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	CLIENT: BÚZIOS			SHEET: 1 of 51	
	JOB: HIGH CAPACITY FPSO				
	AREA: BÚZIOS				
<b>SRGE</b>	TITLE: OFFLOADING SYSTEM			INTERNAL	
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### INDEX OF REVISIONS

<b>REV.</b>	<b>DESCRIPTION AND/OR REVISED SHEETS</b>
0	<i>Original issue</i>
A	<i>Minor updates according to later HAZOP adjustments. Duplicated text was removed, and also some Contractual requirements was removed as this document objective is a technical specification for the system.</i>

	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE	DEC/01/20	APR/08/21							
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## 1. INTRODUCTION

### 1.1 OBJECTIVE

This specification describes and specifies the minimum requirements and criteria for the supply of INTEGRATED OFFLOADING SYSTEM AND EQUIPMENT, henceforth "OFFLOADING SYSTEM" or "PACKAGE". This Specification is aimed to assure the best technical purchase as possible avoiding early failures during tests or in operation.

OFFLOADING SYSTEM is the system designed to discharge produced oil from FPSO to an Oil tanker.

All related equipment for an integrated and reliable OFFLOADING SYSTEM, encompassing Hose Reel, Hydraulic Power Unit, Hawser and Messengers Winches, Electric and Cooling system for HPU, shall be provided.

### 1.2 DEFINITIONS

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

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

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

**SHOULD:** is a recommendation. Alternative solutions having the same functionality and quality are acceptable.

**FIELD PROVEN:** are systems and equipment which 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.

**PACKAGE:** is the OFFLOADING SYSTEM interconnected, tested and operating, requiring only the available utilities from the FPSO for full operation.

**PACKAGER:** is the 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. PACKAGER is the responsible for project, assembly, construction, fabrication, testing and furnishing of the Package.

**HULL SUPPLIER:** is defined as the responsible for all equipment, project, assembly,



construction, fabrication, testing, furnishing, installations and services related to Unit Hull.


UNIT: is defined as the FPSO (Floating Production Storage and Offloading).


SHIPYARD: is the Unit Hull construction and assembly site.

OFFLOADING SYSTEM: is the package name.

### 1.3 ABBREVIATIONS

BLS	Bow Loading System
CCR	Central Control Room
CS	Classification Society
CTV	Cargo Transfer Vessel
dB(A)	Decibel measured weighted noise level
DGPS	Differential Global Positioning System
DP	Dynamic Positioning
DPST	Dynamic Positioning Shuttle Tanker
QRMH	Quick Release Mooring Hook
FAT	Factory Acceptance Tests
FPSO	Floating Production Storage and Offloading
HPU	Hydraulic Power Unit
IMO	International Maritime Organization
NBR	Brazilian Standard
NSV	North Sea Valve or Offloading Hose End Valve
OCIMF	Oil Companies International Marine Forum
RO	Recognized Organization
SPM	Single Point Mooring
ST	Shuttle Tanker

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<p>QA / QC    Quality Assurance / Quality Control</p> <p>QS        Quality Surveillance</p>			
<p><b>1.4 SUBCONTRACTORS</b></p> <p>PACKAGER shall be responsible for all co-ordination with subcontractors and full submission of all documents requested in this specification.</p>			
<p><b>1.5 ALTERNATIVES AND DEVIATIONS</b></p> <p>Deviations shall be kept to a minimum. Where PACKAGER considers deviations to this specification and associated reference documents would result in a more suitable installation, he may propose these modifications in terms of scope and price.</p> <p>The deviations must be clearly indicated by PACKAGER in a specific item of its Technical Proposal named "Deviation List", for PETROBRAS evaluation.</p>			
<p><b>2. NORMATIVE REFERENCES</b></p> <p>All equipment shall comply with the requirements of this technical specification, referenced data sheets, documents as stated below and those referred herein.</p>			
<p><b>2.1 INTERNATIONAL CODES, RECOMMENDED PRACTICES AND STANDARDS</b></p> <p>The equipment will be designed and manufactured in accordance with the following accepted codes and standards, if not mentioned otherwise.</p> <ul style="list-style-type: none"> <li>• DIN German National Standard Code</li> <li>• ISO International Standard Organization</li> <li>• EN European Standards</li> <li>• VDE / IEC German National Electric Standard Codes / International Electric Codes</li> <li>• BGV German Safety Regulations</li> <li>• ASME American Society Of Mechanical Engineers</li> <li>• ANSI American National Standards Institute</li> <li>• Classification Society defined for the Hull scope.</li> </ul>			

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<ul style="list-style-type: none"> <li>• IMO MSC / Circ. 474 - Guidelines for Bow and Stern Loading and Unloading Arrangements on Oil Tankers;</li> <li>• Offshore Loading Safety Guidelines with special relevance to harsh weather zones - OCIMF, 1st Edition – 1999;</li> <li>• Guide to Purchasing, Manufacturing and Testing of Loading and Discharge Hoses for Offshore Moorings, 1991 – OCIMF;</li> <li>• Guidelines for the Handling, Storage, Inspection and Testing of Hoses in the Field – OCIMF;</li> <li>• Buoy Mooring Forum – SPM Hose System – Design Commentary, 1993 – OCIMF;</li> <li>• Recommendation for oil tanker manifolds and associated equipment, Fourth Edition 1991 – OCIMF;</li> <li>• SPM hose ancillaries guide, 3rd Edition 1987 – OCIMF;</li> <li>• International Safety Guide for Oil Tankers &amp; Terminal – ISGOTT;</li> <li>• AWS D1.1: 2000 Structural Welding Code – Steel;</li> <li>• AISC ASD 9th edition (For shear, axial, bending strength, beam and column buckling of other than cylindrical members);</li> <li>• API RP2A-WSD 20th edition (For shear, axial, bending and buckling strength of cylindrical members and code checking of tubular joints. Also for requirements for lifting analysis);</li> <li>• ISO 12944-1:2017 - Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 1: General introduction.</li> <li>• ISO 15156-1: 2015 - Petroleum and natural gas industries — Materials for use in H2S-containing environments in oil and gas production</li> </ul>			
<p><b>2.2 BRAZILIAN CODES AND STANDARDS</b></p> <ul style="list-style-type: none"> <li>• NR 10 Brazilian Federal Government Regulatory Standards – <i>Norma Regulamentadora Nº 10, Segurança em Instalações e Serviços em Eletricidade</i> - Safety in Electrical Facilities and Services;</li> <li>• NR 12 Brazilian Federal Government Regulatory Standards – <i>Norma Regulamentadora Nº 12, Segurança em Instalações e Serviços em Máquinas e Equipamentos</i> - Safety on Installation and Services with Machines and Equipment;</li> </ul>			


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<ul style="list-style-type: none"> <li>• NR 13 Brazilian Federal Government Regulatory Standards – <i>Norma Regulamentadora Nº 13, Segurança em Inspeção de Segurança e Operação de Vasos de Pressão, Caldeiras e Tubulações - Safety on Boilers and Pressure Vessels;</i></li> <li>• NR 26 Brazilian Federal Government Regulatory Standards – <i>Norma Regulamentadora Nº 26, Sinalização de Segurança - Safety Signaling;</i></li> <li>• NR 37 Brazilian Federal Government Regulatory Standards – <i>Norma Regulamentadora Nº 37, Segurança e Saúde em Plataformas de Petróleo - Safety and Health onboard Offshore Platforms;</i></li> <li>• NORMAM 01 – Brazilian Federal Government Regulatory Standards - <i>Normas da Autoridade Marítima Brasileira 01;</i></li> <li>• NBR 13715-2 – Brazilian Federal Government Regulatory Standards – <i>Estruturas oceânicas - Amarras - Parte 2: Requisitos e métodos de ensaio.</i></li> </ul>			
<h3>2.3 CONFLICTING REQUIREMENTS</h3> <p>In case of conflicting information between this Technical Specification and the referred documents and applicable standards, PACKAGER shall state in its deviation list to PETROBRAS clarification.</p>			
<h3>2.4 CLASS APPROVAL AND CERTIFICATION</h3> <p>Certification and approval as required by the above rules is PACKAGER’s responsibility. PACKAGER shall communicate directly and provide all documentation necessary to obtain approvals. HULL SUPPLIER shall be copied on all correspondence. PACKAGER shall obtain approval for all parts of their work before shipment of the equipment to the shipyard and provide PETROBRAS with the Classification Society approval and other duly documentation to start operation and keep a safe operation.</p> <p>The OFFLOADING SYSTEM shall be designed manufactured, installed and tested in accordance with the latest edition Rules, Regulations and Standards.</p> <p>PACKAGER shall produce evidence of having complied with all regulations, always in their indicated editions, as well as with the requirements defined in this specification. In case of any disagreement or discrepancy in fulfillment between regulations or requirements, it shall be submitted a formal technical query to PETROBRAS for analysis.</p> <p>PACKAGER shall provide and deliver 2 (two) originals of the following certificates and related documents:</p> <ul style="list-style-type: none"> <li>- Classification Society certificate;</li> <li>- Certificates required by Classification Society and Regulatory Bodies;</li> <li>- Materials certificates;</li> </ul>			



- Guarantee certificate.

### 3. HIGH CAPACITY FPSO DESIGN REFERENCE DOCUMENTS

TITLE	DOCUMENT NUMBER
AREA CLASSIFICATION – GENERAL	I-DE-3010.1Y-5400-94A-P4X-001
AUTOMATION INTERFACE OF PACKAGE UNITS	I-ET-3010.00-1200-800-P4X-014
AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS	I-ET-3010.00-1200-800-P4X-002
DESCRIPTIVE MEMORANDUM - GENERAL	I-MD-3010.1Y-1200-940-P4X-017
DESCRIPTIVE MEMORANDUM - HULL SYSTEMS	I-MD-3010.1Y-1200-940-P4X-027
DESCRIPTIVE MEMORANDUM - SAFETY	I-MD-3010.1Y-1200-940-P4X-021
ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS	I-ET-3010.00-5140-700-P4X-003
ELECTRICAL SYSTEM AUTOMATION ARCHITECTURE DIAGRAM	I-DE-3010.00-5140-797-P4X-001
GENERAL ARRANGEMENT	I-DE-3010.1Y-1200-942-P4X-001
GENERAL PAINTING	I-ET-3010.00-1200-956-P4X-002
GROUNDING INSTALLATION TYPICAL DETAILS	I-DE-3010.00-5140-700-P4X-003
HULL PIPING SPECIFICATION	I-ET-3010.1Y-1200-200-P4X-002
METOCEAN DATA	I-ET-3A36.00-1000-941-PPC-001
MOTION ANALYSIS	I-RL-3010.1Y-1350-960-P4X-009
NOISE CONTROL REQUIREMENTS FOR ACCOMMODATION / SHIPSIDE	I-ET-3010.1Y-1200-300-P4X-002
NOISE CONTROL REQUIREMENTS FOR TOPSIDE	I-ET-3010.1Y-1200-300-P4X-001
OFFLOADING HYDRAULIC SYSTEM	I-DE-3010.1Y-5139-944-P4X-005

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PIPING AND INSTRUMENT DIAGRAM FOR CARGO SYSTEM	I-DE-3010.1Y-1350-944-P4X-003
PIPING SPECIFICATION FOR HULL	I-ET-3010.1Y-1200-200-P4X-002
POSITIONING REFERENCE SYSTEMS FOR OFFSHORE LOADING SYSTEM	I-ET-3010.1Y-5537-76F-PPT-001
PRELIMINARY TRIM AND STABILITY BOOKLET	I-RL-3010.1Y-1350-960-P4X-007
QUALIFICATION TESTS FOR PAINT SYSTEMS	I-ET-3010.00-1200-956-P4X-001
SAFETY SIGNALLING	I-ET-3010.00-5400-947-P4X-002
SPECIFICATION FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS	I-ET-3010.00-5140-700-P4X-002
TAGGING PROCEDURE FOR PRODUCTION UNITS DESIGN	I-ET-3000.00-1200-940-P4X-001

Table 1 – Reference Document List

#### 4. QUALITY ENSURANCE AND QUALITY CONTROL

##### 4.1 QA/QC SYSTEM

Engineering, fabrication and manufacturing shall conform to good and sound manufacturing practices. Quality system according to ISO 9001 in relevant extent shall be in place and implemented.


PACKAGER shall submit his Quality Assurance / Quality Control handbook to HULL SUPPLIER for information.

##### 4.2 INSPECTION

PETROBRAS and HULL SUPPLIER and their designated agents shall have free access to any relevant part of the works, and the right to perform inspections on all aspects of the job covered by this specification and the relevant contract drawings.

PETROBRAS and HULL SUPPLIER reserves the right to conduct a system audit on the implementation of PACKAGER's quality assurance system. PETROBRAS and HULL SUPPLIER shall have free access to all relevant documents and records.

PETROBRAS reserves the right to inspect the package equipment anytime during fabrication to ensure that material and workmanship are in accordance with this specification.

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#### 4.3 QS SCHEDULE

PACKAGER shall propose a quality surveillance schedule with witness and hold points.

### 5. DESIGN REQUIREMENTS

#### 5.1 DESIGN LIFE

Equipment shall be designed for a 30-year lifetime in a corrosive offshore environment (environmental characteristics as per C5M according to ISO12944-1) without the need for replacement of any major component due to wear, corrosion, fatigue, or material failure.

#### 5.2 DESIGN CONDITIONS

PACKAGER shall design the equipment for the full range of operational conditions as specified in this technical specification.

#### 5.3 PERFORMANCE


OFFLOADING SYSTEM shall be designed to guarantee the compliance of the requirements stated in this specification and also on the Technical Data Sheets indicated on the above reference documents (item 3).

All elements of the PACKAGE, including sub orders, shall be of proven design and well within the manufacturer's actual experience.

### 6. DESIGN PREMISES

#### 6.1 ENVIRONMENTAL CONDITIONS

Refer to METOCEAN DATA and the DESCRIPTIVE MEMORANDUM - GENERAL documents, for the maximum allowed offloading conditions.

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## 6.2 MOTIONS AND ACCELERATIONS

All equipment of the OFFLOADING SYSTEM on board, when are not in an operation of discharging oil to an oil tanker, shall be able to withstand 100-year return period environmental conditions.

All equipment shall be able to operate when the Unit is subjected to 1-year return period worst environmental conditions defined in METEOCEAN DATA, at any draft from fully loaded to the minimum operational draft, and under inclination (static and dynamic) as specified by Class Society.

The equipment is also to withstand inertial forces during transportation from construction site to operation site (onshore or offshore).

The necessary design data and information regarding motion requirements are given in MOTION ANALYSIS.

The equipment is also to withstand inertial forces during transportation from construction site to operation site (onshore or offshore).

The structure of OFFLOADING SYSTEM or "PACKAGE" shall follow this specification and shall be approved by CS structural rules. It shall be issued to PETROBRAS verification. No additional structure will be accepted for alignment or leveling unless it is evaluated and approved by CS rules.

### 6.2.1. Operational Condition

The equipment shall be able to operate under inclination (static and dynamic) as follows:

Heel/roll: 15° static, 22.5° dynamic

Trim/pitch: 5° static, 7.5° dynamic


For safety equipment:

Heel/roll: 22.5° static/dynamic

Trim/pitch: 10° static/dynamic

### 6.2.2. General Design Condition (Transit, Storm, Etc)

All structures and the OFFLOADING SYSTEM itself shall be designed to withstand the 100-year return period condition according to the characteristic environmental parameters as specified on the METEOCEAN DATA.

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### 6.3 CRUDE OIL DATA

The referred data may be found in I-FD-3010.1Y-1350-311-P4X-001 - Cargo pumps (B-1350501 A/T) as operating conditions considered for the pumps performance.

### 6.4 EQUIPMENT LOCATION

Since Buzios Units are of Spread Mooring System type and thus, do not align to the weather as Single point Mooring (Turret) Systems, the OFFLOADING SYSTEM will be installed at the bow as forward as possible at the centerline and stern as afterwards as possible of the FPSO, in order to facilitate Offloading operations, depending on the weather conditions for safety reasons.

GENERAL ARRANGEMENT and AREA CLASSIFICATION - GENERAL shall be used as reference for equipment location.

### 6.5 SAFETY REQUIREMENTS

Personnel safety protection shall be provided according to Regulatory Standards (NR) by Brazilian Federal Government.

Warning signs in Brazilian Portuguese language shall be provided where risk of personnel injury exist.

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.


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".

PACKAGER shall issue a declaration of "asbestos free" compliance and supporting documentation to substantiate the declaration.

Safety signaling shall be in full compliance with SAFETY SIGNALING.

### 6.6 NOISE AND VIBRATIONS

Noise and vibrations limits shall be in accordance to NOISE CONTROL REQUIREMENTS FOR TOPSIDE and NOISE CONTROL REQUIREMENTS FOR ACCOMMODATION / SHIPSIDE, according to reference document list.

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Noise data is required for the final proposal and after the Factory Acceptance Tests (FAT).

The maximum sound level at any location 1m from the equipment shall not exceed 85 dB(A). This is applicable to all of the operating conditions for which the equipment is used.

## 6.7 MODES OF OPERATION

In Brazilian Waters, the offloading operation is performed keeping the oil tanker connected to the Unit or to a CTV by a mooring rope (hawser), in a tandem configuration. To do so, the operation is carried out according to the modes described below.

### Operational Mode 1 - "Full DP mode"

This is an operational mode typically used for Units fitted with Absolute and Relative Positioning Reference System (PRS). In this mode the shuttle tanker has the DP system wholly available (power generation, propulsion and control systems). Under this mode the positioning control of the DPST is automatically done by the DP system, either in absolute or relative mode, via simultaneous control of range between vessels (Unit-Shuttle) and relative heading. The hawser is kept slack all the time.

### Operational Mode 2 - "DP AutoPos mode"


It is a DP operational mode normally used when the SETUP between FPSO and DPST has not been performed yet. In this operational mode the relative PRS are available but not into the Shuttle Tanker DP Software. Under this mode the positioning control of the ST is automatically done by the DP system only by means of absolute positioning reference system (DGPSs).

### Operational Mode 3 - "DP Taut Hawser mode"

This is an operational mode normally used for Units, which are not equipped with Relative PRS. In this mode the shuttle tanker operator (ST Master) maintains the positioning control manually, through the DP console (joystick) or the propeller console (control over each thruster individually). In this way, the DPST Master controls the position of the DPST by monitoring the hawser tension and the relative heading between the two vessels, limited to the values specified in PNBV' operational procedures.

### Operational Mode 4 - "Conventional mode"

This is the usual mode when operating with regular trading tankers and where allowed by PETROBRAS in accordance with the terminal type. As a rule, this mode shall be performed in Single Point Moored Units or by using a Cargo Transfer Vessel (CTV). Usually, an emergency offloading hose string shall be installed to convey the oil to the tanker, as regular trading tankers do not have a BLS.

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## 7. PACKAGE SPECIFICATION AND TECHNICAL REQUIREMENTS

The scope of this Specification is to allow the PACKAGER to offer the most suitable, safe and integrated offloading system TO PETROBRAS.

An international recognized offshore equipment and system supplier company shall supply both bow and stern integrated Offloading system.

All equipment and systems related to the Offloading system shall be subject to Failure Modes and Effect Analysis (FMEA) which report shall be issued to PETROBRAS verification. This analysis is aimed to assure that a simple failure in any component of the bow station as an integrated PACKAGE shall not lead to a failure which could prevent the continuity of safe operations in that station. The same analysis shall be issued related to the stern station. The criticality of the consequences of all failures depicted in this FMEA shall be in the report. FMEA Trials Tests on installed Offloading system shall be witnessed and evaluated by PETROBRAS and the schedule for tests shall be issued two months prior to tests.

### 7.1 SCOPE OF SUPPLY

'PACKAGER's scope of supply shall include a complete engineering OFFLOADING SYSTEM with certified drawings showing dimensions, weights, connections and further information necessary to facilitate the installation work. All necessary approvals or certificates, test sheets, instruction books and other documents required for proper operation and maintenance of the equipment during its lifetime shall be provided by the PACKAGER.

The PACKAGER shall provide, among other documents, a Technical Manual of the OFFLOADING SYSTEM comprising of:

- Technical data of the system and its components;
- Functional description of the main systems;
- Guidelines for the regular maintenance, replacement, repairs, inspection, handling and tests for the OFFLOADING SYSTEM and its components;
- Operational procedures for mooring, unmooring, emergency situations (hawser and hose string disconnection) and offloading (including flushing the hose string and exchange hoses in offshore site) as follows:
  - o Hose, hawser and messenger cable transfer to shuttle tanker in normal operation conditions, as well as hose, hawser and messenger cable retrieval procedure;
  - o Emergency hose string and hawser disconnection from shuttle tanker;
  - o Hose installation at shipyard;



- Hose removal and installation at offshore location;
  - Emergency offloading hose installation; and
  - Internal flushing of the hose using NSV flushing cover (using FPSOs butterworth pump).
- Weight list of the OFFLOADING SYSTEM;
  - Recommendations from the manufacturer where applicable.

Remark: The PACKAGER shall submit the proposed operational procedures and technical specifications for PETROBRAS to analyze.

All necessary spare material shall be stored in adequate quantities in places that allow fast handling. Accordingly, PACKAGER shall indicate the best place to allow it.

PACKAGER shall supply two Offloading systems, at bow and at stern of the Unit, in order to be possible to transfer produced oil from FPSO cargo tanks to an oil tanker. Equipment tag shall be according to the PIPING AND INSTRUMENT DIAGRAM OFFLOADING HYDRAULIC SYSTEM "I-DE-3010.1Y-5139-944-P4X-005" last revision, as follows:

TAG	DESCRIPTION
GN-Z-1359502-01	OFFLOADING HOSE REEL (AFT)
GN-Z-1359502-02	HAWSER REEL (AFT)
GN-Z-1359502-03	AUXILIARY WINCH FOR HOSE MESSENGER / HAWSER MESSENGER (AFT)
GN-Z-1359502-04	EMERGENCY OFFLOADING STATION/WINCH (AFT)
GN-Z-1359506-01	OFFLOADING HOSE REEL (FWD)
GN-Z-1359506-02	HAWSER REEL (FWD)
GN-Z-1359506-03	AUXILIARY WINCH FOR HOSE MESSENGER / HAWSER MESSENGER (FWD)
GN-Z-1359506-04	EMERGENCY OFFLOADING STATION/WINCH (FWD)
PN-GN-Z-1359502-01	AFT OFFLOADING HOSE WINCH & REEL CONTROL PANEL
PN-GN-Z-1359502-02	AFT OFFLOADING HAWSER WINCH & REEL CONTROL PANEL
PN-GN-Z-1359506-01	FWD OFFLOADING HOSE WINCH & REEL CONTROL PANEL
PN-GN-Z-1359506-02	FWD OFFLOADING HAWSER WINCH & REEL CONTROL PANEL



PN-UH-1359506A	OFFLOADING HYDRAULIC POWER UNIT CONTROL PANEL (AFT)
PN-UH-1359506B	OFFLOADING HYDRAULIC POWER UNIT CONTROL PANEL (FWD)
UH-1359506A	OFFLOADING HYDRAULIC POWER UNIT (AFT)
UH-1359506B	OFFLOADING HYDRAULIC POWER UNIT (FWD)
Z-1359503	QUICK RELEASE MOORING HOOK (QRMH) (FWD)
Z-1359504	HOSE REEL SPOOLING DEVICE (FWD)
Z-1359507	QUICK RELEASE MOORING HOOK (QRMH) (AFT)
Z-1359508	HOSE REEL SPOOLING DEVICE (AFT)

*Table 2 - Equipment tag*

The connection from cargo system line to Offloading system it shall be made by use of bow and stern XV valves (tag 1350598 – fwd, and 1350601 – aft).

Valves tags and automation logic are described in document “PIPING AND INSTRUMENT DIAGRAM FOR CARGO SYSTEM”, for the following systems:


- Contingency system;
- North Sea Hydrostatic test;
- Offloading internal cleaning operations;
- Positioning reference system; and
- Interface to the Offloading transfer metering skid.

The Offloading system performance shall be aligned with the cargo system, as follows:

- It shall be dimensioned to transfer within 24h, one million of produced oil barrels from FPSO cargo tanks to an oil tanker. For equipment lifetime design and construction mainly hose and NSV, it shall be designed to withstand 100 offloadings per year;

- The offloading operations shall be performed with at least (6) cargo pumps operating safely and simultaneously. Considering submerged type pumps are used, enough amount of oil shall remain to allow proper function of submerged pumps (around six percent of the volume of the tank). It must be possible to use any combination of any 6 of cargo tanks; and

- The cargo pumps header shall be dimensioned to withstand the flowrate of six (6) cargo pumps operating at the same time, in parallel, at the designed point.

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PACKAGER shall provide arrangements and facilities to allow proper internal cleaning of the offloading system (including the offloading hose), which will be performed immediately after every cargo transfer (offloading) as follows:

- It shall be possible to pump water through the offloading hose from the FPSO to the shuttle tanker.
- After the oil offloading being performed, the shuttle tanker shall pump the water back to the FPSO. Therefore, the FPSO shall not have any constraint, such as non-return valves at the hose reel or emergency hose that may jeopardize the seawater pump-back operation from shuttle tanker.
- Additionally, FPSO shall be capable to perform final flushing (cleaning) of the offloading hose on a “closed circuit mode”. The close circuit mode means the offloading hose will be reeled and stored onboard the FPSO.
- The arrangements for connecting water lines to cargo system slop tank or dedicated return tank shall be submitted to PETROBRAS for analysis.

Related to the ESD system, a shutdown valve shall be installed upstream to both offloading system, bow and stern. This shutdown valve shall be of a single effect hydraulic driven butterfly valve fail closed type.

Related to the safety system, burst discs shall be installed to mitigate hydraulic transients on the offloading headers and shall be dimensioned considering the scenarium of the maximum pressure.

Rupture (burst) discs shall have a burst disc sensor indicator. In case of disc burst, an alarm visual and sound alarm shall be sensed in central control room. The offloading system shall stop offloading pumping automatically and shall be possible to disconnect hose (NSV side) and hawser(s) in a physically and environmentally safe manner.


PACKAGER shall inform the shut-off pressure of the cargo pumps and the burst pressure of the rupture discs. Surge Analysis shall be issued for PETROBRAS verification.


Contingency offloading connections shall be installed downstream of both offloading systems. These contingency offloading connections shall also be provided with oil trays.

A sampling connection shall be installed upstream offloading transfer metering skid. The purpose of this connection is to collect exported crude oil sample. This connection shall also be provided with an oil tray.

Any line, specially located near the accommodation shall be of entirely welded connection, i e, without use of flanges, mitigating possible flange leakages.

The package above shall be connected, wired and supplied as a complete unit, ready for installation and operation.

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<p>All interconnection piping and valves within the limits of the skid. All necessary ancillaries, instruments and control panel. All other parts or components required for operation of the system.</p> <p>Additionally, to ensure reliable operation and maintenance of the Offloading system encompassing control valves, coolers, control panels, for instance, as required in this specification, they shall be supplied from the PACKAGER and PACKAGER's subcontractors.</p> <p>PACKAGER shall provide all equipment and system related to this specification to provide an integrated package, fully operational and tested, assuring the required safety to persons, environment, FPSO and vessels while in operation.</p> <p>And finally, the PACKAGER shall also provide (or address HULL SUPPLIER by formal documentation) all safety means for handling and maintaining the Offloading system, by supplying:</p> <ul style="list-style-type: none"> <li>- Access platforms for safe inspections and maintenance, including the maintenance to NSV (North Sea Valve);</li> <li>- Structural protections for workers;</li> <li>- Storage room for steel wire, ropes and NSV;</li> <li>- Means of internal washing offloading hose (according to internationally recognized procedures). Air outlets will be provided by the HULL SUPPLIER;</li> <li>- Means of safety handling emergency hose and facilities to perform pull in / pull out, by using proper equipment as winch and lifting flange. It will not be accepted procedures where the operators shall be in a unsafe position near tensioned hose, hawser, wires or ropes;</li> <li>- Means of safety handling messenger cables and facilities to perform reel in or pay out, by using proper equipment as winch and shackles;</li> <li>- Flanges both for the offloading hose (main or emergency) shall be of 20 inches class 300 type;</li> <li>- It shall be possible to drain the offloading hose by the FPSO;</li> <li>- It shall be possible to carry out inertization of the offloading hose;</li> <li>- There shall be no interference in the route of the hose pull-in cables from puller and/or protrusions that can cause a damage in hoses;</li> <li>- The lower part of hose reel shall not be excessively high. It shall be possible to proceed the routine hose inspections/maintenance without need scaffolding;</li> <li>- The Spooling device shall be positioned allowing free space in deck for other equipment. It shall also be free of edges or corners that could damage the hoses;</li> </ul>			

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<p>- The structure of the Spooling shall be designed to withstand the impact of the hose during offloading operation in bad weather conditions and shall follow this specification and shall be approved by CS structural rules. Such structural analysis shall be issued for PETROBRAS verification. No additional structure will be accepted for alignment or levelling unless it is evaluated and approved by CS rules.</p>			
<h2>7.2 MOORING EQUIPMENT FOR OFFLOADING OPERATION</h2>			
<h3>7.2.1. General Description</h3>			
<p>The mooring system shall be supplied and installed by the PACKAGER comprising of the Hawser Assembly, the Hawser Winch and related outfitting for each loading station, providing a complete arrangement with characteristics in accordance with these specifications.</p>			
<p>On the FPSO side, the hawser / chafe chain will be permanently attached to a chain stopper (also PACKAGER scope of supply), equipped with a load monitoring system as described above. The load monitoring system shall be designed to allow a continuous hawser tension reading and recording in the CCR. Since the hawser tension data will be stored in a computer, PACKAGER shall provide the necessary hardware such as cables, connectors and panels (not necessarily exclusive for this system).</p>			
<p>The chafe chain for mooring system shall attend NBR 13715-2 Guideline, specifically to prevent links not in compliance with this Guideline.</p>			
<h3>7.2.2. Mooring Hawser Assembly</h3>			
<p>The messenger lines are launched using an air gun, from the FPSO, from the shuttle tanker or from CTV. Portable or similar system from the FPSO shall be made available when necessary. No support vessels shall be used for this objective. The air gun for the FPSO shall be provided by the HULL SUPPLIER.</p>			
<p>Spare material in adequate quantities and stored in places that allow fast movement shall be supplied.</p>			
<p>Electric and air compressed outlets shall also be supplied near by Offloading Stations.</p>			
<p>Pad eyes, bollards and Smit brackets must be made available in both decks near to the offloading main and offloading emergency stations, and their position shall allow alignment with strategic points (example: aligned with the load flange of the reel, close to the emergency load station, between the hawser winch and the guardrail ...).</p>			

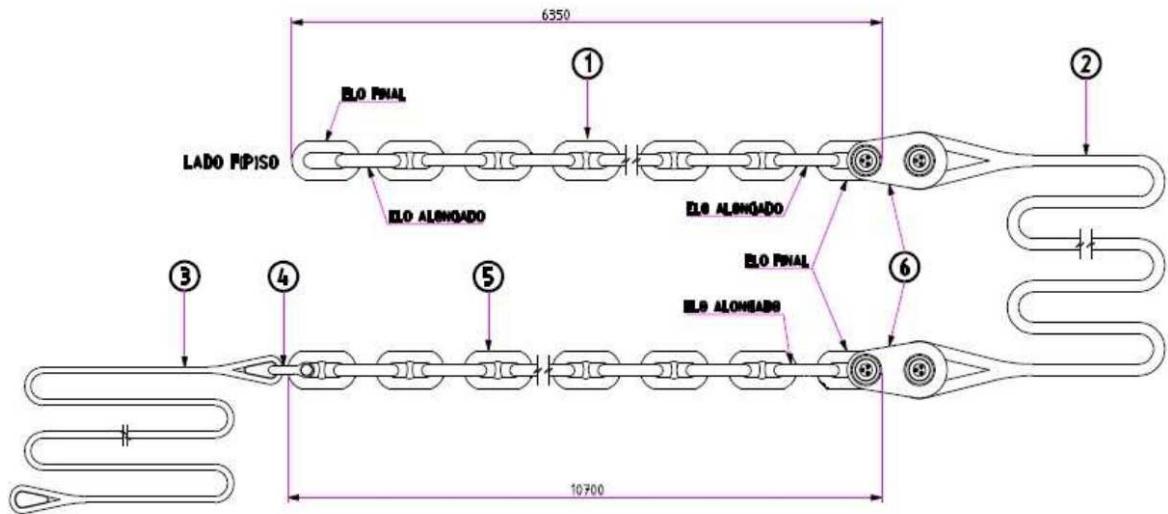


Figura 1 - Mooring Hawser Assembly

- 1) Stud-link chain cable , ABNT NBR 13715-2, R4 , ND 76 mm, both terminals with enlarged end link;
- 2) Fibre rope, ISO 9554, RN 168, polyamide, higher-strength (hs) , double braided construction, MBF 5280 KN , length 150 m , eye splice plus polyurethane coating with RCS certificate of approval;
- 3) Fibre rope, HMPE, ISO 10325, type C (covered), 12 strand, RN 38, MBF 909 KN, with eye splices, length 220 m;
- 4) Bow shackle ABNT NBR 13545, grade 8S , bolt type pin with hexagon head, hexagon nut and AISI 316 split cotter pin, WLL 4o t (body 46 mm, pin 52 mm, width between eyes 77 mm);
- 5) Stud-link cable, ABNT NBR 13715-2 , R4 , ND 76 mm , one terminal with enlarged and end link, other terminal with common link, length 10 m;
- 6) Thimble according to picture below:

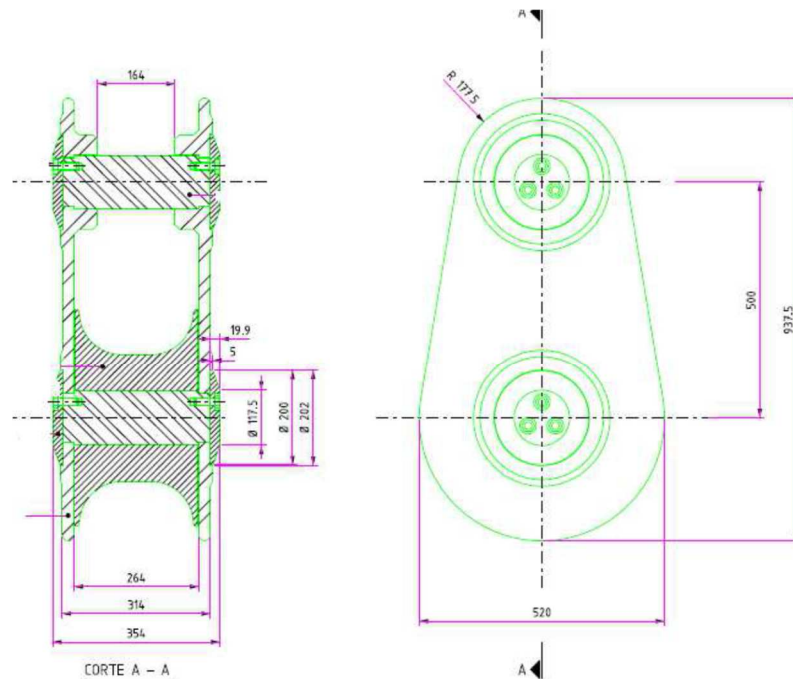


Figura 2 - Rope Chain connector

### 7.2.3. Mooring Hawser Characteristics

The polyamide fibre rope shall be in accordance with ISO 10554.

At least 20% buoyancy reserve is required for the hawser. Lace-on type floats made of closed cell expanded foam elements will be accepted.

The length of the hawser shall be 150 m after permanent stretch, and shall be in accordance to ISO 9554.

Note: The fairlead shall have sufficient internal clearance for the hawser thimble (E-type in both ends) and shackle.

### 7.2.4. Mooring Hawser Winch

The Unit shall be equipped with a hydraulically driven winch at each loading station to handle and to store the mooring hawser.

The hawser winch shall be installed according to the GENERAL ARRANGEMENT.

The winch shall be designed and installed for ease of operation to launch, retrieve and spool the mooring hawser assembly properly.

A Local Control Panel shall be installed adjacent to the hawser winch. The Control Console shall be provided the following functions:



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- Hawser Winch Control;
- HPU Control
- Control of the monitoring of hawser tension

The control panel shall be installed in a place with a clear view of the offloading operational sector. Two (02) control panels shall be provided, one for each offloading station.

The winch drum shall be horizontal or vertical type. No other arrangement will be accepted. If the drum is a horizontal type, it shall be split in two parts, one for the hawser rope and the other for the chafing chain.

The pressure supply line for the hawser winch shall be provided with proportional directional control valve in order to allow variable speed and a smooth operation.

Control panel buttons shall not allow any release of mooring system or hose inadvertently.

A non-hazardous area hydraulic power unit is required.

Lighting for safe operation shall be provided at the offloading stations (consoles, deck work area, access, platforms, etc).

The Hawser winch shall be of welded steel construction installed on both ends (aft and forward) of the Unit.


As structure of Offloading system, the hawser winch structure shall follow this specification and shall be approved by CS structural rules. Such structural analysis shall be issued for PETROBRAS verification and no additional structure will be accepted for alignment or leveling unless it is evaluated and approved by CS rules.

An emergency device, QRMH, for safely and quickly release the hawsers shall be provided in any both offloading stations. This emergency device shall operate even in a Shutdown condition, without HPU running, and thus, accumulators shall be required to trigger such EQRM.


Mooring Hawser Winch main Functions:

- Storage of the entire mooring hawser wire and ropes;
- Hawser spooling mechanism;
- Hawser load monitoring.
- Minimum launching speed.....0.6 m/s
- Minimum retrieval speed.....0.3 m/s

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<ul style="list-style-type: none"> <li>• Drum capacity to store one hawser assembly including the chafe chains and the messenger lines;</li> <li>• Load monitoring system (load cell range 0 - 5000 kN);</li> <li>• Fail Safe Brake System automatically activated in case of hydraulic system failure;</li> <li>• Driving system: Electro-hydraulic driven with local (nearby the winch) control and supervision panel;</li> <li>• Hydraulic System: Two (02) hydraulic pump sets, driven by electrical motor (one set running / one 100 % capacity set stand-by), with: <ul style="list-style-type: none"> <li>○ Emergency accumulator rack, for hawser quick release;</li> <li>○ Oil cooler, adequate for seawater cooling;</li> <li>○ Regular alarms (temperature, oil level etc);</li> <li>○ Stainless steel (AISI 316L) for fittings, valves and tubing.</li> </ul> </li> </ul> <p>Mooring Hawser Winch maintenance considerations:</p> <ul style="list-style-type: none"> <li>• PACKAGER shall provide devices or mechanisms to allow adequate maintenance of the hawser winch drum with no crane assistance;</li> <li>• All equipment shall be provided with suitable marine treatment;</li> <li>• To ensure the hawser winch will be operative and be available when required it is essential that the design take inspection and maintenance activities into consideration;</li> <li>• All grease nipples shall be located to allow easy access and adequate lubrication of the hawser winch.</li> </ul>			
<h3>7.3 TRANSFER OIL RELATED EQUIPMENT</h3> <h4>7.3.1. General</h4> <p>The Offloading System design shall allow a remotely reel in or pay out operation for both hoses or mooring systems, without human intervention and thus, without exposing people to risk areas with tensioned lines.</p> <p>The PACKAGE shall be dimensioned in order to withstand frequent start / stop / reel in / pay out loads, which are customary in an inspection routine.</p> <p>Offloading operations can occur even at night, thus, in both offloading stations it shall be provided good illumination in order to allow safe operations and also inspections of</p>			



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the hoses and mooring system at night and to provide safe operation. The lighting arrangement shall be approved by PETROBRAS.

Controls to start, manage speed and stop operation shall be located in the control panel cabin near by hose reel, but keeping the operator in a safe place protected from the moving devices and whipping wires or ropes.

As structure of Offloading equipment shall follow this specification (including accelerations) and shall be approved by CS structural rules, such structural analysis shall be issued for PETROBRAS verification. No additional structure will be accepted for alignment unless it is evaluated and approved by CS rules.

It is not allowed sharp edges and corners on the internal and external structures (deck and hull) of the Offloading system, including structures of the spooling device in order to avoid damage on the hoses and cables.

The hydraulic system shall be interlocked against inadvertent human action that could cause early failures in the system as a water hammer (hydraulic shock) after start the system with valves closed for instance.

A drainage coaming shall be provided surrounding bow and stern offloading stations, including but not limited to, rose reel, hawser winch and auxiliary winch for hose messenger / hawser messenger. The connection flange between bow /stern offloading header and respective offloading station shall be within this coaming as well as all valves of the offloading station.


### **7.3.2. Worst Operational Case Required Power and Torque**

The worst case required power and torque is defined as follows. The power is related to pump system in HPU and the torque is related to hydraulic gearboxes that move the hose reel.

The hose reel shall be capable of reel in (recover) the offloading hose (filled with seawater and North Sea Valve installed), at the design speed, with the FPSO at the minimum operational draught, and adequate spare capacity considering other effects such as FPSO motions at worst environmental design condition. This is the definition of the worst operational design condition for this document and shall be evaluate accordingly.

The worst environmental design condition is related to the METOCEAN DATA supplied by the PETROBRAS and thus, the accelerations in the system shall be calculated accordingly for use in structural equipment analysis for a safe operation.

The dynamic load shall be considered as 1.5 times the required static load; in the other hand, dynamic safety factors for carrying out tests can be applied as per CS or RO guidelines and shall be approved by PETROBRAS. Procedures of tests shall be issued to the PETROBRAS at least 60 days prior to load tests for comments. Evaluation upon harsh environment condition as per Contract shall be verified by this document.

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### 7.3.3. Hose Reel

The Unit shall be equipped with a welded steel construction, hydraulically driven Hose Reel at each offloading station, bow and stern, designed to handle and to store the entire offloading hose string.

The hose reel shall be installed on the main deck according to GENERAL ARRANGEMENT.

The hose Reel shall be of welded steel construction. The maximum height of the hose reel drum in relation to the deck must be 2.8 meters. The hose reel drum diameter shall be 8.0 meters or larger.

The reel shall be designed and placed for ease of operation to launch, retrieve and spool the hose assembly properly and shall be designed to store the hose string, in one layer, in order to avoid any damage to the hose cover and floating layers. Thus, it must not contain sharp edges or any other part or structure that could damage the hose or hose's cover.

The hose reel shall have the minimum capacity to store the whole offloading hose string and shall have a spooling mechanism and hose load monitoring.

The minimum launching or retrieving speed is 0.3m/s, considering the worst environmental design condition.


Adequate lighting shall be provided over the deck at the offloading stations (consoles, work area, access, platforms, etc).


The gear boxes are the hydraulic devices responsible for turning the offloading hose reel. Each hydraulic gearbox rate of operation will depend on the quantity of hydraulic gearboxes available for each Offloading Unit (bow and stern). All gearbox are intended to operate in parallel.

The hydraulic gearbox is from now on addressed as "gearbox".

The offloading system, bow or stern, shall be designed to allow safe operations (as reel in hose at the design worst operational condition) with one of all gearboxes out of operation. These gearboxes are the ones necessary to move the hose reel. Alternative solutions must be presented in a duly time to PETROBRAS to evaluate. Such alternative design must not cause any postponing in construction.

If in a hose reel there are 2 gearboxes, each gearbox must be designed to deliver, in a case of the worst operational design condition, 100% of total torque required. Thus, a total installed torque shall be 200% of the required torque to keep the hose reel safely operational withstanding the worst operational case. According to this, in a case of 3 gearboxes, each gearbox must be designed to deliver, in a case of the worst operational condition, 50% of total torque required. And so on, in case of 4 gearboxes, 33% each, etc.

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<p>Each of such gearbox has to be torque monitored by means of a load cell. A different value among them to be set at the Offloading panel shall automatically trigger a sound and visual alarm in the Offloading system panels.</p> <p>A fail in a single gearbox and its components shall not unable the hose reel operation with the others gearboxes running. Thus, it must be possible to segregate each gearbox and its components from the operable system. Alternative solutions must be presented in a duly time to PETROBRAS to evaluate. Such alternative design must not cause any postponing in construction.</p> <p>There shall be an interlock system which do not allow overload of any gearbox in case of system failure to turn the hose reel. Also, the interlock shall allow a fail-safe operation. Moreover, an overload value of any of them shall automatically trigger a sound and visual alarm in control cabin and in CCR.</p> <p>The hose reel drive units shall be supplied with an integrated hydraulically operated fail-safe brake.</p> <p>The gearboxes shall be able to withstand the hose reel stopped prior or after the actuation of the static brake. Analysis Report shall be issue along with calculation assuring safety rate levels according to the worst operational design condition.</p> <p>Controls to start, manage speed of turn and stop operation shall be located in a control panel cabin, keeping the operator in a safe distance from the hose reel.</p> <p>The design of the hose reel and its auxiliary equipment must allow inspection and maintenance without exposing people to tensioned load accessories. Including hose string reel in and pay out operations.</p> <p>The gooseneck operational position during offloadings shall be clearly reported in the operational manual.</p> <p>A hydraulic power unit, driven by electric power from the FPSO distribution board, shall generate the required hydraulic power to each hose reel.</p> <p>The hose reel shall have as many hydraulically locking points as possible, equally spaced, which can actuate in many reel positions. This aims to prevent operational malfunction and to prevent devices to early cracks and fractures due to fatigue. The mechanical locking system must provide resources so that the reel operator can lock the reel without any assistance. Sensors shall indicate to the reel operator if it has been locked.</p> <p>The goose neck reinforcement plate (if any) shall allow a passage of the screws and mounting of the flange from pullers.</p> <p>The pad eye to connect the pull-in cables shall not offer a risk of damaging the hoses.</p> <p>There must be an opening in the reel, over the load flange, with pad eye installed on the internal structure of the reel, in order to help, during hose pull in operation, with the connection of the hose first section with the reel load flange.</p>			

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In order to avoid peak loads in the pinions and racks, a joystick control shall be installed at the offloading panel control. It shall be allowed to control start, stop and speed of turn, allowing a smooth movement of hose reel. The pressure supply line shall be provided with proportional directional control valve in order to allow variable speed.

Offloading hose reel material certificates shall be issued along with calculation reports assuring safety torque levels during hose reel operations.

A proportional controller shall act in the pressure line supply so that the hose reel movement starts and stops smoothly.

In each Offloading system, bow and stern, it shall be installed a brake delay (or two hydraulic accumulators) in the parking brake line in order to be able to keep the pressure on the parking brakes avoiding a "crash stop" on the hose reel since it is still in inertial movement. At reduced speed, approximately 3 seconds after stopping hydraulic motors, the parking brakes shall actuate. These accumulators are necessary in order to avoid early wear/burst in parking brakes and, at the same time, they avoid wear/cracks in pinion and rack system of gearboxes when smoothly counteract their movement.

For emergency operation in case of failure of the drive units, the hose can be reeled on the drum by means of a redundant mechanism hydraulically driven. Start, control speed and stop the emergency operation shall be done by a remote control, keeping the operator in a safe distance from the hose reel.

PACKAGER shall provide devices or mechanisms to allow adequate maintenance with no crane assistance.

The Unit shall be equipped with a hydraulically driven winch at each offloading station to launch, retrieve, spool and store the hose messenger line with pull in capacity of 5t and minimum speed of 20m/min.


In order to avoid long nitrogen hoses on the deck, a fixed nitrogen header shall be as near as possible to the offloading stations.

#### **7.3.4. Hose Reel Spooling Device**

The spooling device is hydraulically operated and shall be mounted on the hose reel support structure. It will assist in smooth spooling-on of the hose and messenger line onto the reel.

The spooling device has to be tested in the worst operational case condition as stated in this specification. No difficulties such as stops and bumps shall be observed. It shall withstand the offloading hose whipping.

Structural Report of the spooling device and its related equipment (as for instance the pinion and rack system) shall be issued for PETROBRAS' comments.

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### 7.3.5. Offloading Hydraulic Power Units (HPU)

There shall be 2 (two) offloading hydraulic power units, one dedicated for the bow offloading station and the other for the stern station.

The HPU shall be designed to operate with the winches and the hose reel simultaneously at maximum dynamic load as stated as the worst operational design condition in this specification, regardless at the bow or stern.

The power pack shall supply hydraulic oil for the hose reel hydraulic motors, to the hawser winch, and to all other hydraulic equipment in each station, bow or stern.

All hydraulic piping shall be provided on the hose reel assembly connecting to a manifold.

The hydraulic power unit shall be designed for installation in a non-hazardous area.

The cooling system for HPU shall be included in the Offloading System FMEA as an equipment that could degrade (or eventually stop) offloading operation.

Adequate lighting shall be provided over the deck at the offloading stations (consoles, work area, access, platforms, etc).

Safety valves shall be installed as close as possible to the HPU taking into consideration the maintenance for any device nearby.


Prior to start operations, if HPU valves are closed or there is a low level of hydraulic oil, it shall not be possible to start HPU operation, even if pressing control panel buttons. Accordingly, it shall be provided an interlock system and a visual and audible alarms in order to make these parameters noticeable and not to allow any of these unsafe situations. During operations if any of these unsafe situations occurs, the cited alarms shall be sensed in the Offloading area.


The pump system is from now on addressed as pump.


If a HPU has 2 pumps, each pump must be designed to deliver, in a case of the worst operational design condition, 100% of total power required. Thus, a total installed power shall be 200% of the required power to withstand the worst operational case. If a HPU has 3 pumps, each pump must be designed to deliver, in a case of the worst operational design condition, 50% of total power required. Thus, a total installed power shall be 150% of the required power to withstand the worst operational case. And so on.

These hydraulic pump sets, driven by electrical motor shall encompass an emergency accumulator rack, oil cooler, adequate for freshwater cooling and efficiently redundant; temperature, pressure, oil level alarms; and shall be of stainless steel (AISI 316L) for fittings, valves and tubing.

Analysis Report shall be issue along with calculation assuring safety rate levels according to the worst operational condition as stated in this chapter.

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<p>It shall be possible to operate the HPU with a single pump (and its components) out of operation. Thus, it must be possible to segregate each pump and its components from the operational system.</p> <p><b>7.3.6. Control Cabin &amp; Local Controls</b></p> <p>All information in this item is regarding the Control Cabin, unless when local control is mentioned.</p> <p>A main console installed in a control cabin shall provide manual controls comprising the following main functions:</p> <ul style="list-style-type: none"> <li>• The rotation speed of the reel;</li> <li>• The linear speed of the spooling device;</li> <li>• Emergency shutdown switch (*);</li> <li>• Locking device switch;</li> <li>• Locking device position status (*).</li> </ul> <p>(*) Functions or signals required on the CCR.</p> <p>The control cabin shall be located in a platform providing a good and full visibility on the reeling of the hose reel (as near as safely possible to the hose reel). It shall be possible to control, monitor and operate the hose reel by a single person located at the control cabin.</p> <p>An emergency shutdown switch shall also be provided for installation near the spooling device.</p> <p>During offloading operation (including pumping back flushing from shuttle tanker), whenever a pre-set high pressure or pre-set low pressure is identified, the operator shall be able to manually stop the flow immediately, turning off pumps, closing shutdown valves and starting a safe deviation flow according to safety Offloading procedures.</p> <p>Compliance with such procedures shall enable a quick and sound human action, including immediate identification of any leaks or blockages during Offloading. Accordingly, PACKAGER (along with HULL SUPPLIER) shall supply PETROBRAS with an Offloading system which allows readiness information and concise interpretation by the system to allow a safe and error-proof human action. A technical specification shall be issued to provide PETROBRAS with all relevant information to issue an appropriate Offloading Procedure in accordance to this paragraph.</p> <p>All the console and panel (control, starter and electric) shall be equipped with all necessary controls, pilot lights, instruments and selector switches to ensure easy and safe operation. All consoles and panels shall be compatible with the area classification.</p>			

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<p>Local control panels shall be installed inside a weather proof cabin.</p> <p>The control and supervision consoles for the mooring hawser winches shall be equipped with all necessary components, controls, pilot lights, instruments and selector switches to ensure easy and safe operation and shall monitor at least the following functions:</p> <ul style="list-style-type: none"> <li>• Retrieval and launching speeds;</li> <li>• Axial tension on hawser (*);</li> <li>• Quick release mooring hook (*);</li> <li>• Start/stop of hydraulic unit (*);</li> <li>• Hydraulic unit emergency stop;</li> <li>• Hydraulic system pressure setting;</li> <li>• Pressure and temperature indicator (*);</li> <li>• High and low oil tank level alarms (*);</li> <li>• High oil temperature alarm (*);</li> <li>• Low pressure upstream alarm for the hawser winch hydraulic motors (*);</li> <li>• Energy failure and rotor high temperature alarms for electrical motors (*);</li> <li>• Spooling control (*);</li> <li>• Other devices according to manufacturer's standards.</li> </ul> <p>The information marked with (*) shall be sent to the control system in the Central Control Room.</p> <p>In the Central Control Room there shall be a monitoring panel including an alarm system of hydraulic systems, hose reel, mooring hawser winch and monitoring of the tension in mooring hawser and offloading hose.</p> <p>The Unit Local Panel shall be capable of completely control of the system and the PACKAGER shall provide all necessary signals to a safety supervision.</p> <p><b>7.3.7. Special Devices and Mechanisms</b></p> <ul style="list-style-type: none"> <li>- Crude oil swivel: 20 in diameter, ANSI B16.5 class 300. To be mounted on the drive side of the reel;</li> </ul>			

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- Locking device: hydraulically operated pin or arm that engages locking holes mounted to the flange of the reel. No single hydraulic failure shall lead to stop operations in hose reel and thus, this analysis shall be available in Offloading FMEA.

- Inboard Hose Termination Piece (IHTP): Offloading System shall not have an IHTP. Connections for quick release the offloading hose from FPSO side (hose reel gooseneck) are not allowed because of recent incidents with this kind of device. Emergency disconnections shall be provided at shuttle tanker side only by the means of hose NSV and shuttle tanker bow loading system.

### 7.3.8. Offloading Hose String

One (01) reinforced rubber offloading hose string, field proven type without failure tracking records (to be submitted to PETROBRAS analysis prior to equipment's purchase), for each hose reel, polyurethane elastomer covered, DOUBLE CARCASS type, approximately 230 m (two hundred and thirty meters) length, ANSI 300# pressure class, including sections with 10.7m length sections, end fittings flanged according to ANSI B16.5 Class 300 shall be provided and installed in accordance with the OCIMF guidelines as given in the *Guide to Purchasing, Manufacturing and Testing of Loading and Discharge Hoses for Offshore Moorings*, latest edition.

The offloading hose string configuration comprises the following:

- One (01) end section for the ST end, 20" nominal diameter, Tanker Rail type, 20% net buoyancy, considering one outboard hose termination piece (NSV) included;
- One (01) segment, 20" nominal diameter, Regular Floating Hoses (20%);
- One (01) segment, 20" nominal diameter, Negative Floating Hose (-10%);
- Intermediate segments, 20" nominal diameter, Regular Floating Hoses (20%);
- Two (02) segments, 20" nominal diameter, Negative Floating Hose (-10%);
- Two (02) segments, 20" nominal diameter, Regular Floating Hose (20%).


Note: 20" (twenty) nominal diameter is considered the minimum and most suitable specification for PETROBRAS. However, it is PACKAGER's responsibility to verify if this minimum diameter fulfills the requirement to offload one (01) million barrels of crude oil to the ST in not more than 24 (twenty-four) hours. CONTRACTOR shall advise PETROBRAS about the need to modify the hose string minimum diameter if necessary.

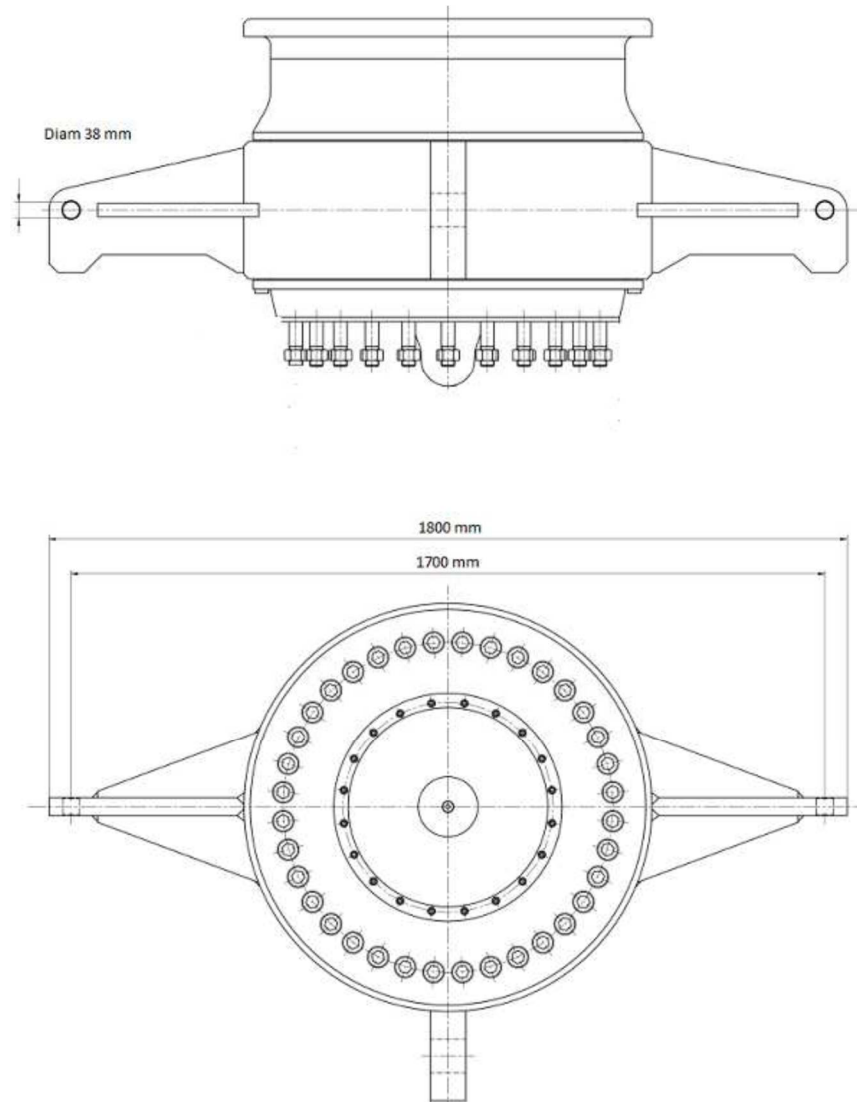
The following components and accessories shall be included in the offloading hose:

- One (01) outboard hose termination piece (flanges ANSI B16.5 Class 300);
- One (01) detachable hose bridle;
- One (01) hose messenger line.

Remarks:



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<p>1. The tanker rail hose shall come with additional integrated buoyancy in DPST side, in order to provide buoyancy to the outboard hose termination piece during hose transferring;</p> <p>2. Two (02) hose intermediate segments and one (01) hose end section shall be furnished as spares for the offloading hose string;</p> <p>3. Stainless steel bolts and nuts shall be provided to make up the flanged connections;</p> <p>4. The electrical continuity of the hose string shall be according to OCIMF guidelines and the requirements from the Classification Society.</p> <p>5. No marine breakaway coupling or similar devices will be accepted as a component of the hose string.</p> <p><b>7.3.9. OUTBOARD HOSE TERMINATION PIECE ( NORTH SEA VALVE )</b></p> <p>The North Sea Valve (NSV) shall be designed to operate in an offshore environment as per “C5M” type according to ISO12944-1. The collar shall be coated with an anticorrosive.</p> <p>Material specifications for NSV shall be based as per inlet fluids characteristics, as follows:</p> <ul style="list-style-type: none"> <li>- CO2 content: up to 5% mol;</li> <li>- H2S content: up to 200 mg/L (water phase);</li> <li>- H2O content: up to saturated;</li> <li>- Chloride (Cl-): up to 170,000 ppm;</li> <li>- Minimum pH: 4.0;</li> <li>- NSV shall be in accordance with ISO 15156 following the parameters described above.</li> </ul> <p>NOTE: The permitted exclusions listed at Table 1 of ISO 15156-1 shall not be applied to this valve.</p> <p>In addition, there shall be means to control the H2S content in slop tanks to below 5.0 mg/l (aqueous phase) and, in case of levels above this, a flushing operation of the hose with seawater shall be possible prior to offloading operation.</p> <p>The outboard hose termination piece shall consist mainly of one valve body, one disc valve, and one valve spring. The hose end valve shall be of proper dimension and design to connect at the BLS of the DPST. The valve spring closes the hose termination piece automatically in an emergency.</p> <p>The outboard hose termination piece shall have a suitable swivel ring with collar to which the hose bridle is connected. Collar external dimensions according to picture in below:</p>			



*Figura 3 - Outboard hose termination piece with collar*

PACKAGER shall provide:

1. Two flushing covers with hydraulic jacks to allow the opening of the hose termination piece, proper flushing and pressure test of the hose string line. These two flushing covers shall have two connections for 4" hoses.
2. It shall be possible to store, reel in or pay out, repairing or having any maintenance on the NSV within FPSO boundaries. This aims to avoid any chances of oil spillage overboard. Accordingly, to do this in an easy and safe manner, means shall be provided to the operator control it from a safe place protected from any moving devices and whipping wires or ropes.

Whenever possible, when the hose reel is in parking position, the NSV shall be positioned within the limit of the bow/stern offloading drainage coaming. If that is not possible, a dedicated oil collection tray shall be provided under NSV with an adequate access platform for visual inspections of such tray.

### 7.3.10. DETACHABLE HOSE BRIDLE

The hose bridle between the hose termination piece and the hose messenger line shall be connected to the hose messenger line using a shackle.

It is extremely important from a safety point of view, that when the outboard hose termination piece is connected to the BLS on the DPST, the hose bridle must be disconnected to the hose line.

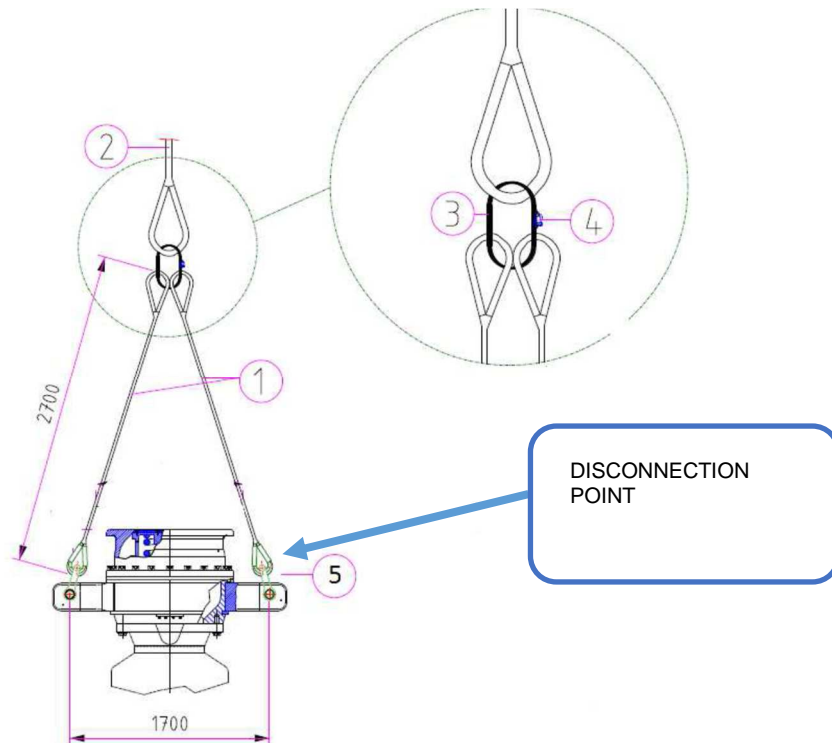



Figura 4 - Hose line disconnection from bridle

1. Fibre rope, HMPE, ISO 10325, type T (12-strand), RN 28, MBF 610 KN, with eye splices, one thimble in one splice;
2. Fibre rope, HMPE, ISO 10325, type C (covered), (12-strand), RN 38, MBF 909 KN, with eye splices;
3. Fibre rope, HMPE, ISO 10325, type T (12-strand), RN 28, MBF 610 KN, with eye splices, length 1,5 m;
4. Bow Shackle ABNT NBR 13545, grade 6, bolt type pin with hexagon head, hexagon nut and split cotter pin, WLL 5 t (Shackle ABNT NBR 13545-6-BX 5t);
5. Bow Shackle ABNT NBR 13545, grade 6, bolt type pin with hexagon head, hexagon nut and split cotter pin, WLL 12,5/13,5 t (Shackle ABNT NBR 13545-6-BX 12,5/13,5 t).

### 7.3.11. EMERGENCY OFFLOADING ASSEMBLY

One connection coupler for each emergency station (bow and stern) shall be provided for emergency situations, which will be used to connect an Emergency Offloading

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Assembly. The 1st hose section over the connection coupler platform is a submersible hose without location collars. The 2nd and 3<sup>rd</sup> hose sections off the connection coupler platform are submersible hoses with location collars and buoys or reinforced floating hoses. The rest of the Emergency String is similar to a regular 20"x300# floating hose string.

PETROBRAS shall supply the Emergency Hose String, if and when it is required.

PACKAGER shall design and install only the standing part (piping, valves, controls) of the emergency offloading line (20", ANSI 300# class) and also the means to install the hose string offshore (winches, sheaves, wire ropes, work platforms, slip way)

PACKAGER shall also provide all necessary means at FPSO side and procedures to install the Emergency Hose String offshore (winches, sheaves, wire ropes, work platforms, slip way). On such procedures, special attention shall be given to safety of operators, which shall not be near or exposed to tensioned cables or similar situations.

The bow/stern emergency connection platforms shall be located in a way to provide adequate clearance for the hose from hull structures. Structures around this area shall be as smooth as possible not having any kind of sharp edges in order not to damage the hose.

An oil spillage tray under the Emergency Offloading Assembly connection flange shall be provided, with means to convey residues to the hull Drainage Header.

### 7.3.12. *METERING SYSTEM*


HULL SUPPLIER shall supply the metering system for the FPSO. Offloading System SUPPLIER shall be as collaborative as possible with the HULL SUPPLIER for an efficient and reliable metering system design, as required.

The metering system shall calculate the volume offloaded from the FPSO. It will not be allowed by-passes or any flow line from FPSO cargo tanks to an oil tanker without a metering system.

Any branch from other system to offloading shall have a sensor (if not a metering system) in order to verified the volume transferred. Volumes transferred to or received from shuttle tanker shall be measured using the tank gauging system.

Piping from off-spec tanks, settling tanks, or any tanks that may have crude oil / oily fluid not metered, shall not have direct communication (for example, by valves) with Cargo and Offloading System. Such communications are only allowed by means of portable devices such as removable spools or portable pumps.

The Unit shall have operational procedure assuring the above mentioned alignments are only used in special circumstances and shall be issued to PETROBRAS for analysis. Unmetered fluid from these tanks shall not be routed to cargo tanks.

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### 7.3.13. DP SHUTTLE TANKERS (DPST) PARTICULARS

- BLS coupler elevation SUEZMAX (from baseline): 27 meters
- BLS coupler elevation AFRAMAX (from baseline): 24 meters
- BLS chain stopper design load: 500 tons
- BLS chain stopper SWL: 250 tons
- Distance from chain stopper to fairlead: 6.2 meters
- Maximum distance from Unit to DPST: 170 meters

## 8. GREEN LINE AND DP SYSTEM INTERFACE

Regarding the Offloading Monitoring Telemetry, or Green Line System, related system and equipment shall be integrated by the HULL SUPPLIER. The appropriate participation of PACKAGER in telemetry issues where sensors in PACKAGER's equipment shall be connected to the green line is necessary.

The System shall provide information related to the status of several devices and Offloading parameters, which shall have a "green" status in order to permit offloading continuity. The following status, as a minimum, shall monitored: chain stopper closed, hose in position, outboard hose termination piece closed, cargo pumping system readiness, crude oil pressure, hawser tension.

This green line shall also be analyzed in Offloading FMEA report.


This system shall be compatible and connected to Emergency Shut Down System and shall be listed in the ESD and Cause-Effect matrix.

### 8.1 ABSOLUTE, RELATIVE POSITIONING REFERENCE AND TELEMETRY SYSTEM

Please refer to the document POSITIONING REFERENCE SYSTEMS FOR OFFSHORE LOADING SYSTEM.

## 9. MANUFACTURING

All materials and equipment shall be new and from PETROBRAS Approved Manufacturer's List. Any materials used in the fabrication of this equipment from an unapproved manufacturer will be rejected, removed and replaced at PACKAGER's expense.

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## 9.1 PAINTING

Painting and coating shall be in accordance with GENERAL PAINTING

The PACKAGER shall submit his painting/coating specification to HULL SUPPLIER for approval.

All components shall be delivered fully painted/coated.

The performed pre-treatment and complete coating shall be in accordance with the paint manufacturer's data sheets.

## 9.2 INSPECTION AND TESTING

PACKAGER and their subcontractors shall perform all required inspection and testing in accordance with the referenced design code and/or applicable industry standards. In addition to industry codes and PACKAGER's standards, PACKAGER and their subcontractor shall comply with the applicable project specifications listed herein, at data sheet and Material Requisition.

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

PACKAGER shall ensure that all the witnessed inspection requirements by the Classification Society are fully accommodated and the due notice requirements are satisfied. The notification period for such inspections shall be informed in advance of 4 (four) weeks for foreign PACKAGER and 1 (one) week for Brazilian PACKAGER.

PACKAGER shall make preliminary test to ensure that all parts of the equipment are operating satisfactory prior to the arrival of PETROBRAS and HULL SUPPLIER's representatives.

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

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



### 9.2.1. INSPECTION AND TESTING (complimentary to Offloading FMEA Test Trials)

#### a) HOSE REEL TESTING

##### Rotation Test

A complete 360-degree rotation of the reel shall be made in both the clockwise and counter-clockwise direction and the torque required to start and turn the reel shall be recorded. Joystick smooth controls will be evaluate at the same test.

##### Speed Test

A set of tests shall be performed to confirm the operational speeds.

##### Load Test

The reel will be locked and a capacity test of the drive unit will be performed. The maximum torque shall be recorded.

##### Spooling Device Test

A set of tests shall be performed to confirm the functionality of the hose spooling device.

##### Emergency Test

The test shall be carry out considering the need to use the spare devices to turn the hose reel, remotely installed and operated.

##### Emergency station

Test the operability of such system

##### Remark:

1- At least once every six months the hose must be inspected.

2- All tests shall be carried out with the hose string stored on the reel, full of seawater, minimum draught, etc, according to the worst case condition as described in this Specification. A mass of water would be used in way of the hose string. Accordingly, in the Test Procedure Report, to be issued to PETROBRAS, the required mass to testing shall be prior calculated.

#### b) HAWSER WINCH TESTING

##### Rotation Test



A set of rotations of the winch drum shall be performed in both the clockwise and counterclockwise direction and the torque required to start and turn the drum shall be recorded.

#### Speed Test

A set of tests shall be performed to confirm the operational speeds.

#### Load Test

The winch drum will be locked and a capacity test of the drive unit will be performed. The maximum torque shall be recorded.

#### Quick release Test

To be carried out performing emergency release of hawser in a controlled condition.

#### c) SPOOLING DEVICE TEST

A set of tests shall be performed to confirm the functionality of the hawser spooling device.

#### d) PRESSURE TEST OF HOSES AND PIPING ON REEL

The piping on the drum, including the swivel shall be pressure tested to 300 psi for a minimum of six (06) hours.

The offloading hose string shall be pay out and reel in, according to OCIMF – Handling, Storage, Inspection and Testing Hose Reels.


During the test, a visual inspection shall be carried out in order to detect any leakage or deformation.

### 9.3 FACTORY ACCEPTANCE TEST (FAT)

The following tests shall be included in PACKAGER's scope:

- Hydrostatic test of all vessels, pipes and pumps;
- Performance test, NPSH test and Mechanical running test of all pumps;
- Electrical continuity checks on all wiring and earthing;
- Functional checks on all instruments and valves;



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- Alarms and Equipment Protection Tests;

PACKAGER shall prepare a factory acceptance test procedure (FAT) for the package and submit for HULL SUPPLIER approval and PETROBRAS verification.

FAT will be witnessed by HULL SUPPLIER and, when necessary, PETROBRAS representatives. PACKAGER shall advise the HULL SUPPLIER of the test schedule at least two (1) week for Brazilian PACKAGERS/subcontractors and 4 (four) weeks for foreign subcontractors before the planned test dates. PACKAGER shall invite CLASS surveyor for FAT. HULL SUPPLIER shall invite PETROBRAS according to the same schedule as above.

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

#### 9.4 COMMISSIONING

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

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

PACKAGER shall provide commissioning support as required by the HULL SUPPLIER.

PACKAGER 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.).


HULL SUPPLIER 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.

### 10. GENERAL REQUIREMENTS

#### 10.1 ELECTRICAL REQUIREMENTS

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.

Electrical equipment and material shall comply with requirements of SPECIFICATION FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.

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This Technical Specification is not intended to raise all electrical issues which may affect the Offloading System, accordingly, the above mentioned documents in this item may be part of the scope of documents fulfilling statutory or safety electrical requirements.

## 10.2 INSTRUMENTATION AND AUTOMATION REQUIREMENTS

The instrumentation and control design shall fulfill the requirements of AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS.

The minimum requirements for the adequate interfacing of the Main Packages' Automation and Instrumentation System with the UNIT are described in AUTOMATION INTERFACE OF PACKAGE UNITS.

This Technical Specification is not intended to raise all instrumentation and automation issues which may affect the Offloading System, accordingly, the above mentioned documents in this item may be part of the scope of documents fulfilling statutory or safety instrumentation and automation requirements.

## 10.3 SPARE PARTS, CONSUMABLES AND TOOLS

Spare parts, consumables, and tools must be provided by PACKAGER and included as follows:


- a) All consumable and spare parts recommended by equipment and PACKAGER material for the construction (erection), testing (on site), commissioning, pre-operation and start-up phases;
- b) All spare parts recommended or required by the Classification Society will be delivered together with the relevant equipment;
- c) All special tools and handling equipment required for construction (erection), maintenance and operation.

Notes:

All supplied spare parts and tools must be physically identified with the TAG of equipment and its part numbers into boxes to easily storage materials in the warehouse.

In addition to the spare parts required above, PACKAGER must issue to HULL SUPPLIER a list of two (2) years operation recommended spare parts, with the price and part number codes of each item included. Those items shall be supplied by HULL SUPPLIER.

To the description of each item, the list must feature quantities and the part numbers used by the relevant PACKAGERS (or their Subcontractors), together with specifications sufficient to PETROBRAS to acquire those spare parts in the future.

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When the package is comprised by more than one identical equipment, the spare parts list shall clearly define if the quantity of spare is for one equipment or for all equipment included in the package.

Examples of spares/tools category:

- Start up & commissioning spare;
- Consumable spares;
- Class recommended spares;
- Special Tools.

Spares/tools which are on loan from manufacturer for use only in commissioning and are to be returned must also be separately boxed and clearly labeled.

#### 10.4 LAYOUT


PACKAGE layout and arrangement shall be designed to provide sufficient access for ease of operability and maintenance, and to maximize safety.


PACKAGES shall be designed and fabricated such that all equipment and components are located entirely within the skids base perimeter, including all equipment, piping, valves, electrical, instrumentation and controls. The projection of such items beyond the perimeter of the skid base shall be strictly prohibited, unless approved in writing by PETROBRAS.

#### 10.5 NAMEPLATES

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. Nameplates shall include at least the following information:

- Owner;
- Petróleo Brasileiro S.A. – PETROBRAS;
- PACKAGER's name;
- Serial number;
- Manufacture Year;
- Main data for design, operation and testing (Power, Pressure, Volume, Temperature, Rotation, Flow rate), where applicable;
- Specific requirements;
- Installation identification;
- Equipment TAG;
- Purchase Order Number;
- Empty Weight;
- Work with Hydrogen – whenever applicable;
- H2S work - whenever applicable;
- Hydrostatic test water requirements – whenever applicable;
- Potential Risk Group Category (for pressure vessels and shells of Shell Heat

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<p>Exchanger) according to NR13 (identification shall be painted on the body of the vessels and visible at distance of at least 5.0 m). - whenever applicable;</p> <ul style="list-style-type: none"> <li>▪ Design Code;</li> <li>▪ Service;</li> </ul> <p><b>10.6 TAG NUMBERING</b></p> <p>Tagging of all instruments, electrical, mechanical and piping items, including valves, shall be carried out. Tag numbers will be supplied by HULL SUPPLIER.</p> <p>The main items shall have individual tag numbers as dictated by HULL SUPPLIER. The actual tag numbers will be advised to PACKAGER after award.</p> <p>Tags shall be supplied with the number and description in the Brazilian Portuguese language, unless otherwise stated in the technical data sheets.</p> <p>Valves, instruments and orifices shall be tagged with the applicable number only. Tag numbers for remaining ancillary equipment shall be given after purchase order placement.</p> <p>For Instrumentation tagging the ISA –5.1, N-1710 and TAGGING PROCEDURE FOR PRODUCTION UNITS DESIGN.</p> <p><b>10.7 PACKING AND SHIPMENT</b></p> <p><b>10.7.1. PRESERVATION</b></p> <p>The equipment shall be thoroughly cleaned internally and be free of all loose foreign materials.</p> <p>The equipment shall be supplied tested, flushed and preserved and, if practical, already charged up with coolant and lubricants.</p> <p>The preparation shall make the equipment suitable for 12 months outdoor storage in a coastal tropical climate from the time of Shipment.</p> <p>All openings shall be covered or capped to protect the inside from dust, rust and moisture. Dryer shall be enclosed in the PACKAGE for absorption of moisture.</p> <p>Flanged openings shall be provided with gasketed metal closures securely fastened with bolts or clamps.</p> <p><b>10.7.2. PACKING</b></p> <p>PACKAGER shall submit the packing design and packing list to the HULL SUPPLIER for approval.</p> <p>PACKAGER shall inform declared weight, rigging plan, package material and type of pesticide used in the package.</p>			

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<p>PACKAGER shall package the equipment in accordance with the packaging requirements of the country to which the equipment is being shipped.</p> <p>PACKAGER shall provide the procedures for unpacking, handling and installation, as well as repacking, and long-term storage requirements.</p> <p>PACKAGER shall specify any limitations applicable to the transport and installation phase.</p> <p>The equipment shall be securely packed for shipment from PACKAGERs location to the actual equipment destination. All items must be protected from handling damage either by protective packing with cartons, crates, etc. or by securing to pallets. All material must be packed in a way that handling with forklift truck or crane is possible.</p> <p>Unless otherwise advised, each item of equipment shall be checked for its suitability to resist horizontal and vertical acceleration of 0.8g (without considering gravity effects) in any direction during sea transportation.</p> <p>The PACKAGE shall be protected from corrosion.</p> <p>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.</p> <p>Spare parts and tools to be packed separately and clearly marked “Spare Parts” and “Tools” respectively.</p> <p>Each package shall be clearly marked with its gross weight, to enable safe handling.</p> <p>PACKAGER shall attach, in a waterproof enclosure to the outside of the package, a packing list, and also a list showing rust preventatives used and where.</p> <p>The packing list shall clearly show:</p> <ul style="list-style-type: none"> <li>• Vessel name;</li> <li>• HULL SUPPLIER’s order number;</li> <li>• HULL SUPPLIER’s item number;</li> <li>• Partial or complete delivery for each order number;</li> <li>• Description;</li> <li>• Number of packages;</li> <li>• Gross weight of each package.</li> </ul> <p>The rust preventatives list shall give instructions for removal of preventatives where required, and also necessary procedures to be imposed during storage.</p> <p>PACKAGER shall provide a Delivery Specification, which shall describe all loose items furnished in a completely or not completely assembled condition. Delivery Specification must clearly indicate HULL SUPPLIER’s order number in the headlines and item number for each loose item shipped by the PACKAGER. One copy of the delivery specification shall follow the goods, one copy to be sent to the FPSO construction site, and one copy to be sent to PETROBRAS.</p>			

## 11. DOCUMENTATION

Drawings shall show all necessary dimensions and details required for interface information and installation. Clearances for maintenance shall be shown. Drawings and documents shall be clear and completely legible with all text in the English language.

Tridimensional visualization software and design database will be asked for issue at the kick off meetings with the HULL SUPPLIER. Offloading system's PACKAGER shall feed the database and any other design software accordingly.

Instruction manuals for operation and maintenance of the equipment/package shall be provided in Portuguese language.

PACKAGER shall submit all major drawings and drawings containing interface information for HULL SUPPLIER approval and PETROBRAS verification according to the PACKAGER list. 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.

PACKAGER shall produce a weight/center of gravity data sheet, which shall reflect the individual component, and assembly weights, and also all necessary center of gravity details, considering with or without operational fluids.

PACKAGER shall send in advance all recommendations for package installation, maintenance and commissioning.

It is suggested to be issued the following set of technical documents:

Description	With	For	Certified	VDF Purpose
	Proposal	Approval		
Deviation List	X			-
Documents and Drawings List / Schedule (SDS)	X	X	X	DFI
Delivery Schedule (Covering plan Approval, Fabrication and Delivery)		X		DFI
Detailed Description of the Scope of Supply	X	X	X	DFI
Equipment / System Technical Specification	X	X	X	DFI
Equipment / System Flow Diagram, showing the limits of Scope of Supply	X	X	X	DFI
Reference List of Similar Installations (See Note)	X			-
Complete Data Sheet	X	X	X	DFD
Equipment Leaflets / Catalogues	X			-
Recommended Installation, Commissioning and Start-up Consumables	X	X	X	DFI
Recommended Two Years Operating Spares		X	X	DFI



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Description	With Proposal	For Approval	Certified	VDF Purpose
Table of Contents (All Manuals)		X	X	DFI
Detailed Description of Operation	X	X	X	DFI
Pressure Test Procedures		X	X	DFI
Performance / Acceptance Test Procedures		X	X	DFI
Weighing Procedure		X	X	DFI
Erection and Installation Procedures		X	X	DFI
Unpacking and Preservation Procedure		X	X	DFI
Handling and Shipping Procedures		X	X	DFI
Structural Steel Calculations	X	X	X	DFI
Hydraulic Calculations	X	X	X	DFI
Performance Curves of Equipment and Accessories	X	X	X	DFI
General Arrangement Drawings / Lay-Out Drawings / Details of Fastening Elements / Details – with Weight and Center of Gravity	X	X	X	DFD
Cross Section / Expl. View Dwg. with Parts List		X	X	DFI
Sub Assembly Arrangements	X	X	X	DFD
Detail Fabrication Drawings with Material Take Off (For Reel Access Ladders, Platforms and Railings)	X	X	X	DFD
List of Supplied Loose Items	X	X	X	DFD
Piping and Instrument Diagrams	X	X	X	DFD
Piping Termination		X	X	DFD
Schematic Diagrams		X	X	DFD
Auxiliary Piping Diagram		X	X	DFD
Foundation Load Diagram & Support Details		X	X	DFD
Name Plate Format Drawings		X	X	DFI
Utilities Consumers List	X	X	X	DFD
Electrical Dimensional Drawing		X	X	DFD
Electrical Material List		X	X	DFD
One Line Electrical Diagrams		X	X	DFD
Block Wiring Schematic		X	X	DFD



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Description	With Proposal	For Approval	Certified	VDF Purpose
Schedule Electrical Equipment in Hazardous Area		X	X	DFD
Equipment Hazardous Area Certificates		X	X	DFI
Electrical Connection Diagram		X	X	DFD
Instrument / Electrical Panel Detail Drawings		X	X	DFD
Instrument & Control Diagram		X	X	DFD
Instrument / Elec. Logic Diagram		X	X	DFD
Instrument Termination and Hook Up Details		X	X	DFD
Instrument Loop Drawings		X	X	DFD
Instrument PLC Data Communication Protocol		X	X	DFD
Cause and Effect Charts		X	X	DFD
Instruments Data Sheets		X	X	DFD
Instrument Index		X	X	DFD
Acceptable Nozzle Loads		X	X	DFD
Bearing Load Data		X	X	DFI
Surface Preparation and Painting Procedure	X	X	X	DFI
Failure Modes and Effects Analysis (incl. Criticality and Tests)		X		DFD
Surge Piping Analysis for Offloading Operation		X	X	DFI
Mounting Instructions		X	X	DFI
Pre-Commissioning / Commissioning Procedure		X	X	DFI
Slings / Lifting Arrangement		X	X	DFD
Lube Oil and Operating Fluids Table / Schedule		X	X	DFI
Vibration Analysis Data		X	X	DFI
Noise Level Data Sheet		X	X	DFD
Weight Data Sheets		X	X	DFI
Equipment Data Sheets	X	X	X	DFI
As Built Dimensions & Data		X	X	DFI
Inspection Certificates		X	X	DFI
Test Data & Certificates		X	X	DFI
Vessel & Heat Exchanger Code Data Certificates		X	X	DFI
Installation, Operating & Maintenance Manual (English / Portuguese)		X	X	DFI
<b>Data Book</b>		X	X	DFI





Description	With Proposal	For Approval	Certified	VDF Purpose
List of Sub-Suppliers	X	X	X	DFI
Mounting & Field Test Report		X	X	DFI
Performance Test Report / Results		X	X	DFI
Factory Acceptance Test Report		X	X	DFI
Vibration Report		X	X	DFI
Noise Report		X	X	DFI
Weighting Report and Certificate		X	X	DFI
Classification Society Certificate		X	X	DFI
ISO 9001 Certificate Compliance		X	X	DFI
Quality Plan		X	X	DFI
PDS equipment drawing set		X	X	DFD
Type Approval Certificate	X	X	X	DFI

Table 3 - Suggested Documentation Titles for PETROBRAS verification

**Notes:**


- 1) For Descriptions having no correlated documents to be issued, it shall be informed in the Documents and Drawings List / Schedule as NA (Not Applicable) beside the Description. All documents appraised by PACKAGER as NA (Not Applicable) shall be listed at "Deviation List" and justified.
- 2) VDF Purpose:
  - DFD = Document for Design;
  - DFI = Document for Information.

**12. TRAINING**

The PACKAGER shall also provide a training program in order to instruct operators on how the OFFLOADING SYSTEM will operate safely and leading to an adequate operational lifetime in order to qualify PETROBRAS technicians to operate and maintain (install, dismantle, replace parts, make adjustments, etc.) each equipment. The training shall encompass all items to its understanding.

The training shall be performed at FPSO construction yard and/or aboard the FPSO, after completion of the FAT and prior to PETROBRAS approval of the FPSO Acceptance Term. PACKAGER shall provide all documentation and materials required for the training program (including the latest revision of the as built documentation, brochures, booklets, material for presentations, transparencies, etc.).

Each individual equipment training program shall encompass all operation and maintenance aspects. All trainees will be operation and maintenance professionals. The participants shall be awarded certificates after the completion of the training course.

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The maintenance training shall be held to ten (10) maintenance technicians and the operation training to ten (10) operators , in Brazilian Portuguese and shall be performed using identical equipment as supplied or using the same equipment supplied at FAT phase. Number of training classes will be defined depending on available space in the proposed place.

PACKAGER shall take full responsibility for the professionals teaching the training course, including for their transportation and lodging. PACKAGER shall submit for PETROBRAS approval the detailed training program. The training program shall cover, at least, the following items:

- a) Complete description of the equipment;
- b) Technical and operational characteristics;
- c) Operating principles;
- d) Operating cautions;
- e) Aspects of construction;
- f) Operating procedures and routines;
- g) Identification of operational problems and possible causes (trouble-shooting);
- h) Preventive maintenance routines;
- i) Signaling and warning devices;
- j) Protection and adjustment;
- k) System drawings and diagram.

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