	<b>TECHNICAL SPECIFICATION</b>		Nr: <b>I-ET-3010.1Y-1350-311-P4X-001</b>		
	CLIENT: BÚZIOS			SHEET: 1 of 35	
	JOB : HIGH CAPACITY FPSO				
	AREA: BÚZIOS				
<b>SRGE</b>	TITLE: <b>CARGO AREA SUBMERGED PUMPS</b>			INTERNAL	
				ESUP	

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### INDEX OF REVISIONS

R E V .	DESCRIPTION AND/OR REVISED SHEETS
0	ORIGINAL ISSUE
A	REVISED WHERE INDICATED

	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE	JAN/08/21	MAR/31/21							
PROJECT	ENG	ENG							
EXECUTION	CXZ0	CXZ0							
CHECK	CXW3	CXW3							
APPROVAL	CYEL	CYEL							

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THIS FORM IS PART OF PETROBRAS N-381 REV.J ANNEX A – FIGURE A.1.



	TECHNICAL SPECIFICATION	Nr: I-ET-3010.1Y-1350-311-P4X-001	REV. A
	BÚZIOS		SHEET: 2 of 35
	TITLE: CARGO AREA SUBMERGED PUMPS		INTERNAL

TABLE OF CONTENTS	PAGE
<b>1. INTRODUCTION .....</b>	<b>4</b>
1.1. OBJECTIVE .....	4
1.2. DEFINITIONS .....	5
1.3. ABBREVIATIONS .....	5
<b>2. NORMATIVE REFERENCES .....</b>	<b>5</b>
2.1. INTERNATIONAL CODES, RECOMMENDED PRACTICES AND STANDARDS .....	5
2.2. BRAZILIAN CODES AND STANDARDS .....	6
2.3. CLASS APPROVAL AND CERTIFICATION .....	6
<b>3. HIGH CAPACITY FPSO DESIGN REFERENCE DOCUMENTS .....</b>	<b>6</b>
<b>4. DESIGN REQUIREMENTS .....</b>	<b>10</b>
4.1. DESIGN CONDITIONS .....	10
4.2. SAFETY REQUIREMENTS .....	10
4.3. NOISE AND VIBRATIONS .....	10
4.4. MOTIONS AND ACCELERATION .....	10
<b>5. PACKAGE SCOPE OF SUPPLY .....</b>	<b>11</b>
5.1. CARGO AREA SUBMERGED PUMPS .....	11
5.2. PORTABLE HYDRAULIC SUBMERGED CARGO PUMP (B-5139502A/B) .....	13
5.3. BALLAST PUMP (FWD) (B-5335501A/B) AND BUTTERWORTH LIFT PUMP (B-5271502) .....	13
5.4. BUTTERWORTH BOOSTER PUMPS (B-5271503A/B) .....	14
5.5. HYDRAULIC POWER UNIT FOR SUBMERGED PUMPS (UH-5139502A/B) .....	15
5.6. HYDRAULIC POWER UNIT CONTROL PANEL (PN-UH-5139502A/B-01) .....	16
5.7. HYDRAULIC PIPING .....	16
5.8. EQUIPMENT LOCATION .....	17
<b>6. PACKAGE TECHNICAL SPECIFICATION .....</b>	<b>18</b>
6.1. GENERAL .....	18
6.2. CARGO AREA SUBMERGED PUMPS .....	19
6.3. CARGO AREA SUBMERGED PUMPS REMOVAL .....	21
6.4. PORTABLE HYDRAULIC SUBMERGED CARGO PUMP (B-5139502A/B) .....	21
6.5. BUTTERWORTH BOOSTER PUMPS (B-5271503A/B) .....	22
6.6. HYDRAULIC POWER UNITS FOR SUBMERGED PUMPS (UH-5139502A/B) .....	22
6.7. HYDRAULIC PIPING SYSTEM .....	23
6.8. ENGINEERING SERVICES .....	23

 <b>PETROBRAS</b>	<b>TECHNICAL SPECIFICATION</b>	Nr: <b>I-ET-3010.1Y-1350-311-P4X-001</b>	REV. <b>A</b>
	BÚZIOS		SHEET: 3 of 35
	TITLE: <b>CARGO AREA SUBMERGED PUMPS</b>		INTERNAL

6.9. LOCAL CONTROL PANEL (PN-UH5139502A/B-01) AND REMOTE WORKSTATION (PN-UH-5139502-03) .....	24
6.10. CARGO AREA SUBMERGED PUMPS DRIVEN BY ELECTRICAL MOTORS ON MAIN DECK – ALTERNATIVE .....	25
<b>7. GENERAL REQUIREMENTS.....</b>	<b>26</b>
7.1. ELECTRICAL REQUIREMENTS .....	26
7.2. INSTRUMENTATION AND AUTOMATION REQUIREMENTS .....	26
7.3. MACHINERY PROTECTION SYSTEM (MPS) .....	27
7.4. MACHINERY MONITORING SYSTEM (MMS).....	27
7.5. AVAILABLE ON BOARD .....	28
7.6. SKIDS LAYOUT AND FOUNDATION REQUIREMENTS .....	29
7.7. NAMEPLATES AND TAG NUMBERING .....	29
<b>8. PACKAGE MANUFACTURING .....</b>	<b>30</b>
8.1. GENERAL.....	30
8.2. QUALITY ASSURANCE AND CONTROL SYSTEM.....	30
8.3. WELDING AND NDT .....	30
8.4. INSPECTION AND TESTS.....	31
8.5. FACTORY ACCEPTANCE TEST (FAT) .....	32
8.6. PRE-COMMISSIONING AND COMMISSIONING .....	32
<b>9. PACKAGE DELIVERY REQUIREMENTS.....</b>	<b>33</b>
9.1. PRESERVATION, PACKING AND TRANSPORTATION .....	33
9.2. SPARE PARTS, CONSUMABLES AND TOOLS .....	34
9.3. DOCUMENTATION .....	34
9.4. TRAINING.....	35



**PETROBRAS**

**TECHNICAL SPECIFICATION**

Nr:

**I-ET-3010.1Y-1350-311-P4X-001**

REV.

**A**

BÚZIOS

SHEET: 4 of 35

TITLE:

**CARGO AREA SUBMERGED PUMPS**

INTERNAL

ESUP


## 1. INTRODUCTION

### 1.1. OBJECTIVE

The purpose of this technical specification is to describe the minimum requirements for the design, manufacturing, assembly, supply, installation, commissioning and tests of CARGO AREA SUBMERGED PUMPS) in conformance with relevant regulations and High Capacity FPSO design.

CARGO AREA SUBMERGED PUMPS PACKAGE is composed by the following equipment and the corresponding parts further detailed on this technical specification:

<b>Equipment</b>	<b>Description</b>
B-1350501A/T	Cargo pump
B-5331501A/D	Produced Water Tank Booster pump
B-5331502A/D	Produced Water Transfer pump
B-5336502A/D	Oil Skimming pump
B-5271501A/B	Slop pump
B-5336503A/B	Slop Discharge pump
B-1358501A/B	Slop Oil Skimming pump
B-1223501A/B	Off-spec Oil pump
B-5335501A/B	Ballast pumps (FWD)
B-5271502	Butterworth Lift pump
B-5271503A/B	Butterworth Booster Pump
B-5139502A/B	Portable Cargo Pump
UH-5139502A/B	Hydraulic Power Unit for Submerged pumps
UH-5139503A/B	Auxiliary Hydraulic Unit for Submerged pumps
UH-5139504	Hydraulic Oil Transfer unit for Submerged Pumps
Z-B-5335501A/B	Self Priming Unit for Ballast pumps (FWD)
PN-UH-5139502-01	Hydraulic Power Unit for Submerged Pumps - Control Panel

 <b>PETROBRAS</b>	<b>TECHNICAL SPECIFICATION</b>	Nr: <b>I-ET-3010.1Y-1350-311-P4X-001</b>	REV. <b>A</b>
	BÚZIOS		SHEET: 5 of 35
	TITLE: <b>CARGO AREA SUBMERGED PUMPS</b>		INTERNAL

PN-UH-5139502-02	Remote Control Valve Assembly
PN-UH-5139502-03	Hydraulic power unit for submerged pumps - workstation

Table 1 – general scope of the technical specification

## 1.2. DEFINITIONS

**PACKAGE:** An assembly of equipment supplied interconnected, tested and operating, requiring only the available utilities from the FPSO for full operation.

**PACKAGER:** manufacturer or vendor of the goods and/or services described in the Equipment/Material Specifications and designated as such in the contract or purchase order.

**OWNER:** PETROBRAS.

**CARGO AREA SUBMERGED PUMPS** the package name.

All other definitions are found on I-ET-3010.00-1200-940-P4X-002 – GENERAL TECHNICAL TERMS.

## 1.3. ABBREVIATIONS


CCR	Central Control Room
CS	Classification Society
FAT	Factory Acceptance Tests
FPSO	Floating Production Storage and Offloading Unit
HPU	Hydraulic Power Unit
NDT	Non-destructive Tests
SOS	Supervisory and Operational System
SOS-HMI	Human Machine Interface of SOS

## 2. NORMATIVE REFERENCES

### 2.1. INTERNATIONAL CODES, RECOMMENDED PRACTICES AND STANDARDS

**PACKAGE** equipment shall be designed and manufactured in accordance with the following codes and standards, if not mentioned otherwise.

- ANSI American National Standards Institute
- API American Petroleum Institute

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.1Y-1350-311-P4X-001	REV. A
	BÚZIOS		SHEET: 6 of 35
	TITLE: CARGO AREA SUBMERGED PUMPS		INTERNAL

- ASME American Society Of Mechanical Engineers
- BGV German Safety Regulations
- DIN German National Standard Code
- EN European Standards
- IMO – International Maritime Organization
- ISO International Standard Organization
- VDE / IEC German National Electric Standard Codes / International Electric Codes
- Classification Society defined for the Hull scope.

## 2.2. BRAZILIAN CODES AND STANDARDS

- NR – Brazilian Federal Government Regulatory Norms;
- NORMAM-01 – Normas da Autoridade Marítima para Embarcações Empregadas na Navegação em Mar Aberto;

## 2.3. CLASS APPROVAL AND CERTIFICATION

PACKAGE shall be designed, manufactured and tested according to the design reference documents, normative requirements and in accordance with the latest editions of Classification Society Rules, Regulations and Standards.

## 3. HIGH CAPACITY FPSO DESIGN REFERENCE DOCUMENTS

REF DOC NUMBER	REF DOC NAME
<b>GENERAL</b>	
I-DE-3010.1Y-1200-942-P4X-002	GENERAL ARRANGEMENT
I-DE-3010.1Y-5400-94A-P4X-001	AREA CLASSIFICATION – 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-RL-3010.1Y-1200-940-P4X-001	GENERAL SPECIFICATION FOR AVAILABLE UTILITIES
I-ET-3A36.00-1000-941-PPC-001	METOCEAN DATA
I-ET-3010.00-1200-940-P4X-002	GENERAL TECHNICAL TERMS



PETROBRAS

TECHNICAL SPECIFICATION

Nr: I-ET-3010.1Y-1350-311-P4X-001

REV. A

BÚZIOS

SHEET: 7 of 35

TITLE:

CARGO AREA SUBMERGED PUMPS

INTERNAL

ESUP

**CONSTRUCTION**

I-ET-3010.00-1200-955-P4X-001	WELDING
I-ET-3010.00-1000-970-P4X-002	REQUIREMENTS FOR NDT
I-ET-3010.00-1200-955-P4X-002	REQUIREMENTS FOR WELDING INSPECTION
I-ET-3010.00-0000-970-P4X-001	REQUIREMENTS FOR PROCEDURES AND PERSONNEL QUALIFICATION AND CERTIFICATION

**HULL SYSTEMS**

I-DE-3010.1Y-1350-944-P4X-003	CARGO SYSTEM
I-DE-3010.1Y-5120-944-P4X-001	ENGINE ROOM CENTRAL FRESH WATER COOLING SYSTEM
I-DE-3010.1Y-5139-944-P4X-001	HYDRAULIC SYSTEM FOR HYDRAULIC SUBMERGED PUMPS
I-DE-3010.1Y-5241-944-P4X-005	PURGING AND STRIPPING SYSTEM FOR SUBMERGED PUMPS PIPE STACKS
I-DE-3010.1Y-5271-944-P4X-001	TANKS CLEANING AND RECIRCULATION SYSTEM
I-DE-3010.1Y-5335-944-P4X-001	BALLAST SYSTEM (FWD)
I-DE-3010.1Y-5336-944-P4X-005	SLOP DISCHARGE SYSTEM
I-FD-3010.1Y-1350-311-P4X-001	CARGO PUMPS (B-1350501A/T)
I-FD-3010.1Y-1350-311-P4X-004	PORTABLE CARGO PUMPS (B-5139502A/B)
I-FD-3010.1Y-1350-311-P4X-005	BUTTERWORTH LIFT PUMP (B-5271502)
I-FD-3010.1Y-1350-311-P4X-006	BUTTERWORTH BOOSTER PUMP (B-5271503A/B)
I-FD-3010.1Y-1358-311-P4X-001	SLOP OIL SKIMMING PUMP (B-1358501A/B)



**PETROBRAS**

**TECHNICAL SPECIFICATION**

Nr:

**I-ET-3010.1Y-1350-311-P4X-001**

REV.

**A**

BÚZIOS

SHEET:

8

of

35

TITLE:

**CARGO AREA SUBMERGED PUMPS**

INTERNAL


ESUP

I-FD-3010.1Y-5271-311-P4X-001	SLOP PUMPS (B-5271501A/B)
I-FD-3010.1Y-5335-311-P4X-001	BALLAST PUMP (FWD) (B-5335501A/B)
I-FD-3010.1Y-5336-311-P4X-001	SLOP DISCHARGE PUMPS (B-5336503A/B)
I-MD-3010.1Y-1200-940-P4X-027	DESCRIPTIVE MEMORANDUM - HULL SYSTEMS
<b>NAVAL</b>	
I-DE-3010.1Y-1350-960-P4X-002	CAPACITIES PLAN
I-ET-3010.1Y-1350-960-P4X-002	DESIGN REQUIREMENTS - NAVAL ARCHITECTURE
I-RL-3010.1Y-1350-960-P4X-009	MOTION ANALYSIS
<b>MECHANICAL</b>	
I-ET-3010.00-1200-300-P4X-001	NOISE AND VIBRATION CONTROL REQUIREMENTS
<b>PAINTING</b>	
I-ET-3010.00-1200-956-P4X-002	GENERAL PAINTING
DR-ENGP-I-1.15	COLOR CODING
<b>SAFETY</b>	
I-ET-3010.00-5400-947-P4X-002	SAFETY SIGNALING
DR-ENGP-M-I-1.3	SAFETY ENGINEERING
<b>PIPING</b>	
I-ET-3010.1Y-1200-200-P4X-002	PIPING SPECIFICATION FOR HULL
I-ET-3010.00-1200-200-P4X-099	REQUIREMENTS FOR PIPING SUPPORTS
I-ET-3010.00-1200-251-P4X-001	REQUIREMENTS FOR BOLTING MATERIALS
<b>ELECTRICAL</b>	



I-DE-3010.00-5140-700-P4X-003	GROUNDING INSTALLATION TYPICAL DETAILS.
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
<b>INSTRUMENTATION AND AUTOMATION</b>	
I-ET-3010.00-1200-800-P4X-002	AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS
I-ET-3010.1Y-1200-800-P4X-014	AUTOMATION INTERFACE OF PACKAGE UNITS
I-ET-3010.00-1200-800-P4X-013	GENERAL CRITERIA FOR INSTRUMENTATION PROJECTS
I-ET-3010.00-5500-854-P4X-001	MACHINERY MONITORING SYSTEM
I-ET-3010.00-5520-888-P4X-001	AUTOMATION PANELS
<b>PROCESS</b>	
I-DE-3010.1Y-5331-944-P4X-005	PRODUCED WATER TANK "A"
I-DE-3010.1Y-5331-944-P4X-006	PRODUCED WATER TANK "B"
I-DE-3010.1Y-1223-944-P4X-015	OFF-SPEC OIL TANK
I-FD-3010.1Y-1223-456-P4X-002	OIL COOLER (P-1223005A/D)

Table 2 – Reference Documents

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.1Y-1350-311-P4X-001	REV. A
	BÚZIOS		SHEET: 10 of 35
	TITLE: CARGO AREA SUBMERGED PUMPS		INTERNAL

## 4. DESIGN REQUIREMENTS

### 4.1. DESIGN CONDITIONS

- 4.1.1. PACKAGE Equipment shall be designed for a 30-year life in a corrosive offshore environment without the need for replacement of any major component due to wear, corrosion, fatigue, or material failure.
- 4.1.2. PACKAGER shall design the equipment for the full range of operational conditions as specified in this technical specification.
- 4.1.3. PACKAGE Equipment shall be designed with the compliance of the normative and design requirements as stated in this specification and complying with the technical parameters stated on the above item 3 with the High Capacity FPSO basic design reference documents.
- 4.1.4. All elements of the PACKAGE shall be of proven design and well within the manufacturer's actual experience.

### 4.2. SAFETY REQUIREMENTS

- 4.2.1. Personnel safety protection shall be provided according to Brazilian Regulatory Norms (NR) issued by Brazilian Government.
- 4.2.2. Warning signs in Brazilian Portuguese language shall be provided where risk of personnel injury exist.
- 4.2.3. Rotating equipment outer parts, such as pulleys, couplings, belts and flywheels, shall have rigid protection, manufactured with aluminum ASTM B211 and shall be capable of being easily removed.
- 4.2.4. In accordance with the requirements of SOLAS II-1, Regulation 3-5, and MSC.1/Circ. 1379, all equipment and material to be supplied by PACKAGER must be "asbestos free".
- 4.2.5. Safety signaling shall be in full compliance with I-ET-3010.00-5400-947-P4X-002 – SAFETY SIGNALING.
- 4.2.6. Double block & bleed arrangements are required for isolation of equipment in piping classes of 300# and above.

### 4.3. NOISE AND VIBRATIONS

- 4.3.1. Noise and vibrations limits shall be in conformance with I-ET-3010.00-1200-300-P4X-001 – NOISE AND VIBRATION CONTROL REQUIREMENTS.

### 4.4. MOTIONS AND ACCELERATION

- 4.4.1. All equipment shall be able to withstand with the UNIT subjected to 100-year return period environmental conditions.

4.4.2. All equipment shall be able to operate with the UNIT subjected to 1-year return period environmental conditions.

4.4.3. All environmental conditions are defined in I-ET-3A36.00-1000-941-PPC-001 – METOCEAN DATA, at any draft from fully loaded to the minimum loaded / ballasted condition.

4.4.4. For the Hull loading conditions details and the maximum designed operational trim and heel inclinations refer to I-ET-3010.1Y-1350-960-P4X-002 – DESIGN REQUIREMENTS - NAVAL ARCHITECTURE.

4.4.5. For the design data and information regarding motion requirements refer to I-RL-3010.1Y-1350-960-P4X-009 – MOTION ANALYSIS.

4.4.6. PACKAGE is also to withstand inertial forces during transportation from construction site to the final offshore location.

## 5. PACKAGE SCOPE OF SUPPLY

### 5.1. CARGO AREA SUBMERGED PUMPS


5.1.1. Submerged pumps scope of supply as below detailed:


Equipment	Description	Qty
B-1350501A/T	Cargo Pump	18
B-5331501A/D	Produced Water Tank Booster Pump	4
B-5331502A/D	Produced Water Transfer Pump	4
B-5336502A/D	Oil Skimming Pump	4
B-1223501A/B	Off-Spec Oil Pump	2
B-5271501A/B	Slop Pump	2
B-5336503A/B	Slop Discharge Pump	2
B-1358501A/B	Slop Oil Skimming Pump	2

Table 3 – Cargo area submerged pumps scope of supply

5.1.2. Submerged pumps shall be completed with at least the following components and accessories:

- a. High pressure hydraulic motor.
- b. Hydraulic pipe stack: which shall be segmented as PACKAGER standard.
- c. Deck trunk.

	<b>TECHNICAL SPECIFICATION</b>	Nr: <b>I-ET-3010.1Y-1350-311-P4X-001</b>	REV. <b>A</b>
	BÚZIOS		SHEET: 12 of 35
	TITLE: <b>CARGO AREA SUBMERGED PUMPS</b>		INTERNAL
ESUP			
<p>d. Top cover plate.</p> <p>e. Bolts for connecting pumps top cover plate to deck trunk.</p> <p>f. Gasket between pump top cover plate and deck trunk.</p> <p>g. Intermediate support rings to be installed inside the tanks.</p> <p>h. Bottom support.</p> <p>i. Hydraulic pressure line ball valve.</p> <p>j. Hydraulic return line non-return valve.</p> <p>k. Hydraulic pilot line connection.</p> <p>l. Ventilating connection with exhaust trap or cofferdam and header tank.</p> <p>m. Cargo purging connection.</p> <p>n. Connection for inert gas (provided by Topside N<sub>2</sub> system. See I-DE-3010.1Y-5241-944-P4X-005).</p> <p>o. Corrosion anodes for cargo pumps (B-1350501A/T) shall be for two years of operation.</p> <p>p. Corrosion anodes for produced water booster pumps (B-5331501A/D) and produced water transfer pumps (B-5331502A/D) shall be for six years of operation.</p> <p>q. Corrosion anodes for slop discharge and slop pumps shall be for six years of operation.</p> <p>r. Discharge flange connection.</p> <p>s. Stripping connection.</p> <p>t. Hydraulic remote operated capacity control valve.</p> <p>u. Local operation capacity control valve.</p> <p>v. MPS (Machinery Protection System) as well as all necessary sensors for monitoring and protection of all equipment supplied by PACKAGER.</p> <p>w. Submerged cargo pumps shall be arranged with double barriers, preventing the hydraulic system serving the pumps from being directly exposed to the cargo. The double barrier shall be arranged for detection and drainage of possible cargo leakages.</p> <p>5.1.3. For submerged pumps design and installation details refer to I-DE-3010.1Y-1350-944-P4X-003 – CARGO SYSTEM.</p>			

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.1Y-1350-311-P4X-001	REV. A
	BÚZIOS		SHEET: 13 of 35
	TITLE: CARGO AREA SUBMERGED PUMPS		INTERNAL


## 5.2. PORTABLE HYDRAULIC SUBMERGED CARGO PUMP (B-5139502A/B)


5.2.1. Two (2) Portable Cargo Pumps (B-5139502A/B) shall be completed with at least the following components and accessories:


- a. High-pressure hydraulic motor.
- b. Portable davit with pneumatic winch for lifting and lowering the pump into the tank.
- c. Connection valves (ball valves and non-return valves) for connection of hydraulic hoses (pressure and return).
- d. Concentric hoses (two pieces) for pressure / return hydraulic oil to pump with adequate connecting on both sides and control valve for the pressure line.
  - o Note: hose's length dimensioning shall consider the full access of the portable pump not only to the cargo area inerted tanks but also to other adjacent compartments that in any event could be contaminated by oil.
- e. Cargo adapter – 1 (one).
- f. Tripod and other arrangements to allow the installation and removal of these pumps from the cargo, slop, produced water and off-spec oil tanks.
- g. Tank hatch with special hatch cover with sluice valve and blind for all inerted structural tanks.
  - o Note: for sluice valve details refer to I-DE-3010.1Y-1350-944-P4X-003 – CARGO SYSTEM – Typical Detail II.
- h. Hatch sluice and special hatch cover to provide means of installing and operate portable pumps, avoiding gas leakage and ensuring tank integrity.
- i. A suitable place in the FPSO forecastle shall be provided by HULL SUPPLIER to store the portable cargo pumps, the flexible hoses, and the test facilities required by PACKAGER.
- j. The flexible hose shall be tightly stowed, and the minimum bending radius must be followed according to makers recommendation (PACKAGER to provide).
- k. A fixed drum and freshwater connection shall be provided for the portable cargo pumps yearly test. Drum drainage shall be done to forecastle bilge wells. The hydraulic headers shall have connections for hydraulic oil pressure and hydraulic oil return as near as possible the portable cargo pumps test place.

## 5.3. BALLAST PUMP (FWD) (B-5335501A/B) AND BUTTERWORTH LIFT PUMP (B-5271502)

5.3.1. Ballast Pump (Fwd) (B-5335501A/B) and Butterworth Lift Pump (B-5271502) shall be centrifugal submerged pumps type.

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.1Y-1350-311-P4X-001	REV. A
	BÚZIOS		SHEET: 14 of 35
	TITLE: CARGO AREA SUBMERGED PUMPS		INTERNAL
<p>5.3.2. Complete with at least the following components:</p> <ul style="list-style-type: none"> <li>a. High pressure hydraulic motor.</li> <li>b. Hydraulic pipe stack.</li> <li>c. Deck trunk.</li> <li>d. Top cover plate.</li> <li>e. Bolts in stainless steel for connecting pumps top cover plate to deck trunk.</li> <li>f. Gasket between pump top cover plate and deck trunk.</li> <li>g. Intermediate support rings.</li> <li>h. Automatic self-priming device for ballast pumps only: Self Priming Unit for Ballast Pumps (Fwd) – Z-B-5335501A/B.</li> <li>i. Cofferdam header tank.</li> <li>j. Hydraulic pressure line ball valve.</li> <li>k. Hydraulic return line non-return valve.</li> <li>l. Discharge and suction flange connection.</li> <li>m. Hydraulic remote operated capacity control valve.</li> <li>n. Local operation capacity control valve.</li> <li>o. Remote reading pressure transmitters with valves (installed submerged in the pump casing);</li> <li>p. Corrosion anodes for ballast and butterworth pumps shall be for two years of operation.</li> </ul> <p>5.3.3. For Ballast Pump (Fwd) (B-5335501A/B) and Butterworth Lift Pump (B-5271502) additional requirements and details refer to I-DE-3010.1Y-5335-944-P4X-001 – BALLAST SYSTEM (FWD) and I-DE-3010.1Y-5271-944-P4X-001 – TANKS CLEANING AND RECIRCULATION SYSTEM.</p> <p><b>5.4. BUTTERWORTH BOOSTER PUMPS (B-5271503A/B)</b></p> <p>5.4.1. Butterworth Booster Pumps shall be centrifugal type hydraulic driven not submerged.</p> <p>5.4.2. Butterworth Booster Pumps shall be positioned in a platform of aprox. 500mm height, installed on the Main Deck shell plate.</p> <p>5.4.3. This platform shall have a drip tray containing one or more drainage points to be kept closed in normal operation conditions.</p>			

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.1Y-1350-311-P4X-001	REV. A
	BÚZIOS		SHEET: 15 of 35
	TITLE: CARGO AREA SUBMERGED PUMPS		INTERNAL
<p>5.4.4. To perform drainage of the drip tray, a portable pneumatic pump shall be used to transfer the fluid to the drainage header (see I-DE-3010.1Y-5330-944-P4X-002). This portable pump is not PACKAGER scope of supply.</p> <p>5.4.5. This platform shall be provided with access facilities from the Main Deck and be suitable for maintenance activities to be performed on the pumps. the pump's platform shall be contained inside the main deck coamings area.</p> <p>5.4.6. For Butterworth Booster Pumps (B-5271503A/B) additional requirements and details refer to I-DE-3010.1Y-5271-944-P4X-001 – TANKS CLEANING AND RECIRCULATION SYSTEM.</p> <p><b>5.5. HYDRAULIC POWER UNIT FOR SUBMERGED PUMPS (UH-5139502A/B)</b></p> <p>5.5.1. Complete assembled, ready to be installed on board, with all components internally connected and wired, comprising at least the following components:</p> <ul style="list-style-type: none"> <li>a. Main hydraulic pumps with pulsation dampers.</li> <li>b. Hydraulic tank.</li> <li>c. Electric motors for hydraulic pumps driven (starter panel is not part of this scope).</li> <li>d. Electric motors fresh water coolers.</li> <li>e. Flexible coupling with hydraulic pump.</li> <li>f. Hydraulic oil cooler.</li> <li>g. Hydraulic oil filter with drain valve and differential pressure switch.</li> <li>h. Temperature control valve.</li> <li>i. Automatic pressure/flow control system.</li> <li>j. Pressure control system.</li> <li>k. Auxiliary Hydraulic Unit (UH-5139503A/B) integrated with Hydraulic Power Unit complete with electro-hydraulic feed pumps (one stand-by) including electric motors and hydraulic oil expansion tank equipped with venting filter, local thermometer for reading of oil temperature and oil level switches.</li> <li>l. Hydraulic Oil Transmission Equipment including venting plugs for hydraulic pipe line, hydraulic heating valve and test connections;</li> <li>m. Hydraulic Oil Transfer Unit (UH-5139504) for hydraulic oil filling, venting and drainage using electric hydraulic transfer pump.</li> <li>n. Relief valves.</li> </ul>			

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.1Y-1350-311-P4X-001	REV. A
	BÚZIOS		SHEET: 16 of 35
	TITLE: CARGO AREA SUBMERGED PUMPS		INTERNAL
		ESUP	

o. Temperature sensors.

p. Pressure switches, pressure transducers and adjustment valves as necessary for the safe and efficient operation of the PACKAGE.

5.5.2. For Hydraulic Power Unit and control panel additional details and requirements refer to I-DE-3010.1Y-5139-944-P4X-001 – HYDRAULIC SYSTEM FOR HYDRAULIC SUBMERGED PUMPS.

#### 5.6. HYDRAULIC POWER UNIT CONTROL PANEL (PN-UH-5139502A/B-01)

a. Alarm lamps and audible signal (buzzer) for warnings and shut down functions.

b. Indicating lamps for power and running status of each component.

c. Push buttons for start/stop of each hydraulic pump set, emergency stop, alarm reset and acknowledgement, test, and other functions.

d. Instruments as required for safe monitoring of the unit according to PACKAGER's standard.

e. One (1) independent starter panel for each auxiliary electrical driven hydraulic pump set with adequate protection.

f. All components, controls, safety devices and alarms shall be according to the PACKAGER's standard and Classification Society requirement.

#### 5.7. HYDRAULIC PIPING

5.7.1. The main hydraulic piping scope of supply shall have the following items:

a. High pressure, return and pilot lines pipes, supplied in pipe lengths.

b. Flanges for above piping lines, supplied loose to be welded by HULL SUPPLIER shipyard team.

c. Prefabricated isometrics.

d. Pipe couplings.

e. Noise isolating fittings for high pressure, return and pilot lines, comprising Resilient pipe clamps.

f. Resilient pipe clamps for cargo/drop lines close to cargo pumps.

g. Resilient anchor supports.

h. Resilient bulkhead penetrations for vertical and horizontal bulkheads.

i. Fixed pipe clamps.

j. Inlet and outlet isolation valves.



5.7.2. For Hydraulic piping design additional details refer to I-DE-3010.1Y-1350-944-P4X-003 – CARGO SYSTEM.

### 5.8. EQUIPMENT LOCATION


5.8.1. CARGO AREA SUBMERGED PUMPS shall be installed inside the Hull cargo area structural tanks as cargo, slop, produced water and off-spec oil and N°7 and N°8 water ballast tanks.

5.8.2. For the hydraulic driven pumps option, HPU units including accessories and components shall be installed in a specific compartment inside the Engine Room and connected to the pumps through hydraulic oil headers on Main Deck on the Marine Pipe Rack.

5.8.3. For Equipment Location refer to I-DE-3010.1Y-1200-942-P4X-001 – GENERAL ARRANGEMENT and I-DE-3010.1Y-5400-94A-P4X-001 – AREA CLASSIFICATION - GENERAL.

5.8.4. Cargo, slop, produced water, off-spec oil and water ballast tanks pumps shall be located on the Unit Hull Cargo Area as the following table:

<b>TAG</b>	<b>Description</b>	<b>Location</b>
B-1350501A/T	Cargo Pump	Cargo Tanks
B-5331501A/B	Produced Water Tanks Booster Pump	Produced Water portside tank (PW Tk-P)
B-5331502A/B	Produced Water Transfer Pump	
B-5336502A/B	Oil Skimming Pump	
B-5331501C/D	Produced Water Tranks Booster Pump	Produced Water starboard tank (PW Tk- S)
B-5331502C/D	Produced Water Transfer Pump	
B-5336502C/D	Oil Skimming Pump	
B-1223501A/B	Off-Spec Oil Pump	Off-Spec Oil tank
B-5271501A	Slop Pump	Dirty Slop Tank (DIRTY SLP TK-P)
B-5336503A	Slop Discharge Pump	
B-1358501A	Slop Oil Recovery Pump	
B-5271501B	Slop Pump	Clean Slop Tank

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.1Y-1350-311-P4X-001	REV. A
	BÚZIOS		SHEET: 18 of 35
	TITLE: CARGO AREA SUBMERGED PUMPS		INTERNAL

B-5336503B	Slop Discharge Pump	(CLEAN SLP TK-S)
B-1358501B	Slop Oil Recovery Pump	
B-5335501A	Ballast Pump (Fwd)	Water Ballast Tank N.7P (N.7 WB TK-P)
B-5335501B	Ballast Pump (Fwd)	Water Ballast Tank N.7S (N.7 WB TK-S)
B-5271502	Butterworth Lift Pump	Water Ballast Tank N.8P (N.8 WB TK-P)
B-5271503A/B	Butterworth Booster Pump	Main Deck (under Module M-17)
B-5139502A/B	Portable Cargo Pumps	Loose


Table 4 – Cargo Area Submerged Pumps location


- 5.8.1. For the above table 4 cargo, ballast, slop, produced water and off-spec oil tanks location, volumes and identification refer to I-DE-3010.1Y-1350-960-P4X-002 – CAPACITIES PLAN.
- 5.8.2. As reference for cargo tanks pumps height, location and additional information refer to I-DE-3010.1Y-1350-944-P4X-003 – CARGO SYSTEM.
- 5.8.3. As reference for slop tanks pumps height, location and additional information refer to I-DE-3010.1Y-5336-944-P4X-005 – SLOP DISCHARGE SYSTEM.
- 5.8.4. As reference for produced water tanks pumps height, location and additional information refer to I-DE-3010.1Y-5331-944-P4X-005 – PRODUCED WATER TANK “A” and I-DE-3010.1Y-5331-944-P4X-006 – PRODUCED WATER TANK “B”.
- 5.8.5. As reference for off-spec oil tanks pumps height, location and additional information refer to I-DE-3010.1Y-1223-944-P4X-015 – OFF-SPEC OIL TANK.
- 5.8.6. As reference for water ballast tanks pumps height, location and additional information refer to I-DE-3010.1Y-5335-944-P4X-001 – BALLAST SYSTEM (FWD).
- 5.8.7. As reference for butterworth booster and lift pumps height, location and additional information refer to I-DE-3010.1Y-5271-944-P4X-001 – TANKS CLEANING AND RECIRCULATION SYSTEM.


## 6. PACKAGE TECHNICAL SPECIFICATION

### 6.1. GENERAL

- 6.1.1. PACKAGE shall be supplied as hydraulic driven design. For the electrical option

	<b>TECHNICAL SPECIFICATION</b>	Nr: <b>I-ET-3010.1Y-1350-311-P4X-001</b>	REV. <b>A</b>
	BÚZIOS		SHEET: 19 of 35
	TITLE: <b>CARGO AREA SUBMERGED PUMPS</b>		INTERNAL
ESUP			
<p>refer to item 6.10 of this technical specification.</p> <p>6.1.2. PACKAGE Hydraulic system design shall be supplied by PACKAGER. For the electric driven option, the electrical system design shall be formally approved by PACKAGER.</p> <p>6.1.3. PACKAGE installation and the interface with the Hull Systems as cargo, slop, produced water, off-spec oil and water ballast system shall be formally approved by PACKAGER.</p> <p>6.1.4. All PACKAGE pumps shall have rotation speed variation devices in both hydraulic and electrical options.</p> <p>6.1.5. PACKAGE design shall have devices for detection and protection of the PACKAGE equipment against high and low pressure scenarios with corresponding indication on SOS.</p> <p>6.1.6. PACKAGE interconnection piping, tubing, supports and accessories shall be PACKAGER standard. PACKAGER shall inform all assembly recommendations in advance.</p> <p>6.1.7. For the products in FPSO cargo area deep structural tanks refer to I-RL-3010.1Y-1200-940-P4X-001 – GENERAL SPECIFICATION FOR AVAILABLE UTILITIES.</p> <p>6.1.8. For cargo, slop, produced water, off-spec oil tanks and water ballast tanks dimensions, capacity volumes and depth refer to I-DE-3010.1Y-1350-960-P4X-002 – CAPACITIES PLAN.</p> <p>6.1.9. For FPSO minimum operational draft refer to I-ET-3010.1Y-1350-960-P4X-002 – DESIGN REQUIREMENTS - NAVAL ARCHITECTURE.</p> <p>6.1.10. For Pumps Technical Data refer to item 3 of this technical specification.</p> <p><b>6.2. CARGO AREA SUBMERGED PUMPS</b></p> <p>6.2.1. Cargo area submerged pumps are those indicated on item 5.1.1 of this technical specification.</p> <p>6.2.2. All submerged pumps shall be vertical centrifugal type hydraulic driven with submerged pipe stacks.</p> <p>6.2.3. For electrical driven option refer to item 6.10 of this technical specification.</p> <p>6.2.4. All submerged pumps shall be installed on cargo area tanks as cargo, slop, produced water, off-spec oil tanks and on N°7 and N°8 water ballast tanks.</p> <p>6.2.5. For the pumps design height inside the tanks refer to 5.8 of this technical specification.</p> <p>6.2.6. For Submerged Pumps not installed on the cargo area tanks bottom but in a high position inside these tanks, a proper structural oil collecting basin shall be</p>			

	<b>TECHNICAL SPECIFICATION</b>	Nr: <b>I-ET-3010.1Y-1350-311-P4X-001</b>	REV. <b>A</b>
	BÚZIOS		SHEET: 20 of 35
	TITLE: <b>CARGO AREA SUBMERGED PUMPS</b>		INTERNAL
ESUP			
<p>provided by HULL SUPPLIER for each pump with requirements detailed on I-MD-3010.1Y-1200-940-P4X-027 – DESCRIPTIVE MEMORANDUM - HULL SYSTEMS.</p> <p>6.2.7. Fluid viscosity for cargo oil pumps shall follow the Topside data sheet I-FD-3010.1Y-1223-456-P4X-002 – OIL COOLER (P-1223005A/D).</p> <p>6.2.8. Produced Water Tank Pumps (B-5331501A/D), Produced Water Tank Booster Pumps (B-5331502A/D), Oil Skimming Pumps (B-5336502A/D) and Off-Spec Oil Tank Pumps (B-1223501A/B) shall have considered on the PACKAGE design the Produced Water Tanks maximum temperature (80°C) and with adequate material, which shall be super duplex stainless steel or 254 SMO.</p> <p>6.2.9. All pumps, pipe stacks and shafts, except pumps installed inside produced water and off-spec oil tanks shall be constructed in corrosion resistant materials adequate to its duty. The material shall be approved by OWNER.</p> <p>6.2.10. Regarding the material for the pumps installed in water ballast and slop tanks, super duplex stainless steel or 254 SMO are acceptable.</p> <p>6.2.11. PACKAGER shall provide two (2) portable submerged pumps as 5.2. Those pumps shall be hydraulic type no matter the hydraulic / electrical option chosen for the cargo area submerged pumps.</p> <p>6.2.12. All Cargo Area Submerged Pumps shall be provided with a cathodic protection system.</p> <p>6.2.13. Produced Water Tank Transfer Pumps (B-5331502A/D), Oil Skimming Pumps (B-5336502 A/D) and Off-spec Oil Pumps (B-1223501A/B) shall have the discharge pressure / flowrates controlled. The pump control shall be capable to adjust the pump speed automatically according to a defined flowrate setpoint.</p> <p>6.2.14. Slop Discharge Pumps (B-5336503A/B) and Slop Pumps (B-5271501A/B - as backup) will feed two (2) Slop Treatment Centrifuges (SC-5336501A/B – not included on this PACKAGE) installed on main deck, each one with a capacity of 50 m<sup>3</sup>/h. The Centrifuges shall operate isolated (flowrate of 50m<sup>3</sup>/h) or simultaneously (flowrate of 100m<sup>3</sup>/h). Thus, Slop Discharge Pumps (B-5336503A/B) and Slop Pumps (B-5271501A/B) shall have means to control its discharge pressure / flowrates, allowing a synchronized operation with the Centrifuges. The pump control shall be capable to adjust the pump speed automatically according to a defined flowrate setpoint.</p> <ul style="list-style-type: none"> <li>○ Note: for the above further details refer to I-DE-3010.1Y-5336-944-P4X-005 – SLOP DISCHARGE SYSTEM.</li> </ul> <p>6.2.15. PACKAGER shall provide devices for detection and protection of the PACKAGE equipment against low and high pressure scenarios and with the corresponding indication on SOS.</p> <p>6.2.16. PACKAGER shall provide high pressure protections in Slop Oil Skimming Pumps</p>			

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.1Y-1350-311-P4X-001	REV. A
	BÚZIOS		SHEET: 21 of 35
	TITLE: CARGO AREA SUBMERGED PUMPS		INTERNAL
			ESUP

(B-1358501A/B) discharge.

6.2.17. Since Slop Oil Skimming Pumps (B-1358501A/B) shall be installed on oil collecting basins as mentioned on item 6.2.6 of this technical specification, PACKAGER shall provide protections to stop the Slop Oil Skimming Pumps (B-1358501A/B) at the collecting basins low level scenario.

6.2.18. PACKAGER shall provide high pressure protections in the discharge of Slop Discharge Pumps (B-5336503A/B) and Slop Pumps (B-5271501A/B).

6.2.19. All cargo area submerged pumps shall be provided with an anti-rotation mechanism to protect the pumps against counter-rotation movements.

6.2.20. For Electrical, Instrumentation, automation and interface with CCR requirements refer to items 7.1 and 7.2 of this technical specification.

### 6.3. CARGO AREA SUBMERGED PUMPS REMOVAL

6.3.1. Submerged Pumps removal procedures shall comply with the PACKAGER's standards and shall be submitted to HULL SUPPLIER and OWNER for approval.

6.3.2. Hatches with proper hatch covers (not PACKAGER scope of supply) shall be installed on Main Deck to allow the pumps removal from the tanks containing submerged pumps.

6.3.3. PACKAGER shall inform the minimum dimensions of the hatches to allow the removal of the pumps.

6.3.4. One (1) tripod with suitable height to proceed with the above mentioned removal procedure shall be included in PACKAGER scope of supply.


### 6.4. PORTABLE HYDRAULIC SUBMERGED CARGO PUMP (B-5139502A/B)

6.4.1. Two (2) portable hydraulic submerged cargo pumps shall be supplied as item 5.2 of this technical specification. Those pumps shall be used in case of any of the cargo area submerged pumps have malfunction or are out of operation.

6.4.2. Portable hydraulic submerged cargo pumps shall be driven by the same HPU as the one defined for the cargo pumps drive. A smaller HPU dedicated solely for the portable hydraulic submerged pumps may be supplied as PACKAGER criteria.

6.4.3. Portable Submerged Portable Pumps shall be installed through submerged caissons installed on the cargo area tanks. Submerged caissons are HULL SUPPLIER scope of supply and installation requirements are defined on I-MD-3010.1Y-1200-940-P4X-027 – DESCRIPTIVE MEMORANDUM – HULL SYSTEMS.

6.4.4. Since Portable Submerged Portable Pumps shall be installed closed to the cargo area submerged pumps, PACKAGER shall advise the proper location and dimensions of the caisson openings at the cargo area tanks top where the

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.1Y-1350-311-P4X-001	REV. A
	BÚZIOS		SHEET: 22 of 35
	TITLE: CARGO AREA SUBMERGED PUMPS		INTERNAL

portable pumps are to installed.

6.4.5. For portable hydraulic submerged cargo pumps typical installation in caissons and with sluice valves to ensure the cargo area tanks gas tightening integrity refer to I-DE-3010.1Y-1350-944-P4X-003 – CARGO SYSTEM.

**6.5. BUTTERWORTH BOOSTER PUMPS (B-5271503A/B)**

6.5.1. Butterworth Booster Pumps (B-5271503A/B) shall be hydraulic driven centrifugal type not submerged and with redundancy configuration 2 x 100%.

6.5.2. Butterworth Booster Pumps (B-5271503A/B) shall be installed on Main Deck close to the Butterworth Lift Pump (B-5271502) discharge.

6.5.3. Butterworth Booster Pumps (B-5271503A/B) shall have synchronized operation with the Butterworth Lift Pump (B-5271502) with an integrated rotation speed control. The main functions of Butterworth Lift/Booster pumps are to feed the cleaning machines header (for cargo tanks seawater washing) or the butterworth pumps header (seawater for main deck) from ballast sea chests.

- Note: for the above further details refer to I-DE-3010.1Y-5271-944-P4X-001 – TANKS CLEANING AND RECIRCULATION SYSTEM.

**6.6. HYDRAULIC POWER UNITS FOR SUBMERGED PUMPS (UH-5139502A/B)**

6.6.1. Two (2) Hydraulic Power Units (2x50%) shall be provided to drive the Cargo Area Submerged Pumps as listed on item 5.1.


6.6.2. Each Hydraulic Power Unit Skid shall be comprised by a combination of hydraulic pumps driven by electric motors running at HV 6,3 kV. The rated power of electric motors shall be limited to a maximum of 1000 kW. The quantity of electric motors by HPU Skid shall be evaluated by this power limitation.

6.6.3. HPU shall have one (1) installed spare HV electric motor (limited to 1,000 kW), that is, HPU shall be capable to reach the required power with one (1) HV electric motor out of operation (for example for maintenance).

6.6.4. Hydraulic Power Unit shall have the total capacity dimensioned to run the below pumps simultaneously:

- Six (6) Cargo Pumps (B-1350501A/T) @ 1200 m<sup>3</sup>/h.
- Two (2) Ballast Pump (FWD) (B-5335501A/B) @ 800 m<sup>3</sup>/h.
- Two (2) Produced Water Tank Booster Pump (B-5331501A/D) @ 670 m<sup>3</sup>/h.
- One (1) Off-Spec Oil Pump (B-1223501A/B) @ 300 m<sup>3</sup>/h.

6.6.5. HPU shall have both hydraulic oil circuit and HV electric motors fresh water cooled. PACKAGER shall inform the required parameters for the fresh water cooling as the minimum flow, inlet temperature and heat transfer rate.

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.1Y-1350-311-P4X-001	REV. A
	BÚZIOS		SHEET: 23 of 35
	TITLE: CARGO AREA SUBMERGED PUMPS		INTERNAL

6.6.6. HPU hydraulic oil cooler shall be designed for adequate velocities of hydraulic oil entering the equipment. Deflector plates shall be provided whenever required by normative standards. PACKAGER shall provide a mechanical calculation memory with the verification of the cooler critical velocity for the erosion, fatigue and vibration and to include this data on cooler PACKAGER data sheet. This requirement aims to prevent early failures on similar equipment experienced by the OWNER.

## 6.7. HYDRAULIC PIPING SYSTEM

6.7.1. The hydraulic piping system shall have at least two longitudinal pressure / return headers to be installed on Main Deck for pumps hydraulic power and hydraulic tubings connected from the HPUs for cargo area submerged pumps control.

6.7.2. The portable cargo pumps shall be connected to the longitudinal headers by hoses provided with proper valves and connection fittings.

6.7.3. The design of hydraulic piping, tubing, valves, fittings, accessories and all parts / components detailed on item 5.7 shall be PACKAGER's standard and submitted to HULL SUPPLIER for approval.

6.7.4. HULL SUPPLIER is responsible for the PACKAGE assembly onboard, hence PACKAGER shall issue all recommendations to HULL SUPPLIER for the hydraulic oil piping and tubing design, supply, fabrication, interconnection, assembly and testing onboard.

6.7.5. At the detail design, being the hydraulic oil headers installed in a higher position than the HPU and hydraulic oil storage tanks, PACKAGER shall design a device to keep the hydraulic oil inventory full inside piping lines to avoid the return of hydraulic oil to the structural storage tanks when the system is stopped or during any shutdown event.

6.7.6. Solution of item 6.7.5 shall ensure a proper restart of the system with the full inventory on the cargo area submerged pumps hydraulic oil system.


6.7.7. The hydraulic piping specification supplied by PACKAGER shall be at least:

- high pressure pipes: duplex stainless steel.
- low pressure pipes: stainless steel AISI 316 or equivalent.
- pilot pipes: duplex stainless steel.


6.7.8. PACKAGER shall provide a rack panel (PN-UH-5139502-02 – REMOTE CONTROL VALVE ASSEMBLY) for hydraulic valves remote control as detailed on I-DE-3010.1Y-5139-944-P4X-001 – HYDRAULIC SYSTEM FOR HYDRAULIC SUBMERGED PUMPS.


## 6.8. ENGINEERING SERVICES

6.8.1. PACKAGER shall submit to HULL SUPPLIER as part of the documents for

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.1Y-1350-311-P4X-001	REV. A
	BÚZIOS		SHEET: 24 of 35
	TITLE: CARGO AREA SUBMERGED PUMPS		INTERNAL
<p>approval, a schematic layout of hydraulic high pressure, return and pilot lines piping system inside Engine Room and along Main Deck cargo area, including piping sizes and characteristics.</p> <p>6.8.2. As well, standard drawings of piping accessories, such as noise isolating fittings (resilient and fixed pipe clamps and bulkhead penetrations), and design recommendations for the correct assembling shall be provided.</p> <p>6.8.3. Based on this information, HULL SUPPLIER shall prepare and submit to PACKAGER approval, a piping layout showing the actual piping routing and the location of inlet and outlet connections of the equipment.</p> <p>6.8.4. Based on this information PACKAGER shall submit to HULL SUPPLIER's appraisal the following information:</p> <ul style="list-style-type: none"> <li>○ Isometrics to be used for manufacturing purposes, as well as the location of all piping accessories.</li> <li>○ Hydraulic Piping Calculation.</li> <li>○ List of Material.</li> <li>○ Technical Data Book containing specification, drawings of piping components.</li> <li>○ Documentation of compliance with CS requirements.</li> </ul> <p>6.8.5. If deemed as necessary, a technical meeting between PACKAGER, HULL SUPPLIER and SHIPYARD team will be held with the purpose of clarifying technical details and scope of supply.</p> <p><b>6.9. LOCAL CONTROL PANEL (PN-UH5139502A/B-01) AND REMOTE WORKSTATION (PN-UH-5139502-03)</b></p> <p>6.9.1. The Remote Workstation (PN-UH-5139502-03) shall be installed by HULL SUPPLIER in the Control Room – Operation Ambiance, in the same console as SOS-HMI, and shall perform all system control and monitoring.</p> <p>6.9.2. The Local Control Panel (PN-UH-5139502A/B-01) shall be installed by HULL SUPPLIER in the Hydraulic Power Unit (UH-5139502A/B) skid inside Engine Room and shall perform all system control and monitoring.</p> <p>6.9.3. The Remote/Local Control panels selecting key shall be designed, supplied and installed by HULL SUPPLIER in the Hydraulic Power Unit for Submerged Pumps (UH-5139502A/B). The status of this key shall be monitored in above mentioned HPU Room and in the CCR.</p> <ul style="list-style-type: none"> <li>○ Note: The interconnection between local control panel and remote control panel (CCR) shall be by dedicated network.</li> </ul> <p>6.9.4. To ensure automation redundancy PACKAGE shall have two PLCs.</p>			



	TECHNICAL SPECIFICATION	Nr: I-ET-3010.1Y-1350-311-P4X-001	REV. A
	BÚZIOS		SHEET: 25 of 35
	TITLE: CARGO AREA SUBMERGED PUMPS		INTERNAL
<p>6.9.5. One PIT (pressure indicator and transmitter) to be installed at the discharge of each submerged pump shall be supplied by PACKAGER with the function to alarm and to stop the pumps at the shut-off condition.</p> <p><b>6.10. CARGO AREA SUBMERGED PUMPS DRIVEN BY ELECTRICAL MOTORS ON MAIN DECK – ALTERNATIVE</b></p> <p>6.10.1. In case HULL SUPPLIER decides to supply submerged pumps driven by electrical motors on main deck instead of hydraulic submerged pumps, the following actions shall be taken:</p> <ol style="list-style-type: none"> <li>a. One (1) hydraulic power unit shall be supplied to drive the portable hydraulic submerged cargo pump.</li> <li>b. The hydraulic piping with fittings, valves and all necessary accessories shall be supplied to the operation of portable hydraulic submerged cargo pumps.</li> <li>c. The driving shafts of the pumps shall be supported by forced lubricated bearings. Dedicated pumps and heat exchanger shall be included in the lubrication system that shall consider tropical conditions for the correct dimensioning. Use of cargo oil or oil water mixtures will not be accepted.</li> <li>d. Two (2) transformers for feeding the VSD. For installation in a closed compartment in the UNIT Hull.</li> <li>e. The pumps shall be directly driven at standard vertical electric motors installed on Main Deck.</li> <li>f. The speed variation shall be made by the VSDs for all pumps. The motors shall have at least IP-56 protection grade.</li> <li>g. Electric Motors shall be compatible with classified area zone 1.</li> <li>h. Electric Motors shall be approved by CS.</li> <li>i. The total amount of VSDs shall be able to run simultaneously: <ul style="list-style-type: none"> <li>▪ Six (6) Cargo Pumps (B-1350501A/T) @ 1200 m<sup>3</sup>/h.</li> <li>▪ One (2) Water Ballast Pump (B-5335501A/B) @ 800 m<sup>3</sup>/h.</li> <li>▪ Two (2) Produced Water Tank Booster Pump (B-5331501A/D) @ 670 m<sup>3</sup>/h.</li> <li>▪ One (1) Off-Spec Oil Pump (B-1223501A/B) @ 300 m<sup>3</sup>/h.</li> </ul> </li> <li>j. VSDs spares shall be provided. VSDs shall be interchangeable in such a way that could support the malfunction of other similar one installed.</li> <li>k. The submerged deepwell pumps shall only be controlled by the CCR.</li> </ol> <p>6.10.2. PACKAGER shall supply a control and monitoring panel for the PACKAGE</p>			

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.1Y-1350-311-P4X-001	REV. A
	BÚZIOS		SHEET: 26 of 35
	TITLE: CARGO AREA SUBMERGED PUMPS		INTERNAL

pumps.

6.10.3. The electrical arrangement and design shall be supplied by the HULL SUPPLIER and be approved by the PACKAGER as mentioned on 6.1.2.

6.10.4. At the decision to supply submerged pumps driven by electrical motors on main deck, HULL SUPPLIER shall revise all the Hull auxiliary systems, HVAC, electrical arrangement, and the arrangement of all compartments affected by this decision according to comply with the electrical submerged pumps alternative characteristics, since High Capacity FPSO Design is based on a hydraulic power submerged pumps system.

## 7. GENERAL REQUIREMENTS

### 7.1. ELECTRICAL REQUIREMENTS

7.1.1. 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.

7.1.2. All electrical signal connections for external interconnection with the panel shall be clustered in junction boxes with at least IP-56 level of protection, located inside the panel and grouped according to the different types of signals involved.

7.1.3. 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.

7.1.4. 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.


7.1.5. 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.

7.1.6. Power lighting and grounding installations inside the package shall comply with requirements of I-ET-3010.00-5140-700-P4X-003 – ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS.

7.1.7. Grounding installations shall comply with I-ET-3010.00-5140-700-P4X-001 – SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS and I-DE-3010.00-5140-700-P4X-003 – GROUNDING INSTALLATION TYPICAL DETAILS.

### 7.2. INSTRUMENTATION AND AUTOMATION REQUIREMENTS

7.2.1. PACKAGE shall be protected with all necessary instruments to operate safely,

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.1Y-1350-311-P4X-001	REV. A
	BÚZIOS		SHEET: 27 of 35
	TITLE: CARGO AREA SUBMERGED PUMPS		INTERNAL

adequately and without interruption in a tropical marine environment.

7.2.2. The instrumentation and control design shall fulfill the requirements of the following technical specifications:

- i. I-ET-3010.00-1200-800-P4X-002 – AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS.
- ii. I-ET-3010.00-1200-800-P4X-013 – GENERAL CRITERIA FOR INSTRUMENTATION PROJECTS.

7.2.3. The minimum requirements for the adequate interfacing of the PACKAGE Automation and Instrumentation System with the UNIT are described on I-ET-3010.1Y-1200-800-P4X-014 – AUTOMATION INTERFACE OF PACKAGE UNITS.

7.2.4. For the control and automation panels design requirements I-ET-3010.00-5520-888-P4X-001 – AUTOMATION PANELS shall be considered.

### 7.3. MACHINERY PROTECTION SYSTEM (MPS)

7.3.1. Machinery Protection System (MPS) shall be according to the API 670 latest revision.

7.3.2. Submersible pump probe arrangement shall be under PACKAGE / MANUFACTURER's standard.

7.3.3. All vibration and temperature protection systems shall be according to Original Equipment Manufacturer (OEM) standards and API 670 compliant.

7.3.4. Monitors shall be assembled on Local Control Panel (PN-UH5139502A/B-01) in Engine Room.

7.3.5. The vibration signals (including displacement and accelerometers) of the whole train shall have an unfiltered output at the UCP (one per channel) for recording and maintenance purposes.

### 7.4. MACHINERY MONITORING SYSTEM (MMS)

7.4.1. Besides the control and supervisory UCP system, Machinery Protection System shall be integrated in the Machinery Monitoring System (MMS) of the FPSO, provided by others, for maintenance purposes.

7.4.2. PACKAGER shall provide interface cards installed in the Machinery Protection System to allow the interconnection with the MMS (software and hardware). All vibration signals (including displacement and accelerometers) shall be available with buffer signal output.

7.4.3. For a basic description, the primary function of this system is to perform analysis of the mechanical parameters: all machinery protection system signals (with possibility to make analysis like FFT, full spectrum, Bode plot, cascade and



**PETROBRAS**

**TECHNICAL SPECIFICATION**

Nr: **I-ET-3010.1Y-1350-311-P4X-001**

REV. **A**

BÚZIOS

SHEET: 28 of 35

TITLE:

**CARGO AREA SUBMERGED PUMPS**

INTERNAL

ESUP

waterfall diagrams, shaft average center line, orbit, X-Y plot and experience-based vibration analysis) and auxiliary system signals (lube, seal, etc.).

7.4.4. MPS radial vibration monitoring cards shall have all available variables enabled to send data to MMS.

7.4.5. In addition to the signal available through the MPS Communication Card, PACKAGER shall make available the required process variable signals presented in the I-ET-3010.00-5500-854-P4X-001 – MACHINERY MONITORING SYSTEM, through the Package Fast Ethernet Network to perform the functions above in the Machinery Monitoring System.

7.4.6. PACKAGER shall provide all documentation of vibration signals and configuration files of the Machinery Protection System to be implemented by the MMS Supplier for Monitoring System configuration.

7.4.7. Connectivity to external system through open communication protocols shall be MODBUS and OPC (Open Platform Communications) by Ethernet TPC/IP Protocol. All I/O variables, controllers (including performance, load sharing and surge) and first-out events shall be available.

**7.5. AVAILABLE ON BOARD**

7.5.1. PACKAGER shall consider on the PACKAGE design the hydraulic oil structural tanks available onboard to be supplied by HULL SUPPLIER inside Engine Room 3<sup>rd</sup> Deck, close to the Hydraulic Power Units Room.


<b>Structural Hydraulic Oil Tanks</b>	<b>Description</b>	<b>Volume (m3)</b>
TQ-5139501	Hydraulic storage Tank for Submerged pumps	19.391
TQ-5139502	Hydraulic drain tank structural or cargo pump	19.391

Table 5 – Structural Hydraulic Oil Tanks.

- Note 1: Volumes on the above table 5 are the actual volume discarding the 0,95 permeability and shall be confirmed during design detail phase.
- Note 2: Those steel structural tanks are to be painted according to I-ET-3010.00-1200-956-P4X-002 – PAINTING SPECIFICATION. Level transmitters, sounding, drain and vent piping, access hatches and ladders are HULL SUPPLIER scope of supply.

7.5.2. PACKAGER shall inform all the consumables: total electric consumption of each voltage, as well as the individual power of each consumer.

7.5.3. For available utilities refer to I-RL-3010.1Y-1200-940-P4X-001 – GENERAL SPECIFICATION FOR AVAILABLE UTILITIES.


	TECHNICAL SPECIFICATION	Nr: I-ET-3010.1Y-1350-311-P4X-001	REV. A
	BÚZIOS		SHEET: 29 of 35
	TITLE: CARGO AREA SUBMERGED PUMPS		INTERNAL


## 7.6. SKIDS LAYOUT AND FOUNDATION REQUIREMENTS


- 7.6.1. PACKAGE components supplied as Skids, as HPU shall follow the below minimum requirements.
- 7.6.2. PACKAGE skid structure shall be designed to withstand the design conditions mentioned on item 4.4 and to ensure the lifting conditions on manufacturing site and shipyard. Lifting lugs shall be provided according to PACKAGER lifting procedure.
- 7.6.3. The Skid main frame shall be all welded construction. Structural skid welds, including lifting facilities shall be continuous and shall comply with AWS D1.1 (structural welding code) and CS Rules.
- 7.6.4. Skid structure shall be designed to be welded to the supporting structure unless otherwise specified.
- 7.6.5. PACKAGE skid layout and arrangement shall be designed to provide sufficient access to pumps, instruments, equipment, and control panels so as to ease the operability and maintenance with safe conditions. Instruments and alves shall be installed on a suitable height to allow safe access for monitoring, operation, and maintenance.
- 7.6.6. All necessary maintenance davits, monorails, padeyes or trolleys shall be provided to ensure the safe and easy maintenance conditions.
- 7.6.7. Access ladders, platforms, gratings and any other access device shall be metallic type and designed according to PACKAGER / MANUFACTURER standard and to the industrial recognized international codes.
- 7.6.8. PACKAGE skid shall have a drip pan to collect drained water from the equipment with drain flanges for the connection with the Hull draining system.
- 7.6.9. PACKAGE Equipment and components shall be located entirely within the skids / equipment base perimeter, including all equipment, piping, valves, electrical, instrumentation and controls.

## 7.7. NAMEPLATES AND TAG NUMBERING

- 7.7.1. PACKAGER / MANUFACTURER Equipment shall have nameplates in Brazilian Portuguese language, made of stainless steel AISI 316L, with 3 mm minimum thickness and fixed by stainless steel (AISI 316L) bolts or fasteners on visible and accessible location.
- 7.7.2. Tagging of all instruments, electrical, mechanical and piping items, including valves, shall be carried out.
- 7.7.3. Tags shall be supplied with the number and description in the Brazilian Portuguese Language, unless otherwise stated in the technical data sheets.
- 7.7.4. For TAG numbering refer to I-ET-3000.00-1200-940-P4X-001 – TAGGING

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.1Y-1350-311-P4X-001	REV. A
	BÚZIOS		SHEET: 30 of 35
	TITLE: CARGO AREA SUBMERGED PUMPS		INTERNAL
<p>PROCEDURE FOR PRODUCTION UNITS DESIGN</p> <p>7.7.5. For Instrumentation tagging the ISA –5.1 and N-1710 shall be followed.</p> <p><b>8. PACKAGE MANUFACTURING</b></p> <p><b>8.1. GENERAL</b></p> <p>8.1.1. All materials and equipment supplied by PACKAGER / MANUFACTURER shall be brand new (not overhauled), field proven, free from defects and accepted by Owner and the Classification Society.</p> <p>8.1.2. Materials and equipment shall be manufactured according to internationally recognized standards for the offshore oil drilling and production industries, and shall be in conformance with the Basic Design and Agreement specifications and requirements.</p> <p>8.1.3. Field proven definition: Systems and equipment shall demonstrate satisfactory operation at least in 3 floating offshore installation units, operating under process conditions (pressure, flow, capacity and similar fluids) for a minimum of 24,000 hours. For rotating equipment, they must demonstrate operation with fluid, flow and discharge pressure similar to the design. Unproven designs or prototypes (including components) without offshore service will not be accepted.</p> <p><b>8.2. QUALITY ASSURANCE AND CONTROL SYSTEM</b></p> <p>8.2.1. PACKAGER shall submit his Quality Assurance / Quality Control handbook to HULL SUPPLIER for information.</p> <p>8.2.2. Engineering, fabrication and manufacturing shall conform to good manufacturing practices. Quality system according to ISO 9001 in relevant extent shall be in place and implemented.</p> <p><b>8.3. WELDING AND NDT</b></p> <p>8.3.1. All equipment, structures and piping welds shall be performed according to the requirements described in the latest revision of I-ET-3010.00-1200-955-P4X-001 – WELDING.</p> <p>8.3.2. Welding shall be carried out with procedures and welders qualified in accordance with ASME Section IX. Welding shall not be performed before qualified welding procedures have been approved.</p> <p>8.3.3. Intermittent fillet welds are not acceptable.</p> <p>8.3.4. Welding inspection and NDTs shall be performed according to the requirements described in the latest revision of</p> <ul style="list-style-type: none"> <li>○ I-ET-3010.00-1000-970-P4X-002 – REQUIREMENTS FOR NDT and</li> </ul>			

	<b>TECHNICAL SPECIFICATION</b>	Nr: <b>I-ET-3010.1Y-1350-311-P4X-001</b>	REV. <b>A</b>
	BÚZIOS		SHEET: 31 of 35
	TITLE: <b>CARGO AREA SUBMERGED PUMPS</b>		INTERNAL
ESUP			
<p>○ I-ET-3010.00-1200-955-P4X-002 – REQUIREMENTS FOR WELDING INSPECTION.</p> <p>8.3.5. Qualification and Certification for procedures and personnel shall be in accordance with I-ET-3010.00-0000-970-P4X-001 – REQUIREMENTS FOR PROCEDURES AND PERSONNEL QUALIFICATION AND CERTIFICATION.</p> <p>8.3.6. Final NDTs, for acceptance purposes shall be carried out after completion of any post weld heat treatment (when applicable) and before the applications of painting, hydrostatic testing, etc.</p> <p><b>8.4. INSPECTION AND TESTS</b></p> <p>8.4.1. PACKAGER / MANUFACTURER shall develop and implement an Inspection and Test Plan (ITP) containing hold points, review and witness points following the schedule of the PACKAGE inspections, tests and events accordingly.</p> <p>8.4.2. PACKAGE inspection, tests and events shall be attended by the MANUFACTURER, PACKAGER, HULL SUPPLIER, CS and OWNER inspection team whenever necessary.</p> <p>8.4.3. PACKAGE shall be tested according to the design codes, applicable industry standards, CS Rules and any other one requirement stated on this technical specification.</p> <p>8.4.4. Unless waive by OWNER, the following PACKAGE inspections and checks shall be witnessed by OWNER inspector:</p> <ul style="list-style-type: none"> <li>i. verification of equipment construction materials (vessels, heat exchangers, pumps, etc.) for conformity with the specification requirements.</li> <li>ii. verification of piping, fittings and valves conform to specification of materials and fabrication.</li> <li>iii. reports for all NDT performed on the pressure retaining parts (radiographic, dye penetrant, magnetic particles and ultrasonic inspection).</li> <li>iv. approval of the relief valve settings and witness of their testing after setting.</li> <li>v. review of Inspection and Test Records.</li> <li>vi. visual check.</li> <li>vii. Electrical tests as:           <ul style="list-style-type: none"> <li>- a MEGGER test for cables and electric motors;</li> </ul> </li> </ul>			

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.1Y-1350-311-P4X-001	REV. A
	BÚZIOS		SHEET: 32 of 35
	TITLE: CARGO AREA SUBMERGED PUMPS		INTERNAL

- all tests stated in the respective motors and power / control panel respective specifications.

## 8.5. FACTORY ACCEPTANCE TEST (FAT)

8.5.1. FAT is a set of functional and performance tests to be executed in any equipment, electrical, instrumentation and telecom panels or any other commissionable item carried out on the PACKAGER / MANUFACTURER factory or in specialized test facilities, in order to demonstrate its compliance with the project specifications and allow its release to shipyard.

8.5.2. For Factory Acceptance Test (FAT) minimum scope requirements:


- i. Hydrostatic test of all pipes.
- ii. Performance test and Mechanical running test of all pumps. At performance test, PACKAGER shall run the pump until minimum suction level is reached, simulating pump operation, and shall record vibration to evaluated possible cavitation problems. PACKAGER shall run the pump with maximum submergence and with closed discharge to verify mechanical pump casing integrity.
- iii. Electrical continuity checks on all wiring and earthing.
- iv. Functional checks on all instruments and valves.
- v. Alarms and Equipment Protection Tests.
- vi. All other equipment tests and factory checking to be carried out according to the FAT procedure approved by parts.


8.5.3. For Factory Acceptance Test (FAT) event invitation e reports:


- i. OWNER, CS and HULL SUPPLIER shall be communicated about the FAT event following ITP and the fabrication schedule. FAT invitation schedule shall be negotiated during PACKAGE kick-off meeting on the detail design phase.
- ii. PACKAGER shall issue the FAT procedure for all parts involved as OWNER, HULL SUPPLIER and CS, where applicable, and submit to them for approval.
- iii. PACKAGER shall issue the FAT report with all test results and duly signed or stamped by all parts that witnessed the FAT and with the test reference documentation attached.
- iv. Acceptance of FAT will not be considered as the final acceptance test of the PACKAGE.

## 8.6. PRE-COMMISSIONING AND COMMISSIONING



	<b>TECHNICAL SPECIFICATION</b>	Nr: <b>I-ET-3010.1Y-1350-311-P4X-001</b>	REV. <b>A</b>
	BÚZIOS		SHEET: 33 of 35
	TITLE: <b>CARGO AREA SUBMERGED PUMPS</b>		INTERNAL
ESUP			
<p>8.6.1. PACKAGER / MANUFACTURER shall be required to provide any necessary support for installation, assembly, pre-commissioning and commissioning of the PACKAGE either at a shore based fabrication yard or onboard the FPSO.</p> <p>8.6.2. PACKAGER / MANUFACTURER is responsible for assembly supervision of the PACKAGE equipment, including the assembly of components to be delivered loose (for example, some components of the pumps, like stuffing box, etc.).</p> <p>8.6.3. Final acceptance will be on satisfactory completion of commissioning tests as specified by OWNER.</p> <p><b>9. PACKAGE DELIVERY REQUIREMENTS</b></p> <p><b>9.1. PRESERVATION, PACKING AND TRANSPORTATION</b></p> <p>9.1.1. PACKAGER / MANUFACTURER shall ensure all the conditions and practices of preservation, packing and transportation are fulfilled and following the PACKAGE / Equipment specific and technical characteristics recommendations.</p> <p>9.1.2. PACKAGER / MANUFACTURER shall submit to HULL SUPPLIER the PACKAGE preservation requirements and recommendations with all necessary considerations for the PACKAGE Equipment preservation during the UNIT whole design life.</p> <p>9.1.3. Preservation and packing shall be proper for transportation and storage in a marine environment and protected against moisture and damage during transport, handling and lifting.</p> <p>9.1.4. In any case, suitable preservation and protective measures shall be provided to prevent equipment deterioration prior to entering into service.</p> <p>9.1.5. All packings shall be clearly marked for shipping, including lifting points, gross weight, dimensions and center of gravity.</p> <p>9.1.6. All sea fastening and temporary supports used on the equipment for shipment shall be clearly identified.</p> <p>9.1.7. PACKAGER / MANUFACTURER shall ensure that all loose valves, tubes and instruments are supplied with plastic caps.</p> <p>9.1.8. PACKAGER / MANUFACTURER shall also ensure that all electric panels and motors will be supplied with Volatile Corrosion Inhibitor (VCI) impregnated plastic protection or similar, and external plug for space heater connection.</p> <p>9.1.9. PACKAGER / MANUFACTURER shall provide clear and comprehensive instructions on the exterior of all packages advising the necessary warning notices for unpacking, handling and installing the equipment on arrival at destination.</p> <p>9.1.10. The equipment shall be thoroughly cleaned internally and be free of all loose foreign materials.</p>			

	<b>TECHNICAL SPECIFICATION</b>	Nr: <b>I-ET-3010.1Y-1350-311-P4X-001</b>	REV. <b>A</b>
	BÚZIOS		SHEET: 34 of 35
	TITLE: <b>CARGO AREA SUBMERGED PUMPS</b>		INTERNAL
ESUP			
<ul style="list-style-type: none"> <li>i. The preparation shall make the equipment suitable for outdoor storage in a coastal tropical climate from the time of Shipment.</li> <li>ii. If there is a risk of damage to valves and other appurtenances during transportation, they shall be disconnected and tagged. All components shall then be securely packed as above.</li> <li>iii. Spare parts and tools to be packed separately and clearly marked "Spare Parts" and "Tools" respectively.</li> </ul>			
<b>9.2. SPARE PARTS, CONSUMABLES AND TOOLS</b>			
9.2.1. All equipment / material consumable and spare parts recommended by PACKAGER / MANUFACTURER for the construction, testing, commissioning, pre-operation and start-up phases.			
9.2.2. All spare parts recommended or required by the CS: such spare parts will be delivered together with the relevant equipment;			
9.2.3. All special tools required for construction, pre-commissioning, commissioning and all levels of maintenance and operation.			
9.2.4. Spare parts list recommended by PACKAGER / MANUFACTURER for two years of operation.			
<b>9.3. DOCUMENTATION</b>			
9.3.1. Drawings and Weight Control			
For Engineering Documentation minimum requirements:			
<ul style="list-style-type: none"> <li>i. PACKAGER / MANUFACTURER design drawings shall show all necessary dimensions and details required for interface information and installation.</li> <li>ii. Clearances for maintenance shall be shown on the drawings.</li> <li>iii. Drawings and documents shall be clear and completely legible with all text in the English language.</li> <li>iv. Instruction manuals for operation and maintenance of the PACKAGE equipment shall be provided in Portuguese language.</li> <li>v. Drawings are only accepted when signed by PACKAGER as checked and approved. All revised editions of drawings or documents shall show the revisions clearly marked up, the issue date and PACKAGER's checked and approved signatures.</li> <li>vi. PACKAGER / MANUFACTURER shall produce a weight / center of gravity data sheet considering each PACKAGE component with the respective assembly dry and operational weight and CoG.</li> </ul>			

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.1Y-1350-311-P4X-001	REV. A
	BÚZIOS		SHEET: 35 of 35
	TITLE: CARGO AREA SUBMERGED PUMPS		INTERNAL

- Note: Operational weight means the component dry weight added to the respective component fluid weight on operational condition.

- vii. PACKAGER shall send in advance all recommendations for PACKAGE installation, maintenance and commissioning.

### 9.3.2. Data Book

PACKAGER shall issue a PACKAGE / Equipment Data Book to be delivered to HULL SUPPLIER for approval. Data Book minimum content shall be as the following:

- i. Certified drawings, data sheets, technical specifications, performance curves and calculation memorandum.
- ii. Construction, maintenance and operating manuals, instructions for preservation and commissioning, and all catalogs, including of the sub-suppliers.
- iii. All certificates of materials and equipment, certificates of electrical cables and equipment to hazardous areas, all tests, destructive and non-destructive examinations, test reports (including FAT), certificates and reports of classification society, procedures for welding qualifications and welding processes.
- iv. The documentation requested by Brazilian law NR-13, subdivided for equipment (if applicable).
- v. The documentation requested by Brazilian law NR-10, subdivided for equipment (if applicable).

Data Book delivery standard and conditions including number of parts and sections, number of printed and electronic copies will be further defined by OWNER on detail design phase.

## 9.4. TRAINING

- 9.4.1. PACKAGER shall provide training to qualify OWNER technicians for operation and maintenance (install, dismantle, replace parts, make adjustment, etc.) of each equipment.