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	TITLE: TECHNICAL SPECIFICATIONS FOR SEA WATER LIFT PUMPS - FLEXIBLE INTAKE PIPE		ESUP
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1 INTRODUCTION

This specification covers the minimum requirements for the design, fabrication, inspection, testing and delivery of five (5) seawater lift hose strings (or flexible intake pipes), complete with ancillary equipment (including strainer, hypochlorite lines, connecting device and handling tools), connected to the FPSO external caissons located at midship on starboard side and to be furnished to the project P-86 FPSO.

The requirements herein listed are applicable to all players performing such related activities within the scope of this unit, including manufacturers, packagers, suppliers, sub suppliers, integrators, constructors, and all technical personnel involved. Within the scope of this document, they are all referred to as being a SELLER.

In addition to the requirements of this technical specification, SELLER shall follow all the requirements of the Exhibit I (SCOPE OF SUPPLY), as well as Exhibit III (DIRECTIVES FOR ENGINEERING EXECUTION), Exhibit IV (DIRECTIVES FOR CONSTRUCTION AND ASSEMBLY), Exhibit V (DIRECTIVES FOR PROCUREMENT), Exhibit VI (DIRECTIVES FOR PLANNING AND CONTROL), Exhibit VII (DIRECTIVES FOR QUALITY MANAGEMENT SYSTEM) and Exhibit VIII (DIRECTIVES FOR COMMISSIONING PROCESS).

2 NORMATIVE REFERENCES AND DESIGN SPECIFICATIONS

2.1 CLASSIFICATION

2.1.1

SELLER shall perform the work in accordance with the requirements of the Classification Society.

2.1.2

SELLER is responsible to submit to the Classification Society the documentation in compliance with stated Rules.

2.1.3

Classification Society rules may only be waived upon the formal approval from the Classification Society itself and from BUYER.

2.2 CODES AND STANDARDS

2.2.1

The following codes and standards include provisions which, through reference in this text, constitute provisions of this specification. The latest issue of the references shall be used unless otherwise agreed.

2.2.2


Other recognized standards may be used, provided it can be shown that they meet or exceed the requirements of the standards referenced below. Formal approval from BUYER and from Classification Society is also required.


ASTM A105

- Specification for Forgings, Carbon Steel, for Piping Components

ASTM A350

- Standard Specification for Carbon and Low-Alloy Steel Forgings, Requiring Notch Toughness Testing for Piping Components

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<div>ASTM A234<ul style="list-style-type: none">Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service</div> <div>ASTM A420<ul style="list-style-type: none">Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Low-Temperature Service</div> <div>ASTM A193<ul style="list-style-type: none">Specification for Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service</div> <div>ASTM A194<ul style="list-style-type: none">Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service or both.</div> <div>ASME B16.20<ul style="list-style-type: none">Metallic Gasket for Pipe Flanges Ring-Joint, Spiral-Wound and Jacketed</div> <div>ASME B16.47<ul style="list-style-type: none">Large Diameter Steel Flanges NPS 26 through NPS 60</div> <div>ASME B16.5<ul style="list-style-type: none">Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24</div> <div>ASME BPVC sec. VIII<ul style="list-style-type: none">Rules for Construction of Pressure Vessels</div> <div>ASME BPVC sec. IX<ul style="list-style-type: none">Qualification Standard for Welding, Brazing and Fusing Procedures</div> <div>API SPEC 17K<ul style="list-style-type: none">Specification for Bonded Flexible Pipe (ISO 13628-10)</div> <div>ISO 12944<ul style="list-style-type: none">Paints and varnishes — Corrosion protection of steel structures by protective paint systems</div> <div>ISO 15614<ul style="list-style-type: none">Specification and Qualification of Welding Procedures for Metallic Materials. Welding procedure tests</div> <div>ISO 17636<ul style="list-style-type: none">Non-destructive testing of Welds</div> <div>ISO 1461<ul style="list-style-type: none">Hot Dip Galvanized Coatings</div> <div>EN 10204<ul style="list-style-type: none">Metallic products – Types of inspection documents</div> <div>OCIMF<ul style="list-style-type: none">Guide to Manufacturing and Purchasing Hoses for Offshore Moorings (GMPHOM)</div> <div>DNVGL-RP-F203<ul style="list-style-type: none">Riser interference</div> <div>DNV RP B401<ul style="list-style-type: none">Recommended Practice B401: Cathodic Protection Design</div>				
<h3>2.3 GOVERNMENTAL REGULATION</h3> <p>Brazilian Government regulations are mandatory and shall prevail, if more stringent, over the requirements of this specification and other references herein.</p>				

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2.4 DESIGN SPECIFICATIONS

I-ET-3000.00-1200-940-P4X-001	-	TAGGING PROCEDURE FOR PRODUCTION UNITS DESIGN.
I-ET-3010.00-1200-940-P4X-002	-	- GENERAL TECHNICAL TERMS
I-DE-3010.2Q-1200-942-P4X-002	-	GENERAL ARRANGEMENT
I-FD-3010.2Q-5111-311-P4X-001	-	SEA WATER LIFT PUMP (B-5111001A/E)
I-DE-3010.2Q-1350-960-P4X-001	-	LINES PLAN AND OFFSET TABLE
I-RL-3010.2Q-1350-960-P4X-007	-	PRELIMINARY TRIM AND STABILITY BOOKLET
I-ET-3000.00-1000-941-PPC-001_F	-	METOCEAN DATA
I-RL-3010.2Q-1350-960-P4X-002	-	MOTION ANALYSIS

2.5 CONFLICTING REQUIREMENTS

2.5.1 In case of conflicting requirements between this technical specification and other cited references, the most stringent shall prevail. If necessary, the **Error! Unknown document property name.** may revert to PETROBRAS for clarification.

3 DEFINITIONS AND ABBREVIATIONS


3.1 DEFINITIONS


3.1.1 All Terms and definitions are established in the latest revision I-ET-3010.00-1200-940-P4X-002 - GENERAL TECHNICAL TERMS.


3.1.2 **Suction hose:** generic name given in this document for marine hoses used to suck seawater below the hull of an FPSO in order to cool down the process topsides equipment. They can be also named “seawater intake hoses / risers (swir)” or “seawater lift hoses /risers (swl)”.

3.2 ABBREVIATIONS

API	• American Petroleum Institute
ASME	• American Society of Mechanical Engineers
ASTM	• American Society for Testing and Materials
CDR	• SELLER’s Data Requirements
EPDM	• Ethylenepropylenedienemonomer
FAT	• Factory Acceptance Test
FEA	• Finite ElementAnalysis
FPSO	• Floating Production, Storage and Offloading system
GMPHOM	• Guide to Manufacturing and Purchasing Hoses for Offshore Moorings
ID	• Internal Diameter

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<div>IRC<ul style="list-style-type: none">• IRC Inspection Release Certificate</div> <div>LOA<ul style="list-style-type: none">• Length Overall</div> <div>MBR<ul style="list-style-type: none">• Minimum Bending Radius</div> <div>OCIMF<ul style="list-style-type: none">• Oil Companies International Marine Forum</div> <div>OER<ul style="list-style-type: none">• One End Reinforced hose</div> <div>PTFE<ul style="list-style-type: none">• Polytetrafluoroethylene</div> <div>SWL<ul style="list-style-type: none">• Safe Working Load</div> <div>TCL<ul style="list-style-type: none">• Technical Clarifications List</div> <div>VDL<ul style="list-style-type: none">• Vendor Deviation List</div> <div>VIV<ul style="list-style-type: none">• Vortex Induced Vibration</div>			
<h2>4 SCOPE OF SUPPLY</h2> <div>4.1.1 SELLER's scope of supply shall include, but not necessarily be limited to, five (5) suction hose strings, for diverless installation through FPSO caissons, comprising of the following:<div>A. Five (5) suction hoses approximately 90 meters long (provided by sections (maximum number of sections limited in nine (9) sections for sea water lift pumps (B-5111001A/E).</div><div>B. Riser heads to connect the hoses to the riser seats.</div><div>C. Caisson Interface Structures c/w Integral Riser Seat and Riser Seat Blind Flange.</div><div>D. Bottom strainers.</div><div>E. Hypochlorite hoses (2 lines per hose string).</div><div>F. Installation and handling tools for diverless installation and retrieval operations.</div></div> <div>4.1.2 Although not listed above, it is reminded that SELLER shall also include in its scope of supply any relevant equipment needed to complete the package such to have a fully operative systems in line with requirements of this specification. If need be, e.g.: Clump weights for distribution along the section, and/or a Ballast weight under the strainer.</div> <div>4.1.3 SELLER shall define the hoses ID, taken into account the maximum permitted erosional flow velocity and hydraulic losses. The selected value of the ID shall be informed to PETROBRAS for approval.</div>			
<h2>5 PROJECT SPECIFIC DATA</h2> <div>5.1 FPSO MAIN CHARACTERISTICS</div> <div>5.1.1 For vessel dimensions see latest version of I-DE-3010.2Q-1350-960-P4X-001 - LINES PLAN AND OFFSET TABLE.</div> <div>5.1.2 The FPSO bow pointing towards 190°from true North in positive clockwise sense.</div> <div>5.1.3 The hose strings shall be assembled using FPSO Crane with maximum capacity of 40 ton.</div> <div>5.1.4 For the minimum and maximum FPSO draft see the latest version of I I-RL-3010.2Q-1350-960-P4X-007 - PRELIMINARY TRIM AND STABILITY BOOKLET</div> <div>5.1.5 Minimum FPSO draft during suction hose installation could be around.</div>			

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<p>5.1.6 For vessel LOA information see I-DE-3010.2Q-1200-942-P4X-002 – GENERAL ARRANGEMENT.</p> <p>5.2 OPERATION ENVIROMENT</p> <p>5.2.1 The equipment shall be suitable for the environment and range of ambient conditions, including, atmospheric pressure, relative humidity, rainfall, dry-bulb air temperature, characteristic monthly values and wind motions defined in I-ET-3000.00-1000-941-PPC-001_F - METOCEAN DATA</p> <p>5.3 MOTION REQUIREMENTS</p> <p>5.3.1 The necessary design data and information on motion requirements are given in I-RL-3010.2Q-1350-960-P4X-002 - MOTION ANALYSIS</p> <p>5.4 HOSE STRINGS LOCATION</p> <p>5.4.1 There are five (5) parallel suction hose strings, for B-5111001A/E, each of them being connected to the bottom of a dedicated seawater lift caisson, on starboard side of the FPSO.</p> <p>5.4.2 Location of the caissons is informed in 3D model supplied by PETROBRAS. This location shall be updated during detailed design.</p> <p>5.5 CAISSONS AND RISER SEATS</p> <p>5.5.1 For B-5111001 A/E the caisson internal diameter is defined: 1900mm.</p> <p>5.5.2 The Riser Seat is the component that is directly connected to the vessel at the caisson either by welding or as a bolted connection. The connection type shall be approval by Buyer.</p> <p>5.6 SEAWATER LIFT PUMPS</p> <p>5.6.1 The pumps main characteristics are presented in I-FD-3010.2Q-5111-311-P4X-001 - SEA WATER LIFT PUMP (B-5111001A/E).</p> <p>6 SYSTEMS DETAILED REQUIREMENTS</p> <p>6.1 SUCTION HOSES REQUIREMENTS</p> <p>6.1.1 Hoses shall be manufactured in accordance with OCIMF 2009 - Guide to Manufacturing and Purchasing Hoses for Offshore Moorings (GMPHOM).</p> <p>6.1.2 Design conditions shall be defined by SELLER and submitted to PETROBRAS for approval. The design conditions shall consider both maximum and minimum sea water temperature expected in the hose, and the total pressure acting in the hose including the sea water static column. Information is provided from I-RL-3010.2Q-1350-960-P4X-002 - MOTION ANALYSIS and I-ET-3000.00-1000-941-PPC-001_F- METOCEAN DATA.</p>				

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6.2 RUBBER HOSE CONSTRUCTION

6.2.1 The hose body shall basically consist of rubber, reinforced with an adequate number of textile fabric, textile cord and/or steel wire cord layers. The first off segment shall be reinforced on its upper part to sustain the high bending moments in the vicinity of the connection to the steel spool piece or riser head.

6.2.2 Hose in HDPE may be supplied under previous BUYER approval.

6.2.3 The hose shall have flanged ends in accordance with ASME B16.47 (type A) or ASME B16.5.

6.2.4 If other specific flange design may be proposed by SELLER, it shall be submitted to PETROBRAS for approval.

6.2.5 The flange material shall be forged steel material in accordance with ASTM A105 - Specification for Forgings, Carbon Steel, for Piping.

6.2.6 An acceptable substitute for ASTM A105 is ASTM A350 LF2 CL1 (for flanges), and ASTM A234WPB or ASTM A420 WPL6 (for reducers). Other alternative materials may be acceptable subject to approval by PETROBRAS.

6.2.7 The geometry of the end fittings shall allow a smooth and easy insertion of the corresponding bolting and gaskets (if any), including an easy integration of the hydraulic torquing tools (the considered type of torque tool shall be advised by SELLER).

6.2.8 All exposed carbon steel areas shall be protected – both internal and external faces - against corrosion using EPOXY based coating compliant with ISO12944-9 for Lm4 environment (painting system for submergence in seawater).

6.2.9 Rubber encapsulated flanges are acceptable; however, the hoses shall be supplied with steel quadrants to allow bolt torquing.

6.2.10 The hose internal lining shall be chemically resistant to hypochlorite.

6.2.11 The hose lining shall have anti-fouling properties to guarantee minimum adhesion of the marine growth at inner liner inside the suction hoses in case of interruption of the injection of hypochlorite to the bottom strainer.


6.2.12 All weld procedures and welders are to be qualified in accordance with ISO 15614- Specification and Qualification of Welding Procedures for Metallic Materials. Welding procedure tests or ASME BPVC section IX - Qualification Standard for Welding and Brazing Procedures. All welds are to be 100% radiographed in accordance with ISO 17636- Non-destructive testing of Welds.


6.2.13 All suction hoses shall be electrically continuous.


6.3 GENERAL MARKING


6.3.1 The following markings shall be applied as a minimum on hose outer cover:

- A. Nominal inside diameter
- B. Hose length.
- C. Hose rated pressure.

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<p>D. SELLER's serial number</p> <p>E. Month and year of manufacture</p> <p>F. Hose type ("double carcass" e.g.)</p> <p>G. Hose weight in air empty.</p> <p>H. Submerged weight full of seawater.</p> <p>6.4 HOSE COVER</p> <p>6.4.1 The hoses shall have a chloroprene cover and shall be black with one straight white stripe parallel to the longitudinal axis of the hose and in line with the center of one flange bolt hole.</p> <p>6.4.2 Hoses with reinforced end shall have a white stripe perpendicular to the longitudinal axis on reinforced side.</p> <p>6.5 HOSE PROPERTIES</p> <p>6.5.1 SELLER shall pay a particular attention to the maximum allowable tolerances. Three sets of data may be analyzed and checked by PETROBRAS:</p> <p>A. Preliminary hose datasheets (before placement of Purchase Order, to be used by BUYER for preliminary calculations)</p> <p>B. Final hose datasheets</p> <p>C. As-built hose properties.</p> <p>6.5.2 In preliminary datasheets, particular care shall be given to submarine hose displacement and bending stiffness. The following tolerances are required with respect to the final hose datasheets:</p> <p>A. Weight in air empty: +/- 4%</p> <p>B. Weight in seawater full of seawater: +/- 4%</p> <p>C. Bending stiffness: +/- 10%</p> <p>D. Axial stiffness: +/- 10%</p> <p>*Any other tolerance proposed by SELLER shall be analyzed and agreed by SELLER but can be subjected to rejection.</p> <p>6.5.3 Unless otherwise agreed SELLER is not allowed to change hose properties during project execution.</p> <p>6.5.4 Any new hose design that would be needed for a particular application shall be qualified and its properties shall be finalized before purchase order award, so that dynamic analyses can be safely performed at project start.</p> <p>6.5.5 The following tolerances are required on as-built hose properties with respect to the final hose datasheets:</p> <p>A. Weight in air empty: +/- 4%</p> <p>B. Weight in seawater full of seawater: +/- 6%</p> <p>C. Bending stiffness: +/- 15%</p> <p>D. Axial stiffness: +/- 10%</p>				

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<p>*Any manufactured hose out of these tolerances may be rejected by BUYER, if impacting the overall hose string configuration.</p>				
<h3>6.6 HYPOCHLORITE LINES</h3>				
<p>6.6.1 Hypochlorite will be injected at the bottom strainer of the hose string.</p>				
<p>6.6.2 The hypochlorite lines length shall be assessed by SELLER. It shall be long enough to allow connection at the FPSO main deck, pass through the caisson, down to the strainer at the bottom of the suction hose string. The length shall be suitable for assembly and installation purposes.</p>				
<p>6.6.3 Hypochlorite lines shall have sufficient over length to cope with maximum hose deformations against extreme loads in dynamic conditions.</p>				
<p>6.6.4 For internal hypochlorite lines, each section shall be long enough to allow a suitable and easy connection by operators during the suction hose assembly.</p>				
<p>6.6.5 Hypochlorite lines diameter shall be 1.5 inch.</p>				
<p>6.6.6 Hypochlorite content in the hypochlorite hose = 1.1 kg/m³</p>				
<p>6.6.7 Dosing should be 1ppm (continuous) and 2ppm (shock) for the seawater lift hose. SELLER shall confirm whether these values are suitable to ensure the best protection of the suction hoses or advise other values if needed.</p>				
<p>6.6.8 Hypochlorite line flanges shall be SW (socket weld) or WN (weld neck) type in accordance with ASME B16.5 - Pipe Flanges and Flanged Fittings NPS 1/2 through NPS.</p>				
<p>6.6.9 Flanges shall be made of titanium grade 2.</p>				
<p>6.6.10 Threaded end connections if any shall have all wetted metallic components from titanium grade 2.</p>				
<p>6.6.11 Hypochlorite line shall be suitable for an internal working pressure of 10 to 15barg.</p>				
<h3>6.7 ANCILLARY EQUIPMENT</h3>				
<h4>6.7.1 GASKETS</h4>				
<p>A. For the suction hoses gaskets shall be suitable for seawater and for environment.</p>				
<p>B. For the hypochlorite lines, gaskets shall be resistant to hypochlorite and environment condition.</p>				
<h4>6.7.2 SPOOL PIECE</h4>				
<p>The use of spool piece is only acceptable with prior BUYER approval.</p>				
<h4>6.7.3 BOLTING</h4>				
<p>A. For the suction hoses, the stud-bolts shall meet the requirements of ASTM A193 B7 (Specification for Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service) and nuts shall be ASTM A194 2H (Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service or both).</p>				
<p>B. All bolting items shall be protected from corrosion by cathodic protection as per section 6.7.7.</p>				
<p>C. For the hypochlorite hoses bolting, titanium grade 2 shall be used.</p>				

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<p>6.7.4 RISER SEAT</p> <p>A. The Riser Seat shall be directly connected to the vessel at the caisson by welding. SELLER shall perform this activity, at dry dock in Shipyard.</p> <p>B. Riser seat material shall be compatible with caisson structural material (mechanical proprieties and weldability). The coating to be applied at riser seat shall be the same as for the cassion.</p> <p>6.7.5 RISER HEAD</p> <p>The riser head shall:</p> <p>A. fit with the vessel riser seat + casting arrangement.</p> <p>B. fit with the suction hose.</p> <p>C. fit with the seawater lift pump depending on the specified pump elevation inside the caisson; based on pump characteristics informed in section 5.6.</p> <p>D. be designed against the loads induced by the suction hose string.</p> <p>E. prevent any movement of the hose string inside the riser seat once installed.</p> <p>F. include interface with the installation and retrieval tools.</p> <p>G. include interface with hypochlorite lines.</p> <p>H. be made of carbon steel.</p> <p>I. have the exposed surfaces protected from corrosion.</p> <p>6.7.6 BOTTOM STRAINER</p> <p>A strainer is needed at the bottom of the suction hose string. It shall meet the following requirements (but not limited to):</p> <p>A. The mesh area (suction area) shall be defined by SELLER such that the pressure drop across the strainer will be minimum and the protection of the seawater lift pump against debris will be maximum; proposed design shall be approved by BUYER.</p> <p>B. Material and coating requirements shall be the same as for the hose end fittings (see section 6.2.8) as a minimum.</p> <p>C. Anti-fouling solution shall be considered to protect the inside of the strainer when no hypochlorite is injected.</p> <p>D. The connecting flange shall be in accordance with ASME B16.5 or ASME B16.47 (Type A).</p> <p>E. The strainer shall contain necessary titanium grade 2 tubing and connections for internal hypochlorite injection.</p> <p>F. The hypochlorite injection shall be located at the top part of the strainer.</p> <p>G. The inside of the strainer shall be accessible by divers if the hose string is not retrievable (e.g. the bottom shall be made of removable hand cap).</p> <p>H. Two lifting lugs shall be included for handling purpose, they shall be located away of the flange to avoid any potential clash with the bolting.</p> <p>I. Lugs welding shall be full penetration welds in accordance with ASME BPVC section IX and checked under Magnetic Particle Inspection as per ASME BPVC section VIII, after proof load testing.</p>			

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6.7.7 SACRIFICIAL ANODES

A. In addition to the coating requirements in section 6.2.8, metallic parts shall be protected from corrosion by cathodic protection.

B. Sacrificial anodes shall be installed on the strainer, hose fittings and riser heads.

C. Cathodic protection calculation shall consider the riser seat surface, accounting for the Inconel overlay on the casting.

D. On the hose fittings, SELLER shall make sure that there is enough space available according to **DNV RP B401**.

E. For instance, it may be preferable to place the anodes on the nipples if there are uncovered by hose rubber, rather than on the flanges which do not have a large enough surface to be an option for long-term protection.

F. Aluminum anodes should preferably be used as their electrochemical efficiency is much higher than for zinc anodes. They should be welded to the structure to ensure a very good electrical continuity.

G. Electrical continuity shall be checked after installation and resistance shall not exceed 0.75ohm.

6.7.8 HYPOCHLORITE LINES INTERFACE INSIDE THE CAISSON

A. Hypochlorite lines shall be run inside the caissons from the FPSO main deck. SELLER shall provide the necessary interface to:

B. Connect the hypochlorite lines to the piping at the top of the caissons.

C. Have the lines secured internally all along the caissons.

D. Prevent any interference with the pump.

E. Connect the hypochlorite lines to the riser head and ensure their routing inside the suction hoses.

6.7.9 HYPOCHLORITE LINES FASTENING INSIDE THE SUCTION HOSES

A. The fastening system shall be compatible with the selected installation type of the sea water lift hose assembly.

B. The internal hypochlorite lines shall be securely fastened inside the suction hoses to avoid any detachment of failure during the specified system service life:

- SELLER shall demonstrate that the integrity of the internal hypochlorite hoses and fastening system is guaranteed for the specified suction conditions (sea water flow velocity).
- Securing supports shall be positioned at each hose flange connection as a minimum.


6.8 INSTALLATION EQUIPMENT

Installation of the suction hose strings shall be feasible from the FPSO main deck, through FPSO caissons, without any diver assistance.

6.8.1 HANG-OFF TOOL

A. For vertical hose assembly, a hang-off tool shall be supplied to secure and suspend the already assembled hose sections in the caisson while another hose section is being connected.

B. The hang-off tool should be designed to avoid damaging the suction hose outer cover.

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C. The lifting capacity shall be tested and certified by a third party.

D. If the opening of the tool is to be performed via hydraulic jack and controlled from a hydraulic pump on the FPSO deck. The hydraulic jack shall be correctly positioned to ensure a correct opening/closing of the tool, two distinct positions are recommended.

E. If made of different pieces, the hang-off tool shall be delivered as already fully mounted (to avoid hazardous offshore assembly).

F. The hang-off tool shall be supplied with sufficient bolting to be mounted on the caisson top flange.

6.8.2 LIFTING TOOL

A. The lifting tool shall be supplied to enable to lift one hose section from its horizontal lay-down position to the vertical assembly position.

B. The lifting capacity shall be tested and certified by a third party.

6.8.3 SAFETY TOOL

A. For vertical hose assembly, a safety tool shall be supplied to provide sufficient clearance in between two suction hose flanges for the assembly of the internal hypochlorite lines, and to prevent operators to work under a suspended load.

B. Design shall be verified through FEA considering the maximum hose weight of the suction hose string during installation.

6.8.4 DEPLOYMENT AND RETRIEVAL TOOL

A. For diverless suction hose design through FPSO caissons, SELLER shall provide a deployment and retrieval tool to lower the fully assembled suction hose string and riser head into the caisson (i.e., from FPSO deck) down to the riser seat interface.

B. It shall be possible to release the tool from the riser head once the suction hose string is installed, even if the riser head is submerged below water level, without the use of divers.

C. The tool shall allow retrieving the full suction hose string up to the FPSO deck for maintenance or replacement.

D. The tool shall be compatible with the FPSO caissons and riser seat design. The lifting capacity shall be tested and certified by a third party.

6.8.5 SPREADER BAR


A. A spreader bar shall be supplied to correctly lift / handle each hose section from containers, steels pallets or shipment cradles.

B. It shall be supplied with sufficient nylon lifting slings.

C. It shall be certified as a lifting appliance by a third party.

6.8.6 SPECIAL TOOLS

SELLER shall advise the list of all installation tools necessary for correct hose assembly and installation (dynamometer, special torque wrenches or deep sockets for instance), if not already included by BUYER in the purchase order.

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7 DESIGN REQUIREMENTS

7.1 DESIGN LIFETIME

- 7.1.1 The global system shall be designed to allow effective utilization for a period of 25 years onsite (FPSO design life).
- 7.1.2 SELLER shall commit that this lifetime can be met for the complete package (e.g. suction hoses, hypochlorite line) for the specified environmental conditions, or indicate the minimum anticipated lifetime of the different items for the specified conditions, along with recommended maintenance and replacement philosophy.

7.2 DESIGN CALCULATIONS

- 7.2.1 The design calculations shall be submitted to BUYER prior beginning of the fabrication and all shall be with status released by BUYER prior FAT.
- 7.2.2 The design calculations shall be executed considering all hoses foreseen. The loads induced to the FPSO shall be minimized.
- 7.2.3 SELLER shall carry out all analyses necessary to demonstrate the suitability of the system under the specified environmental conditions and for the specified lifetime.
- 7.2.4 SELLER shall submit the following analyses:
- A. Hydrodynamic analysis (including interference analysis – no clash between hoses and risers is allowed).
 - B. VIV analysis.
 - C. Structural analysis of the steel connecting parts (riser head and installation tools if not load tested)
 - D. Fatigue analysis of the suction hose and steel connecting parts.
 - E. Sacrificial anodes design analysis (to be in accordance with **DNV RP B401** - Det Norske Veritas Recommended Practice B401: Cathodic Protection Design)
 - F. Process analysis to demonstrate that the strainer has enough effective area to avoid clogging, that the internal hypochlorite lines can withstand the pumped seawater flow, and to calculate the maximum pressure losses in the complete suction hose string.
 - G. The pressure drop calculation in the hypochlorite hoses.
 - H. The maximum hose loads considered to design the vessel riser seats. SELLER should check that the extreme loads induced by the suction hoses are not exceeding these values.
- 7.2.5 There shall not be any uplift of the hose strings inside the caissons (to be demonstrated through the hydrodynamics analysis). If any uplift be calculated, SELLER shall update the design of the hose string to remove it.
- 7.2.6 The following items shall be clearly described in the results/conclusion chapter of hydrodynamic analysis report:
- A. Results includes Wake Effect only.
 - B. Results includes VIV DAF only.
 - C. Interface Loads Normal Operating
 - D. Summary of Interface Loads Extreme
 - E. Summary of Interface Loads Survival

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F. Summary of maximum loads of tension, shear and bending moment at the upper hose end connecting to the riser head for each load case.

7.3 DETAILED DRAWINGS

7.3.1 SELLER shall provide detailed drawings for all supplied equipment.

7.3.2 Each drawing shall show the overall equipment dimensions and weights.

7.3.3 Each ancillary equipment item shall have its corresponding detail drawing approved by PETROBRAS before being procured by SELLER.

7.3.4 SELLER shall ensure that final document revision is as-built and identified as such either in the title or the revision block;

7.3.5 Particular attention shall be paid to:

A. The detailed drawing of the hang-off tool, to ensure a suitable check of the interface with the FPSO deck.

B. The detailed drawings of the riser head and riser seat to ensure a suitable check of the interface with the FPSO hull, caisson, and seawater lift pump – these drawings shall be submitted with the bid (CAD versions to allow easier interface check).

C. Dimensional tolerance required of FPSO structures (e.g. Cassion) shall be presented at detailed drawing.

D. A 3D assembly drawing, which shall be provided to clearly show all assembly and installation steps for all items of the package. BUYER tag numbers and needed quantities shall be indicated for each item for each connection.

7.4 INTERFERENCE CRITERIA

7.4.1 Wave data and Current profiles shall be obtained from applicable Metocean Data (I-ET-3000.00-1000-941-PPC-001_F). If, for each direction, two types of current profiles (for instance, surface referenced velocities and mid-water referenced velocities) were provided, both shall be used for analysis. As required hereafter, an interference analysis shall be performed also by using currents normally adopted for fatigue evaluation, which shall be used to find the 98% non-Exceedance current profile.

7.4.2 The interference of hoses suction strings with the following structures is not acceptable:

A. Flexible or rigid risers.

B. Mooring lines.

C. UNIT hull or structures of Fixed Platforms.

D. Unprotected accessories (such as unprotected flanges, strainer).

E. Depending on the environmental loading case (according to the table 1), the clashing between risers in the bare section and protected accessories (i.e. without any ancillary components) is allowed.


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Table 1: Acceptance criteria for interference analysis

Environmental Loading Case (Current Return period) ²	Interference Criteria
98% non-exceedance	No clashing
100-Year	Allowed interference between risers only in the bare section and protected accessories

2: Compass directions shall be considered for surface referenced currents and for Mid Water referenced currents

7.4.3 The calculated clash energy and frequency of occurrence shall be demonstrated to be acceptable by SELLER i.e., not impacting the integrity of the suction strings.

7.4.4 If clashing is expected in the strainer area or unprotected accessories, to reduce the damage severity caused by these clashes, protection plates (or similar) shall be installed.

7.5 DETERMINATION OF LOAD CASES

7.5.1 The combinations of the following factors shall be considered:

- A. Operational, extreme waves, extreme current conditions.
- B. Vessel loading condition, minimum and maximum FPSO draft.
- C. Marine growth effect.
- D. Wake effect.

7.5.2 Wake effect analysis shall be in accordance with DNVGL-RP-F203.

7.5.3 Sensitivity of current direction: Current profiles shall be rotated from their original Compass direction $\pm 7,5^\circ$ and $\pm 15^\circ$ if sectors are defined each $22,5^\circ$ degrees in Metocean Data or $\pm 10^\circ$, $\pm 20^\circ$ and $\pm 30^\circ$ if sectors are defined each 45° .

7.6 DESIGN DOCUMENTS TO BE SUPPLIED BY SELLER

7.6.1 Vessel Seawater Lift Hose General Arrangement

7.6.2 FPSO Seller Data Requirement Specification

7.6.3 Vessel Caisson Riser Seat construction drawing

7.6.4 HOSE DATASHEETS

- A. SELLER shall provide, for each supplied hose type, a datasheet presenting the main hose characteristics.
- B. SELLER shall provide all properties listed in APPENDIX A– HOSE DATASHEETS.
- C. SELLER shall provide hose bending stiffness characteristics at bid stage to allow checking of system suitability by BUYER.
- D. SELLER shall provide bending stiffness laws instead of single values. These laws shall be non-linear curves displaying bending stiffness values (or induced bending moment) in function of various hose curvatures.
- E. When hose has one or several reinforced sections (suction hose OER e.g.), bending stiffness characteristics shall be provided for each of these different sections.

7.6.5 PERFORMANCE DATA

If not already included in the hose datasheet, SELLER shall provide the data listed in following tables as a minimum for each supplied hose type:

Table 2 - SELLER to advise – suction hose data.

PERFORMANCE DATA REQUIREMENTS
Hose reference and type
Rated working pressure, burst pressure
Diameters (inner nominal, outer for different sections)
Weights (in air empty, submerged full of seawater)
End fitting dimensions (weight, length, flange type, bolt diameter)
Presence of reinforced sections (length)
Bending, axial and torsional stiffnesses (at 0 barg)
Maximum allowable tension
Breaking tension
Maximum allowable compression
Minimum bending radius (normal and extreme conditions)
Maximum allowable twist angle
Maximum allowable differential pressure
Allowable vacuum and collapse pressure
Internal roughness
Bolting torques


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Table 3 - SELLER to advise – hypochlorite lines data.

PERFORMANCE DATA REQUIREMENTS
Hose reference and type
Rated working pressure, burst pressure
Diameters (inner nominal, outer)
Weights (in air empty, submerged full of seawater)
Maximum allowable tension
Breaking tension
Minimum bending radius (normal and extreme conditions)
Maximum allowable differential pressure
Allowable vacuum and collapse pressure
Bolting torques


8 INSPECTION AND TESTING

8.1 GENERAL

- 8.1.1 SELLER is required to propose a program for inspection and testing of all supplied equipment for approval by BUYER, prior to commencement of work in accordance with document schedule. Inspection and Test Plans (ITP) shall be issued for each equipment that are part of the Unit.
- 8.1.2 Unless otherwise stated, all inspections and tests shall be performed at the workshop of SELLER in the presence of BUYER representative and CLASS surveyor as applicable.
- 8.1.3 Inspections and tests are an integral part of the order which will not be considered complete until such inspections and tests have been carried out in full and recorded in an inspection report that shall be part of the data-book.

8.2 CERTIFICATION REQUIREMENTS

- 8.2.1 SELLER is responsible to obtain a Class Certificate granted by the appointed Classification Society (indicated in Purchase Order), certifying that the goods or services described in this specification are in compliance with the requirements mentioned in the project documentation.
- 8.2.2 Any equipment or system, for which the above statement is not applicable, shall be designed and built by a well-qualified designer/manufacturer. In those cases, SELLER shall provide a workshop certificate, certifying that the equipment is fit for the required services, in the conditions as specified.
- 8.2.3 Unless otherwise specified in the project documentation, the material certification for the steel parts shall be in accordance with EN 10204- Metallic products – Types of inspection documents: EN 10204 – type 3.1.

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8.3 FACTORY ACCEPTANCE TESTS (FAT)

8.3.1 SELLER shall perform as a minimum for the suction hoses:

- A. Weight in air, submerged weight tests
- B. Bending stiffness test (*)
- C. Hydrostatic test (**)
- D. Vacuum test
- E. Electrical test.

8.3.2 These tests shall follow the **OCIMF**- Guide to Manufacturing and Purchasing Hoses for Offshore Moorings (GMPHOM) procedures.

8.3.3 Special other tests may be required by BUYER like bending test at MBR calculated in the analysis.

Notes:

(*) Stiffness test method has been updated in the new revision of the **OCIMF**- Guide to Manufacturing and Purchasing Hoses for Offshore Moorings (GMPHOM) procedures. The differences in between the two methods being non-negligible, BUYER may require to perform the test in accordance with one of the two procedures, or both. Any other method proposed SELLER shall be reviewed and approved by SELLER. Acceptance criteria shall be as defined in section **6.5**.

(**) There is no requirement on pressure capacity for the suction hoses. However, the hydrostatic test shall be performed as per **OCIMF2009** procedure to the rated pressure defined by SELLER. Purpose is to check potential leakage of the hose before carrying out the vacuum test.

8.3.4 SELLER shall perform as a minimum for the steel components (riser head, strainer):

- A. Weight in air
- B. Measurements
- C. Proof load tests.

8.3.5 SELLER shall perform as a minimum for the installation tools:

- A. Weight in air
- B. Measurements
- C. Proof load tests
- D. Functional tests.


8.4 TRIAL FITMENT

8.4.1 A complete trial fitment of one entire suction hose string (as a minimum) shall be performed at SELLER plant, including all items of the package.

8.4.2 Trial fitment of the suction hose string items with all handling and installation tools shall be performed. Trail fitment of the hydraulic torque tools shall be performed.

8.4.3 The riser heads shall be trial fitted into the riser seats.

8.4.4 SELLER shall provide procedure recommendations for this trial fitment activity.

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9 SPARE PARTS

- 9.1.1 SELLER shall advise the list of all spares recommended for start-up and commissioning, and shall supply as a minimum:
- A. 20% of various bolting
 - B. 100% of various gaskets.
 - C. Backing quadrants (if any)
 - D. Complete sets of hypochlorite lines (1 complete line per suction hose string, including necessary bolting, gaskets and fittings)
 - E. Hypochlorite line fastening system (if not integrated to the hoses e.g., clamps or plastic fasteners – quantity to be advised, including one special tool if any).
- 9.1.2 SELLER shall advise the list of all spares recommended for operation and maintenance.


10 DELIVERY

10.1 TAG NUMBERING AND LABELLING

- 10.1.1 SELLER shall identify each equipment with a unique Tag Number, for easy reference, installation, and assembly. These Tag Numbers shall be as specified in the Purchase Order.
- 10.1.2 In addition to PETROBRAS Tag Number, SELLER shall identify each hose with a unique serial number. This serial number shall be weld marked on the outer edge of the flanges and on the hose outer cover. This serial number shall also be shown on the associated hose certificates.
- 10.1.3 PETROBRAS Tag Numbers shall be marked on each hose outer cover.
- 10.1.4 PETROBRAS Tag Numbers shall be according to I-ET-3000.00-1200-940-P4X-001-TAGGING PROCEDURE FOR PRODUCTION UNITS DESIGN (the latest version).
- 10.1.5 For easier material recognition during installation, a plastic label or sticker shall be attached or stuck to each item (hoses and ancillaries as per below pictures. On each label, the items serial and tag numbers shall be written as a minimum.

10.2 PACKING AND SHIPPING ARRANGEMENT PROCEDURES

- 10.2.1 SELLER shall provide all necessary recommendations for packing, shipping and preservation of the goods.
- 10.2.2 The packing (special frames e.g.) shall be suitable for long transportation on FPSO storage area from yard to site, including relevant fastening solutions.
- 10.2.3 Basic recommendations about hose handling / unpacking shall be indicated on a notice stuck on the hose.
- 10.2.4 The hoses shall be covered with a polyethylene film, and both ends flanges shall be covered with wooden or plastic blank and secured by temporary bolts and nuts with holes to allow for air circulation.
- 10.2.5 All suction hose sections and hypochlorite line sections shall show a clear identification in between the top and bottom sides (special marking shall be added on the blanking flanges).

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10.2.6 Each item shall be properly labelled as per previous section. Should the hypochlorite lines be provided in several sections of different lengths, they shall be clearly identified to avoid any confusion during assembly.

10.2.7 Metal plugs or caps shall protect threaded connections. For stainless steel items these caps shall be stainless steel as well.

10.2.8 All spare parts shall be packed separately with clear identification and delivered in a packing for long term storage.

10.3 DELIVERY SCHEDULE

10.3.1 Potential items (hypochlorite top connectors e.g.) to be integrated into the caissons during their fabrication may be delivered in advance to the yard, delivery date to be confirmed.

10.3.2 Delivery date for the other items shall be as indicated in the Purchase Order.

11 INSTALLATION, OPERATION AND MAINTENANCE

Installation, operation, and maintenance of the seawater suction hose system shall be feasible without any diver assistance.

11.1 INSTALLATION

11.1.1 SELLER shall provide all detailed procedures (including 3D explanatory assembly sketches) and tools needed for the complete assembly of the suction hose strings from FPSO deck, and installation of the strings through the FPSO caissons.

11.1.2 Torque values shall be indicated.

11.1.3 Special markings shall be added onto the riser head, suction hoses, and deployment tool to allow correct alignment of the hose string in the caisson and riser seat.

11.2 SPECIAL TOOLS

11.2.1 In addition to the equipment listed in section 6.8, SELLER shall advise the list of all installation tools necessary for correct hose assembly and installation (dynamometer and special torque wrenches for instance), if not already included by PETROBRAS in the purchase order.


11.2.2 If the hose flanges have a different geometry from ASME B16.5 and ASME B16.47, SELLER is responsible to provide the corresponding tightening tools to allow an easy fitment to apply the specified torque.

11.3 OPERATION AND MAINTENANCE

11.3.1 The suction hose system shall be designed to allow a zero or minimum needed maintenance (especially underwater).

11.3.2 Each hose string shall be retrievable on FPSO deck for maintenance or replacement, without any diver assistance.

11.3.3 SELLER shall provide a maintenance and operation manual, including its recommendations to ensure integrity of the suction hose assembly along the specified service life and conditions. This shall indicate recommendations for regular inspections, cleaning procedures, repair, and replacement instructions if any.

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<p>11.3.4 SELLER shall advise solutions to monitor the integrity of the suction hoses (internal and external) and hypochlorite lines from FPSO deck (via video, sensors etc.).</p> <p>11.3.5 SELLER shall advise all procedures to clean or repair the package items and provide corresponding tools if necessary.</p> <p>11.3.6 For the suction hoses, one hose repair kit shall be supplied, containing as a minimum: glue, hardener, several sheets of rubber, needed tools to make the repair (knives, brushes, trowel, protective gloves...), all product datasheets, repair procedure.</p>				

APPENDIX A– HOSE DATASHEETS

- A. SELLER shall specify the hose model and properties.
- B. If as-built data are not available, “catalogue” values may be used.
- C. SELLER shall pay a particular attention to the maximum allowable tolerances between preliminary and final datasheets and as-built data.
- D. It is then the SELLER’s responsibility to check the consistency of the “catalogue” with “as-built” values and, if necessary, perform again the analyses.

Table 4 - Suction hoses general properties

Properties	Unit	Mainline Hose	One End Reinforced Hose
Hose Type	-		
Size (ID x length)	[inch x ft]		
Pressure rating	[barg]		
Flange rating	[lbs]		
Total weight in air, empty	[kg]		
Mass of the displaced seawater volume	[kg]		
Submerged mass, full of seawater	[kg]		


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Table 5 - Detailed properties - Suction hose mainline.

Hose reference:	Unit	End Fitting		Body Section	/
Properties		End A	End B		
		#	#		
Length	[m]				/
Unit weight in air, empty	[kg/m]				/
Unit weight in water, sea water filled	[kg/m]				/
Weight of bolt set	[kg]			/	/
Nominal inside diameter ID	[m]				
Outer diameter OD	[m]				/
Axial stiffness no pressure kN	[kN]	/			/
Bending stiffness no pressure ¹	[kN.m ²]	/			/
Torsional stiffness no pressure	[kN.m ² /deg]	/			/
Minimum bending radius	[m]	/			/
Minimum bending radius in rare events (survival conditions e.g.)	[m]	/			/
Maximum allowable tension	[kN]				
Maximum allowable twist	[deg/m]				
Maximum allowable differential pressure	[barg]				

Notes:

Error! Unknown document property name. is requested to provide non-linear bending stiffness laws. When test values are provided, reference to the used test procedure shall be indicated (i.e. GMPHOM2009).

Table 6 - Detailed properties - Suction hose OER

Hose reference:	Unit	End Fitting		Body Section	Reinforced Section
Properties		End A	End B		
		#	#		
Length	[m]				
Unit weight in air, empty	[kg/m]				
Unit weight in water, sea water filled	[kg/m]				
Weight of bolt set	[kg]			/	/
Nominal inside diameter ID	[m]				
Outer diameter OD	[m]				
Axial stiffness no pressure kN	[kN]	/			
Bending stiffness no pressure ¹	[kN.m²]	/			
Torsional stiffness no pressure	[kN.m²/deg]	/			
Minimum bending radius	[m]	/			
Minimum bending radius in rare events (survival conditions e.g.)	[m]	/			
Maximum allowable tension	[kN]				
Maximum allowable twist	[deg/m]				
Maximum allowable differential pressure	[barg]				