR0175 (all parts) or NACE MR0103 if and as specified in IOGP S-615D. Refer to IOGP S-615, 6.12.1.8
	Non Metallic Components ANSI/API Std 610 Annex H or as specified in IOGP S-615D	2.2	Level II	Type 3.2 Certification is applicable as per the Design Requirements

Material inspection certificates shall be provided in accordance with Table 1 of ISO 10474 or Table A.1 of EN 10204.

Explanatory notes:

- A. "2.2" Test Report - A document in which the vendor declares that the products supplied are in compliance with the requirements of the PO, and in which test results are supplied based on non-specific inspection and testing.
- B. "3.1" Inspection Certificate - A document with test results based on specific inspection and testing, issued by the vendor and validated by the vendor's authorised inspection representative independent of the manufacturing department.
- C. "3.2" Inspection Certificate - A document prepared by both the vendor's authorised inspection representative, independent of the manufacturing department, and either the purchaser nominated representative or the inspector designated by the regulations in which they declare that the products supplied are in compliance with the requirements of the order and for which test results are supplied.
- D. Additionally, purchaser has specified that all material product testing associated with "3.2" Inspection Certificates be performed in the presence of either a purchaser nominated representative or the inspector designated by the regulations, and the resultant test report stamped as "Witnessed". Failure to adhere to this requirement may lead to rejection of all material(s) being qualified for production.
- E. Level I - Full Traceability - Material is uniquely identified and its history tracked from manufacture through stockist (where applicable) to vendor and to actual position on the equipment with specific location defined on a material placement record. (The traceability to a specific location only applies to skids, packaged equipment, not to bulks)
- F. Level II - Type Traceability - vendor maintains a system to identify material throughout manufacture, with traceability to a material certificate.
- G. Level III - Compliance Traceability - vendor maintains a system of traceability that enables a Declaration of Compliance to be issued.



TITLE:

**API 610 CENTRIFUGAL PUMPS SPECIFICATION**

NP-1

ESUP

**SECTION IV - IOGP S-617L MODIFIED INFORMATION REQUIREMENTS FOR CENTRIFUGAL PUMPS**

**1 SCOPE**

To specify the information requirements for API 610 centrifugal pumps, detailing data documents and/ or models to be provided by the supplier.

**2 ABBREVIATIONS AND DEFINITIONS**

WAD Weeks after delivery

WAI Weeks after inspection

WAO Weeks after order

WAO (monthly) Weeks after order monthly

WAT Weeks after test

WPTD Weeks prior to delivery

WPTF Weeks prior to fabrication

WPTT Weeks prior to test

**3 LIST OF DOCUMENTS**

Item	Description	With Proposal	First issue Post Purchase Order			Requirement as built
		Document	Purpose	Weeks	Period	
<b>Contract Management Information Deliverables</b>						
MD#01	Supplier master information schedule	No	For Acceptance	2	WAO	Yes
MD#02	Delivery schedule	Yes	For Information	4	WAO	No
MD#03	Progress report	No	For Information		WAO (Monthly)	No
MD#04	Quality plan	Yes	For information	10	WAO	No
MD#06	Sub-vendor delivery schedule	Yes	For Information	6	WAO (Monthly)	No
MD#07	Inspection and test plan for complete package	No	For Acceptance	4	WAO	No
MD#08	Handling, shipping, storage and preservation procedure	No	For Information	6	WPTD	No
MD#09	Non-conformance records	No	For Acceptance		WAO (Monthly)	Yes
MD#10	Concession requests	No	For Acceptance	2	WAO	Yes
PB#01	Reference list of similar installations	Yes	For Information			
PB#02	Interface and connection schedule	No	For Information		WAO (Monthly)	No
<b>Technical Information Deliverables</b>						
API 610#01	Pump performance curves	Yes	For Acceptance	4	WAO	Yes
API 610#02	Noise data sheets	Yes	For Information	10	WAO	Yes
API 610#03	Installation, operation and maintenance instructions index	No	For Information	10	WAO	No



**PETROBRAS**

**TECHNICAL SPECIFICATION**

Nº I-ET-3010.1M-1200-310-P4X-001

REV. B

BÚZIOS

SHEET 48 of 54

TITLE:

**API 610 CENTRIFUGAL PUMPS SPECIFICATION**

NP-1

ESUP

API 610#04	Installation, operation and maintenance instructions	No	For Information	6	WPTD	No
API 610#05	Shaft and rotor total indicator (TIR) reading certificates	No	For Information	4	WAT	Yes
API 610#06	Wear part running clearance certificates	No	For Information	4	WAT	Yes
API 610#07	Torsional critical speed analysis	No	For Acceptance	2	WAO	No
API 610#08	Performance test data	No	For Acceptance	2	WAT	No
API 610#09	Rotating component balancing certificates	No	For Information	4	WPTD	Yes
API 610#10	Non-destructive examination records	No	For Information	4	WAT	Yes
API 610#11	Material certificates	No	For Acceptance	2	WPTF	Yes
API 610#12	Weld procedures, procedure qualification records and weld maps	No	For Information	10	WAO	No
API 610#13	Surface preparation and painting inspection certificates		For Information	4	WAT	Yes
API 610#14	Major weld repair certificates	No	For Acceptance	2	WAT	Yes
API 610#15	Welders qualifications	No	For Information	10	WAO	No
API 610#16	Heat treatment certificates	No	For Information	4	WAT	Yes
API 610#17	Nameplate Drawing	No	For Acceptance	6	WPTD	No
API 610#18	Baseplate flatness and coplanarity certificates	No	For Information	4	WAT	Yes
API 610#19	Nozzle forces and moments testing certificates	No	For Acceptance	2	WAT	Yes
API 610#20	Special tools list	Yes	For Information	10	WAO	No
API 610#21	Positive material identification certificates	No	For Information	4	WAT	Yes
API 610#22	Performance and mechanical run test procedures	Yes	For Information	6	WPTT	No
API 610#23	Optional test procedures	Yes	For Information	6	WPTT	No
API 610#24	Certified hydrostatic test data	No	For Acceptance	2	WAT	No
API 610#25	Disassembly after testing certificates	No	For Acceptance	2	WAT	Yes
API 610#26	Optional test data and reports	No	For Acceptance	2	WAT	No
API 610#27	Structural resonance test certificates	No	For Acceptance	6	WAT	Yes
API 610#28	Certified dimensional outline drawings	Yes	For Acceptance	4	WAO	Yes
PB#03	Piping termination (tie-ins)	No	For Acceptance	4	WAO	Yes
PB#04	Foundation loading diagram and support details	Yes	For information	4	WAO	Yes
PB#05	Structural steel calculations	No	For Acceptance	4	WAO	No
API 610#29	Cross-sectional drawings and bills of materials	Yes	For Information	2	WAO	Yes
API 610#30	Overall package piping and instrument diagram	Yes	For Acceptance	4	WAO	Yes
API 610#31	Data sheets	Yes	For Acceptance	4	WAO	Yes
PB#06	Pre-commissioning / commissioning procedure	No	For Acceptance	10	WAO	No
API 610#32	Recommended installation, commissioning and start-up spares list	Yes	For Information	6	WPTD	Yes
PB#07	Recommended two years operating spares list	No	For Information	6	WAO	No
API 610#33	Utility requirements	Yes	For Acceptance	2	WAO	No
API 610#34	Lubrication schedule	No	For Information	10	WAO	No
API 610#35	Inspection and test equipment calibration certificates	No	For Information	10	WAT	No
API 610#36	Lateral critical speed analysis	No	For Acceptance	2	WAO	No
API 610#37	Damped unbalanced response analysis	No	For Acceptance	2	WAO	No




**TECHNICAL SPECIFICATION**

Nº

I-ET-3010.1M-1200-310-P4X-001

REV.

B

BÚZIOS

SHEET

49

of

54

TITLE:

**API 610 CENTRIFUGAL PUMPS SPECIFICATION**
**NP-1**
**ESUP**

API 610#38	Material safety data sheets	Yes	For Information	10	WAO	No
API 610#39	Electrical, piping and instrumentation wiring diagrams	No	For Acceptance	4	WAO	Yes
API 610#40	Motor performance data	No	For Acceptance	4	WAO	No
PB#08	Electrical equipment schedule in hazardous area	No	For Information	4	WAO	No
PB#09	Cause and effect charts	No	For Acceptance	8	WAO	No
PB#10	Instrumentation / electrical logic diagram	No	For Acceptance	4	WAO	No
PB#11	Grounding connections drawings	No	For Acceptance	8	WAO	No
API 610#41	Shaft coupling assembly drawing and bill of materials	No	For Acceptance	2	WAO	Yes
API 610#42	Shaft seal drawing and bills of materials	Yes	For Acceptance	2	WAO	Yes
API 610#43	Overall package piping systems schematics and bills of materials	No	For Acceptance	2	WAO	Yes
API 610#44	Pump speed-torque curve superimposed on motor driver speed-torque curves	No	For Acceptance	4	WAO	No
S-615#01	Warm-up (or Cool-down) procedure	No	For Information	4	WAO	No
S-615#02	Instrument data Sheets	No	For Acceptance	8	WAO	Yes
S-615#03	Instrument list	No	For Information	8	WAO	No
S-615#04	Non-destructive examination procedures	No	For Acceptance	10	WAO	No
S-615#05	Non-destructive examination operators qualifications	No	For Information	10	WAO	No
S-615#06	Certified hydrostatic test procedure	No	For Information	6	WPTT	No
S-615#07	Impeller as-built drawing	No	For Information	4	WAT	Yes
S-615#08	Painting procedure	Yes	For Information	6	WPTD	No
S-615#09	Manufacturing record book index	No	For Acceptance	10	WAO	No
S-615#10	Manufacturing record book	No	For Acceptance	4	WPTD	Yes
S-615#11	Declaration of conformity	No	For Acceptance	6	WPTD	No

## SECTION V - PUMPS SPECIFIC REQUIREMENTS

### 1 SCOPE

1.1 The scope includes the following pumps:

TAG	IDENTIFICATION
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

### 2 GENERAL REQUIREMENTS

#### 2.1 General Specifications For Vertical Pumps

- 2.1.1 Coupling and impellers fixing device shall allow reverse direction, without damage to main equipment.
- 2.1.2 Unless required per API 610, radial and thrust bearing shall be roller type.
- 2.1.3 Main exportation oil pumps shall be BB3 or BB5 type as per API 610.
- 2.1.4 Main exportation oil pumps velocity shall not exceed 3600 rpm in any case.

#### 2.2 Material

- 2.2.1 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 H<sub>2</sub>S partial pressure.
- 2.2.2 All pumps shall be in accordance with table H1 of API 610.
- 2.2.3 Booster and Main Injection Water Pumps for sea water service shall apply class material D2 of API-610, table H.1
- 2.2.4 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.
- 2.2.5 Materials for sea water lift pumps shall be in accordance with table H1 of API 610, D2 class or Br-Al-Ni alloy.



TITLE:

**API 610 CENTRIFUGAL PUMPS SPECIFICATION**

NP-1

ESUP

## 2.3 Monitoring

2.3.1 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
- 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.

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

2.3.3 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.

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

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

2.3.6 All bearings shall be supplied with individual temperature elements .Temperature indicators located in common housing sumps or common drain lines are not acceptable.

2.3.7 Bearing surfaces shall be prepared for accelerometer installation or proximity probes including respectably radial and axial probes.

## 2.4 String test

2.4.1 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.



TITLE:

**API 610 CENTRIFUGAL PUMPS SPECIFICATION**

NP-1

ESUP

### 3 MAIN INJECTION WATER PUMP

#### 3.1 Scope

3.1.1 The scope includes the following pumps:

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

3.1.2 The Scope of Supply of the packages shall include, but not necessarily be limited to the following items. Main Injection Water Pump Packages, each one comprising to in addition to item 3 of section I:

- Multistage Barrel type (BB5) Centrifugal Pump or High Speed Pump;
- 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);
- Unit Control Panels (PN-B-1251002A/C – Main Injection Water Pump Control Panel);

#### 3.2 General Requirements

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

3.2.2 All pumps shall feature a minimum flow valve.

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

3.2.4 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.

3.2.5 Vertical booster pumps are not allowed.

3.2.6 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.

3.2.7 The materials of construction shall be such that all wetted parts shall be suitable for continuous or intermittent seawater service and produced water (ISO 15156 requirement), according to specification on technical data sheet.

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

3.2.9 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.

3.2.10 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.

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

#### 3.3 Lube Oil System

3.3.1 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

3.3.2 Except as stated below, the system shall be in full compliance with API 614.

3.3.3 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.

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

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

3.3.6 The preference for oil coolers is type plate heat exchanger skid mounted. If a shell and tube type heat exchanger is used BIDDERS approval is required.

3.3.7 If specified 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.

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

3.3.9 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 BIDDERS.

## 4 SEA WATER LIFT PUMP

### 4.1 Scope

4.1.1 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

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

- Submerged Centrifugal Pump/Motor with anodes;
- Design of anodic protection.
- Flanged riser pipes with internal & external anodes, centralizers and coating;
- Centralizers for pump and pipe stack;
- 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;
- Lubrication system;

### 4.2 General Requirements

4.2.1 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.

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

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

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

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



equipment.

4.2.6 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.

4.2.7 Speed shall not exceed 1800 RPM.

4.2.8 Radial and thrust bearing shall be roller type.

4.2.9 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.

4.2.10 Suitable instrumentation shall provide an alarm in the event of either seawater ingress or loss of motor cooling fluid.

### **4.3 Circulation System**

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

4.3.2 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.

4.3.3 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.

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

### **4.4 Couplings**

4.4.1 Couplings shall be furnished in accordance with API Standard 671.

## **5 OIL TRANSFER PUMPS**

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

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

5.3 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.

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

5.5 The NPSH available shall be calculated considering transient pressure variations at V-TO-1223002 in order to avoid vaporization at pump suction.

5.6 NPSH test shall be performed at manufacturer.