PETROBRAS	**TECHNICAL SPECIFICATION**	Nº I-ET-3000.00-1500-310-PEK-005	
	CLIENT: DPT		SHEET 1 de 24
	JOB:		
	AREA:		
SUB/ES	TITLE: **SUBSEA SEAWATER INTAKE AND SKIMMER 10.000 PSI**		**INTERNAL** SUB/ES/EECE/EES

REVISION INDEX

REV.	DESCRIPTION AND/OR REVISED SHEETS
	Based on ET-3530.00-1251-27A-PPC-001 Rev C
0	ORIGINAL

	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE	19/10/2023								
DESIGN	EES								
EXEC.	B2N8								
CHECK	MA9N								
APRROV,	UP65								

INDEX

1 INTRODUCTION

The objective of this technical specification is to establish the requirements for SUBSEA SEAWATER INTAKE AND SKIMMER 10.000 PSI.

Reference Documents

1.1.1 Codes, Standards, Rules and Regulations

1.1 The latest issue of the reference standards shall be used unless it is specified in the table below or otherwise agreed. Other recognized standards may be used, provided that the SUPPLIER proves that they meet or exceed the requirements of the standards referenced below.

[1] Resolução ANP nº 41 – DOU 13.10.2015	Sistema de Gerenciamento de Segurança Operacional de Sistemas Submarinos – SGSS (Management System of Operational Safety of Subsea Systems)
[2] ISO 13628-15:2011	Petroleum and natural gas industries – Design and operation of subsea production systems – Part 15: Subsea structures and manifolds
[3] API 6A 2018	Specification for Wellhead and Tree Equipment
[4] ISO 13628-1:2005	Petroleum and natural gas industries Design and operation of subsea production systems – Part 1: General requirements and recommendations
[5] ISO 13628-8	Design and operation of subsea production systems Part 8: Remotely Operated Vehicle (ROV) interfaces on subsea production systems
[6] ISO 10423:2009	Petroleum and natural gas industries Drilling and Production Equipment Wellhead and Christmas Tree Equipment
[7] API RP 17N, 2nd Ed., Addendum 1 – May 2018	Recommended Practice on Subsea Production System Reliability, Technical Risk, and Integrity Management
[8] API RP 17Q	Recommended Practice on Subsea Equipment Qualification
[9] API RP 17V	Recommended Practice for Analysis, Design, Installation, and Testing of Safety Systems for Subsea Applications FIRST EDITION; ERTA 1: July 2015
[10] API STANDARD 17O	Standard for Subsea High Integrity Pressure Protection Systems (HIPPS)
[11] ASME BPVC section VIII	Rules for Construction of Pressure Vessels
[12] ISO 15156-3	Petroleum and natural gas industries — Materials for use in H2S-containing environments in oil and gas production — Part 3: Cracking-resistant CRAs (corrosion-resistant alloys) and other alloys
[13] API Std 670	Machinery Protection Systems
[14] DNVGL-RP-F303	Subsea Pumping Systems
[15] API STD 526 - SEVENTH EDITION; ERTA: September 2018	Flanged Steel Pressure-relief Valves

[16] API STD 520 PART I - TENTH EDITION	Sizing, Selection, and Installation of Pressure-relieving Devices Part I—Sizing and Selection
[17] API STD 2000 - Seventh Edition	Venting Atmospheric and Low-pressure Storage Tanks
[18] ISO 21940-11	Mechanical vibration - Rotor balancing - Part 11: Procedures and tolerances for rotors with rigid behavior
[19] ISO 17781	Petroleum, petrochemical and natural gas industries — Test methods for quality control of microstructure of ferritic/austenitic (duplex) stainless steels
[20] NACE MR0175	Petroleum, petrochemical, and natural gas industries — Materials for use in H2S-containing environments in oil and gas production —
[21] DNVGL-RP-F112	Duplex stainless-steel - design against hydrogen induced stress cracking
[22] ISO 23936-2	Petroleum, petrochemical and natural gas industries — Non-metallic materials in contact with media related to oil and gas production — Part 2: Elastomers
[23] ISO 23936-1	Petroleum, petrochemical and natural gas industries — Non-metallic materials in contact with media related to oil and gas production — Part 1: Thermoplastics
[24] Norsok M-710	Qualification of non-metallic materials and manufacturers – Polymers
[25] DNV RP B401	Cathodic protection design
[26] ISO 21457	Petroleum, petrochemical and natural gas industries — Materials selection and corrosion control for oil and gas production systems
[27] DNV RPF112	Duplex stainless steel - design against hydrogen induced stress cracking

1.1.2 PETROBRAS Documents

[28] RM	Material Requisition(s) with technical aspects and scope specific to the project
[29] I-ET-3000.00-1500-310-PEK-004	Subsea Raw Water Injection System 10.000 Psi
[30] Fluids TS	Technical Specification(s) with the characteristics of the fluids of the project
[31] Engineering Diagram	Base Case Engineering Diagram of the Equipment/System
[32] Control System TS	Control System Specification(s) of the project
[33] Subsea Electrical Power System TS	Subsea Electrical Power System Specification(s) of the project
[34] Subsea Pump Datasheet	
[35] ET-3000.00-1500-600-PEK-005	Requisitos de Estruturas de Equipamentos Submarinos
[36] ET-3000.00-1500-600-PEK-006	Requisitos Gerais de Equipamentos Submarinos

[37] ET-3000.00-1521-600-PEK-001	Projeto de Interfaces para Operações com ROV / E&P
[38] ET-3000.00-1500-610-PEK-002	Eslingas e Skids para Transporte de Equipamentos Submarinos
[39] ET-3000.00-1500-251-PEK-001	Fixadores em Aço Baixa Liga de Alta Resistencia para aplicação Submarina / Instalações Submarinas
[40] ET-3000.00-1500-251-PEK-002	Rastreabilidade de Fixadores de Alta Resistencia para Utilização o Submarina / Instalações Submarinas
[41] N-2037	Pintura de Equipamentos Submersos em Água do Mar
[42] N-1852	Estruturas Oceânicas Fabricação e Montagem de Unidades Fixas
[43] N-133	Soldagem
[44] DE-3500.00-1516-273-PPC-738	Receptáculo para Dual Hot Stab
[45] DE-3000.00-1500-270-PEK-001	HUB de Instalação Padrão Petrobras
[46] ET-3000.00-1500-600-PEK-004	Documentação Técnica para Equipamentos Submarinos
[47] ET-3000.00-1500-940-PEK-001	Projeto de Proteção Catódica para Equipamentos Submarinos
[48] ET-3000.00-1514-270-PAZ-001	Sistema de Conexão Vertical Direta com Pescoço de Ganso
[49] ET-3000.00-1500-220-PEK-002	Requisitos Gerais de Projeto e Testes de Válvulas e Atuadores Submarinos
[50] ET-3000.00-1500-221-PEK-001	Requisitos Específicos de Projeto e Testes de Válvulas Gaveta para Aplicação Submarina.
[51] Special Operations Fluids TS	Fluids for Special Operations applicable in specific projects
[52] Subsea Motor-Pump Transducer System TS	Subsea Motor-Pump Transducer System
[53] Topside Interface TS	Topside Equipment Module Interface with FPSO/FPU
[54] ET-3000.00-1500-600-PEK-008	Instalação de Equipamentos Submarinos
[55] I-ET-3000.00-1500-310-PEK-003	SUBSEA SEAWATER PUMP
[56] I-ET-3000.00-1500-310-PEK-004	Subsea Raw Water Injection System 10.000 Psi

1.1.3 Order of Precedence

If there is any conflict between requirements, the following order of precedence shall be applied ((i) being higher in the order):

i. Resolução ANP nº 41 – DOU 13.10.2015
ii. RM;
iii. I-ET-3000.00-1500-310-PEK-004 [29];
iv. This Technical Specification.
v. API 6A [3]

vi. API RP 17V [9]

vii. Other PETROBRAS documents.

viii. Other ISO Standards and RPs.

ix. API Standards and RPs.

x. Other Standards and RPs.

TERMS, DEFINITIONS, ACRONYMS AND ABREVIATIONS

1.2 1.2.1 Acronyms and Abbreviations

BFHPU: Barrier Fluid Hydraulic Power Unit

BSRWI: Subsea Seawater Pump

CAT: Component Acceptance Test

CMAT: Complete Model Acceptance Test

CFD: Computational Fluid Dynamics Analysis and Simulation

CRA: Corrosion Resistant Alloy

DPIEF: Define, Plan, Implement, Evaluate, Feedback

DRS: Diverless Rigid Spool

ESRWI: Subsea Raw Water Injection Station

EFAT: Extended Factory Acceptance Tests

EFL: Electric Flying Lead

ESD: Emergency Shutdown

ET = TS

FAT: Factory Acceptance Testing

FEA: Finite Element Analysis and Simulation

FMECA: Failure Modes, Effects, and Criticality Analysis

FWKO: Free Water Knockout

FPSO: Floating Production, Storage and Offloading Vessel

HAZID: Hazard Identification

HAZOP: Hazard and Operability Study

HFL: Hydraulic Flying Lead

HPU: Hydraulic Power Unit

ID: Internal Diameter

IM-FMECA: Integrity Management Failure Modes, Effects, and Criticality Analysis

ITMM: Inspection, Testing, Monitoring, and Maintenance

LAS: Low Alloy Steel

MATIC: Manufacture, Assembly, Testing, Installation, and Commissioning

MAY: used when alternatives are equally acceptable

MBSRWI: Subsea Raw Water Injection Retrievable Module

MCV: Vertical Connection Module

MCSF: Minimum Continuous Stable Flow

MRFB: Barrier Fluid Subsea Retrievable Module

NP: Part Number

NPS: Nominal Pipe Size

P-FMECA: Process Failure Modes, Effects, and Criticality Analysis

PSL: Product Specification Level, according to ISO 13628-4: 2010 [2] and ISO 10423: 2009 [5]

PVT: Performance Verification Testing

QA: Quality Assurance

QC: Quality Control

Q-FMECA: Qualification Failure Modes, Effects, and Criticality Analysis — ref. [8]

RAM: Reliability, Availability, and Maintainability

RBI: Risk Based Inspection

RIAD: Reliability and Integrity Assurance Document

RIM: Reliability and Integrity Management

RM: Material Requisition

RP: Recommended Practice

SEPS: Subsea Electrical Power System

SHALL: used when a provision is mandatory

SHALL: used when a provision is not mandatory, but is recommended as a good practice

SIS: Safety Instrumented Systems. According to reference [10]

SIT: System Integration Test

SMAT: Subsystem Model Acceptance Test

SMPTS: SUBSEA MOTOR-PUMP TRANSDUCER SYSTEM. As defined in [52].

SMYS: Specified Minimum Yield Strength

SRWI SYSTEM: Subsea Raw Water Injection System

SRWIFB: Subsea Raw Water Injection Flow Base

SRWIIS: Subsea Seawater Intake and Skimmer

SVSD = SVFD: Subsea Variable Frequency Drive= Subsea Variable Speed Drive

TRAR: Technical Risk Assurance Review

TRC: Technical Risk Categorization

TS: Technical Specification = ET

UTA: Umbilical Termination Assembly

VFD= VSD: Variable Frequency Drive= Variable Speed Drive

XT: Christmas Tree

1.2.2 Definitions

1.2.2.1 SUPPLIER: Contractor (Subsea Raw Water Injection System SUPPLIER)

1.2.2.2 Critical Element of Operational Safety: any Critical Equipment, System or Procedure of Operational Safety, according to [1].

1.2.2.3 Critical Equipment of Operational Safety: any equipment or structural element of the system whose failure could cause or contribute to operational accidents, according to [1].

1.2.2.4 Critical Procedure of Operational Safety: any procedure or criteria used to control operational risks, according to [1].

1.2.2.5 Critical System of Operational Safety: any engineering control system designed to maintain the system inside its Safety Envelope, to stop partially or totally the system in case of operational safety failure, and to reduce risks to personnel and environment exposed to failure consequences, according to [1].

1.2.2.6 Package: A named system, subsystem, or defined set of components considered as a single entity for the purposes of a design study or for procurement (e.g., subsea tree, control system).

1.2.2.7 Safety Envelope: Operational limits and conditions defined during system Detailed Design stage and complying with applicable industry standards that shall not be surpass and that guarantee the integrity and operational safety of the system, according to [1].

2 SUBSEA RAW WATER INJECTION SYSTEM APPLICATION CONDITIONS AND PARAMETERS

Each SUBSEA RAW WATER INJECTION SYSTEM BSRWI shall be designed to withstand all conditions and parameters described in RM [28] and Fluids TS [30].

2.1 Each SUBSEA RAW WATER INJECTION SYSTEM BSRWI shall be designed to comply with [34].

2.2

3 SUPPLIER RESPONSIBILITY

SUPPLIER shall perform the work in accordance with the requirements of all references in 1.1 of this TS.

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

3.1

SUPPLIER's responsibility shall also include but not be limited to:

3.2

3.3.1 Resolving all engineering questions and/or problems relating to design and manufacturing.

3.3

3.3.2 Providing details as requested, for the main and auxiliary equipment, relating to design and manufacturing.

Compliance by the SUPPLIER with the provisions of this specification and industry standards does not relieve the SUPPLIER's responsibility to furnish equipment and accessories of a proper mechanical design suited to meet the specified service conditions.

3.4

3.5

SUPPLIER is responsible for all coordination with MANUFACTURERS and collections of all details, drawings and data to achieve optimum design and full submission of all documents requested in the specification.

4 SUBSEA SEAWATER INTAKE AND SKIMMER TECHNICAL REQUIREMENTS

Each BSRWI shall comply with all the requirements in [28], [29] and [34].

Each BSRWI shall be designed in a way that none of its equipment can generate pressure superior to 10ksi or the lines design pressure in [28] (whichever is more conservative) or temperature superior to 120ºC or the lines design temperature in [28] (whichever is more conservative) in order to protect all other subsea or topside components of the production system. This includes the shutoff conditions of individual pumps or all pumps in the system. Logic VSD limitation shall not be considered a safety barrier.

4.1

4.2

If the SUBSEA RAW WATER INJECTION SYSTEM Pumping System does not fully comply with 4.2 or any other analysis in this TS or other SUBSEA RAW WATER INJECTION SYSTEM TS deems necessary, a SIS according to [10] shall be implemented.

4.3

Other subsea equipment (PLET, PLEM, XTs, etc.) are rated for 10.000 psi. SUBSEA RAW WATER INJECTION SYSTEM System's pumps (individual or all in the system) discharge pressure and all other SUBSEA RAW WATER INJECTION System's equipment shall be designed to keep equipment's integrity throughout all SUBSEA RAW WATER INJECTION SYSTEM design life in any operational or incidental scenario without intervention in the SUBSEA RAW WATER INJECTION SYSTEM or in the XT to keep the integrity.

4.4

4.5

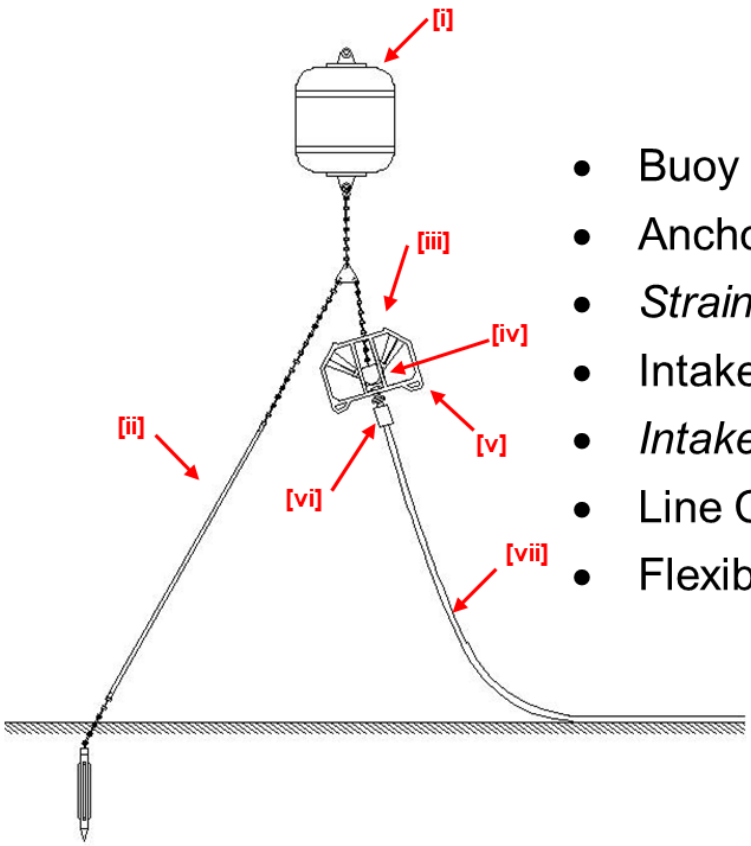
If there is more than one SUBSEA SEAWATER INTAKE AND SKIMMER in the scope of supply (RM [28]) and they are not exactly the same (including

internals) and interchangeable, SUPPLIER shall deliver at least one spare SRWIIS for each different design.

The SUBSEA SEAWATER INTAKE AND SKIMMER is part of the SRWI System [29] and shall be installed 100m above seabed.

4.6.1 The components and subcomponents numbered [iii], [iv] and [v] in Figure 4-1 are in the scope of the SRWI System SUPPLIER.

4.6



4.7

Figure 4-1

SRWIIS and all its components shall fully comply with [9] including the recommended safety devices in annex A. SUPPLIER shall verify if the base cases in [29] and [34] complies with [9] and alert PETROBRAS of any deviation for written approval. At the end of the DETAIL DESIGN STAGE SUPPLIER shall submit a report stating that the SUBSEA RAW WATER INJECTION SYSTEM final design fully complies with [9].

SUPPLIER shall clearly mark the locations of all connections and identify them on the drawing.

Design for Installation:

4.8 4.9.1 The SRWIIS shall be designed for installation loads considering minimum speed of 0.7 m/s according to ref. [14]

4.9 4.9.2 The SRWIIS shall be designed for installation loads without heave compensation according to ref. [54].

Material and Compatibility with Fluids:

4.10 4.10.1 Material selection and cathodic protection design shall be according to [29], [34], [35], [36], [20], [21], [22], [23], [24], [25], [26] and [27] considering lifetime in [28]. Additional requirements shall be followed:

4.10.1.1 The SUPPLIER shall guarantee and provide evidence during Detail Design Stage that all non-metallic materials in the SRWI SYSTEM in contact with injection fluids are compatible with the fluid, O2 content (psl-3G, according to [3]) and with Fluids for Special Operations [51]. High O2 fluids are known to be aggressive to most elastomeric materials. The fluids are described in [30], [34] and [51].

4.10.1.2 The SUPPLIER shall guarantee and provide evidence that all non-metallic materials in the SRWI SYSTEM in contact with control system fluids, compensation fluids and pumps barrier fluids are compatible with those fluids.

4.10.1.3 The SUPPLIER must provide traceable and irrefutable evidence on the compatibility/ageing of the non-metallic materials considering:

4.10.1.3.1 Representative operational conditions (temperature, pressure, fluids like O2, water, and their concentrations and exposure time of the materials to the scenario/design lifespan).

4.10.1.3.2 Chemical products that may be in contact with non-metallic parts, considering representative treatment conditions (temperature, pressure, chemicals their concentrations and exposure time of the materials to these during equipment design lifespan).

4.10.1.3.3 Any events that may take place considering equipment operation (for instance, but not limit to, rapid gas decompression – RGD events).

4.10.1.4 Evidence in 4.10.1.3 must be provided considering representative experimental data based on renowned standards such as ref. **[23]** (thermoplastics) and/or ref. **[22]** (elastomers) or other representative standards, as conservative or more than the ones proposed herein. These results must evidence material overall performance in the application (for instance, but not limited to, compression set, stress relaxation, creeping, mechanical properties, RGD so on and so forth) taking into consideration material within equipment design (for instance, groove fill and squeeze that strongly influence RGD behavior of seals, so on and so forth).

*4.10.1.4.1 A point of attention to be highlighted: the aforementioned standards and others as well (for instance, ref. **[24]**) propose in their scope the so-called "Standard gas mixtures", especially for RGD testing. Supplier must provide evidence on material performance considering bespoke mixtures, i.e., as agreed between interested parties, considering technical specifications. Moreover, if decompression events are expected for the application, those must be evaluated from the material performance point of view (regardless they are thermoplastics or elastomers or their composites) not only using representative scenarios, but also considering representative decompression rates (not necessarily the standardized ones – in ref. **[22]**: 20bar/min shall be compared with the ones in [34], [28], [29]and [30] and the most conservative case shall be considered).*

4.10.2 SUPPLIER shall guarantee and provide evidence that all materials in contact with production fluids in SUBSEA RAW WATER INJECTION SYSTEM are compatible with the all fluids and O_2 content and with Fluids for Special Operations (materials shall be trim HH and psl-3G, according to [3]; If cladded, Ni alloy 625 shall be used with a minimum layer of 3mm. SUPPLIER shall comply with all requirements from [12].). High O_2 fluids are known to be aggressive to most elastomeric materials. The internal fluids are described in [30] and[51].

4.10.3 SUPPLIER shall guarantee that internal seals (such as the ones between pump shaft and impellers and between diffusers and casing) are compatible with all internal fluids and O_2 content and with Fluids for Special Operations. The internal fluids are described in [30], [34] and [51]. Materials shall be trim HH and psl-3G, according to [3]; If cladded, Ni alloy 625 shall be used with a minimum layer of 3mm. SUPPLIER shall comply with all requirements from [12].

4.10.3.1 The following exceptions shall be submitted for approval by PETROBRAS:

4.10.3.1.1 Internal components in the subsea pumps, if approved by PETROBRAS, MAY be 25%Cr duplex according to ref. [19] (Quality Level I) and limitations by ref. [20] / ref.[12].

4.10.3.1.2 Whenever 25%Cr duplex is under cathodic protection, ref. [21] shall be followed.

4.10.3.1.3 In case there are dissimilar welds (for example between LAS/C-Mn steel — internally cladded with alloy 625 — and alloy 25% Cr) and subjected to cathodic protection, special consideration shall be taken regarding the welding procedure specification in order to avoid the risk of hydrogen induced stress cracking, therefore, a technical query shall be firstly sent to Petrobras for approval.

4.10.3.1.4 F22 MOD MAY be used for the subsea pump, with internally weld overlay with alloy 625 where process is exposed (minimum layer of 3 mm).

4.10.4 SRWI painting, anti-fouling and coating shall comply with the requirements of [36], and [41]. Sealing areas and/or surfaces with relative movement shall not be painted.

4.10.4.1 SRWIIS shall be coated with anti-fouling painting to prevent marine growth. SUPPLIER shall submit the coating material with the corresponding selection criteria for approval by PETROBRAS.

4.10.5 SUPPLIER shall submit for approval by PETROBRAS a report with full analysis and simulation of the design and ability of the SUBSEA SEAWATER INTAKE AND SKIMMER to handle all operational conditions of pump operation presented in [30] and [34]. The maximum intake allowed waterflow speed shall be 0.2 m/s in order

to avoid trapping sea life. This report shall present CFD and process analysis relating flow conditions in SUBSEA SEAWATER INTAKE AND SKIMMER and SRWI PUMP ([35]) for all operational conditions according to requirements in [56].

4.10.6 SUPPLIER shall submit for approval by PETROBRAS a report with full finite element analysis and simulation (FEA) of the design and ability of the SUBSEA SEAWATER INTAKE AND SKIMMER to handle all operational loads.

4.10.7 SUBSEA SEAWATER INTAKE AND SKIMMER shall be manufactured in a "Y" shape, with a 90-degree angle between the upper sections, in order to minimize pressure losses involved. Alternative configurations may be submitted for approval by PETROBRAS.

4.10.8 Interface with strainers: It shall have dimensions compatible with the attached strainer design, meeting the following premises:

4.10.8.1 It shall have an upper end ring/disc with sufficient width for the magnetic contact of the magnets mounted on the strainer.

4.10.9 It shall have at least six equally spaced longitudinal guides between the upper ring and the base to provide structural rigidity of the assembly.

4.10.10 There shall be two parking places designed according to [37] each side for the ROV strainer replacement operation.

5 THE SUBSEA SEAWATER STRAINER TECHNICAL REQUIREMENTS

The STRAINER is the first coarse filter to avoid sea life, foreign objects, debris and larger particles intake.

5.1

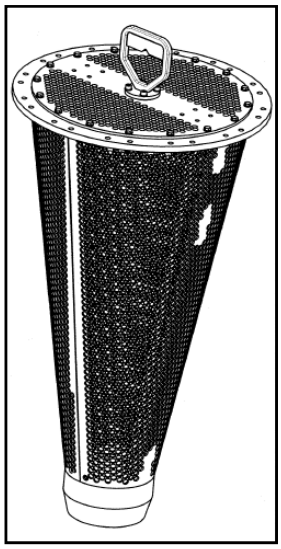


Figure 5-1 — Strainer

5.2 The STRAINER shall be designed to be installed and retrieved inside the SUBSEA SEAWATER INTAKE AND SKIMMER by ROV.

5.3 5.2.1 The design and ROV interface shall comply with [36] and [37].

5.4 The STRAINER shall have a steel frame designed to handle seawater with high O_2 content and able to handle all expected loads.

5.5 The STRAINER shall have anti-fouling painting and coating according to 4.10.4 to avoid sea life.

5.6 The STRAINER fixing in the SUBSEA SEAWATER INTAKE AND SKIMMER
5.7 shall be magnetic. Alternative modes may be submitted for approval by PETROBRAS.

The maximum STRAINER mesh size shall be 5 mm.

SUPPLIER shall delivery a STRAINER STORAGE SKID designed for transportation and storage in order to protect the STRAINER and the spares.

6 THE SUBSEA SEAWATER INTAKE TECHNICAL REQUIREMENTS

The SUBSEA SEAWATER INTAKE shall be designed to be the connection between the strainer, the anchoring system and the flexible line.

The SUBSEA SEAWATER INTAKE is connected to the buoy through anchor chains or cables fixed in the SUBSEA SEAWATER INTAKE upper part by padeyes and shackle.

6.1

6.2 The lower part of the SUBSEA SEAWATER INTAKE shall be connected to the flexible lines through a flange according to the requirements in [28].

6.3

7 THE SUBSEA SEAWATER INTAKE AND SKIMMER PROTECTION SKID TECHNICAL REQUIREMENTS

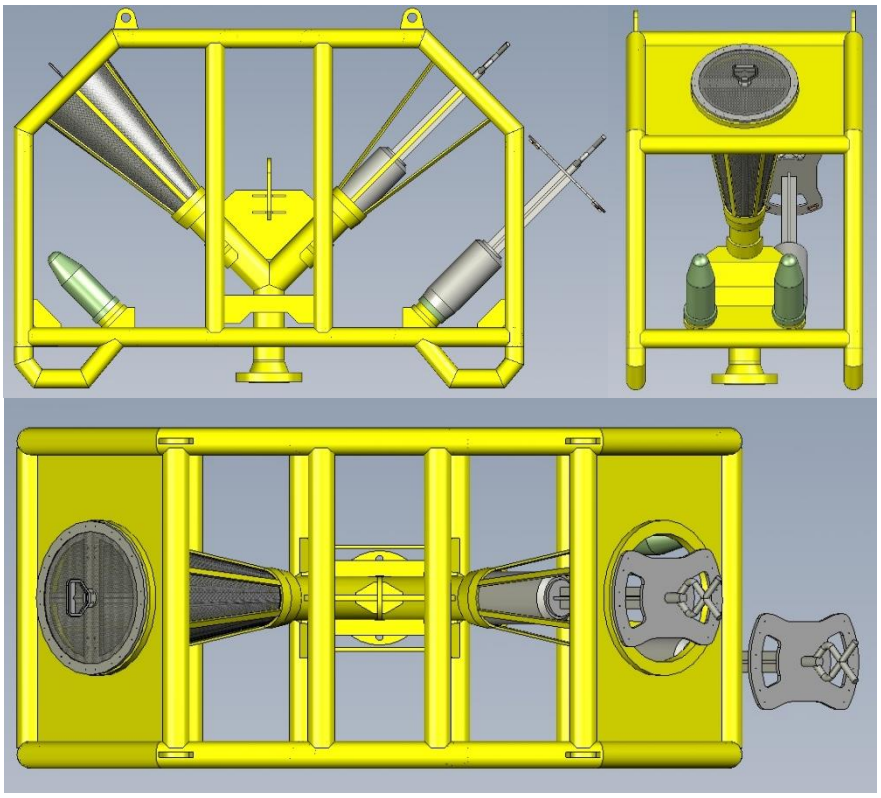


Figure 7-1 – SUBSEA SEAWATER INTAKE AND SKIMMER PROTECTION SKID

7.1 The SUBSEA SEAWATER INTAKE AND SKIMMER PROTECTION SKID shall be designed for housing all the internal items of the capture subsystem and the cathodic protection of the SUBSEA SEAWATER INTAKE AND SKIMMER assembly, as well as serving as a protective barrier against impacts during transport, deployment, and installation maneuvers. It shall have dimensions larger than all the components enclosed within it.

7.2

7.3 It shall have four lifting padeyes on the upper face. Additionally, it shall have four supports on the bottom to maintain a minimum distance of 150mm between the ground and the flange when not connected to the flexible line.

7.4

It shall have at least two transverse bars on the upper face to prevent potential collisions of the anchoring line with the components of the assembly subsystem.

The SUBSEA SEAWATER INTAKE AND SKIMMER PROTECTION SKID shall have a closing plate around each strainer intake. The given letter of the

strainer (A, B, …), tags of each SRWI and QR code shall be imprinted in each of those plates according to [36].

8 THE SUBSEA SEAWATER INTAKE DUMMY STRAINER REQUIREMENTS

The DUMMY STRAINER is responsible for preventing debris from entering the water intake during skid deployment, recovery, or maintenance operations.

It shall be designed considering a perfect fit in the strainer location.

8.1 It shall respect the geometric limits of the strainer fitting location and ensure a minimum seal.

8.2

8.3 It shall have cathodic protection according to [36] designed for the lifetime in [28].

8.4

8.5 The DUMMY STRAINER shall be designed to be installed and retrieved inside the SUBSEA SEAWATER INTAKE AND SKIMMER by ROV.

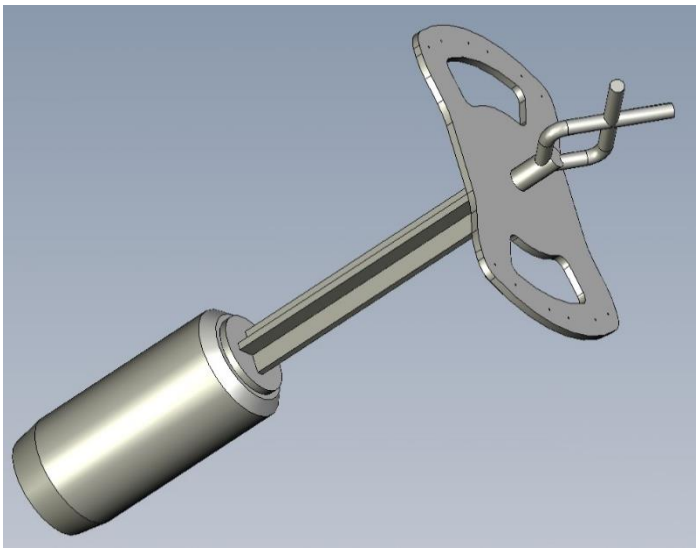
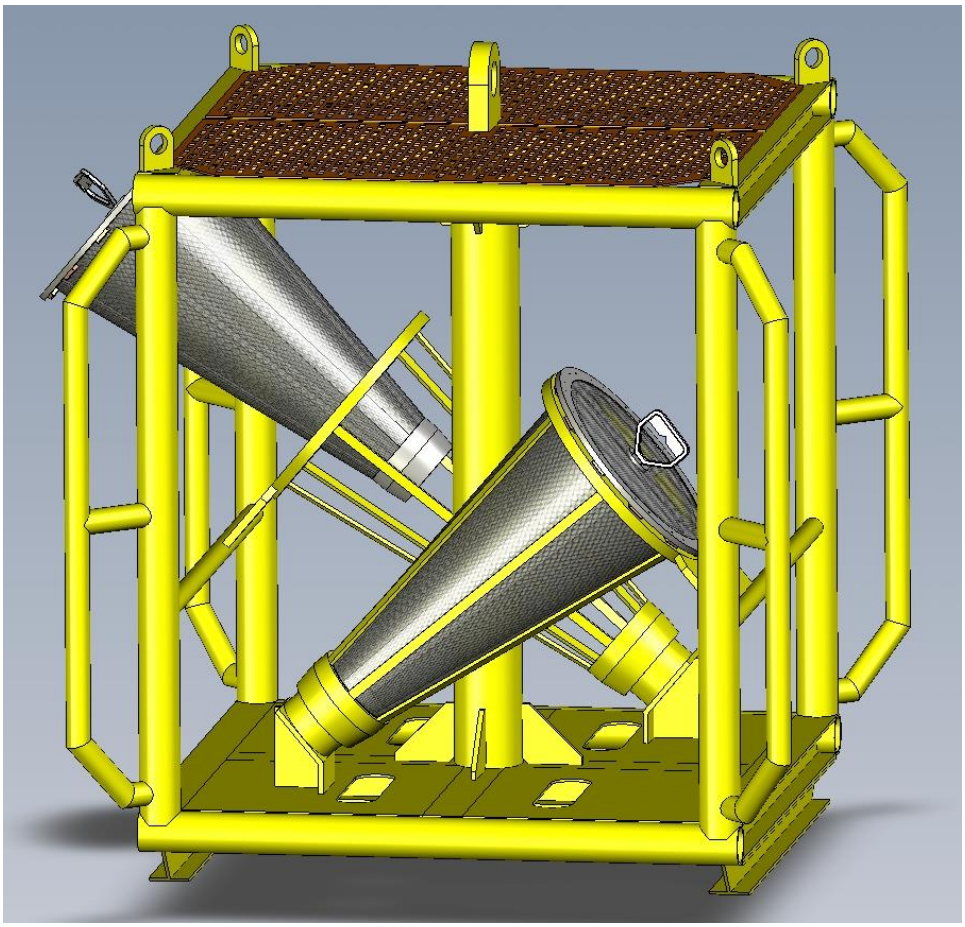


Figure 8-1 Dummy Strainer

9 THE SUBSEA SEAWATER INTAKE STRAINER DEPLOYMENT FRAME REQUIREMENTS

The STRAINER DEPLOYMENT FRAME is responsible for protecting at least two STRAINERs during storage, transportation, and deployment from the boat to the seabed. It shall also receive at least two DUMMY STRAINERs after they are REMOVED from SRWIIS.

9.1



9.2

Figure 9-1 SUBSEA SEAWATER INTAKE STRAINER DEPLOYMENT FRAME

9.3

It shall be designed for its STRAINERs to be removed and to receive DUMMY STRAINER by ROV according to [37].

9.4

It shall have cathodic protection according to [36] designed for the lifetime in [28].

It shall have four lifting padeyes on the upper face for lifting during transportation. Additionally, it should have a center padeye designed for installation by cable without heave compensation according to [36] and [38].

10 FAT — FACTORY ACEPTANCE TEST

10.1.1 The FATs shall be witnessed by PETROBRAS.

10.1.2 SUPPLIER shall provide FAT test reports up to 30 days after their execution.

10.1.3 For the Factory Acceptance Test (FAT), the PACKAGER / MANUFACTURER shall make preliminary test to ensure that all parts of the equipment are operating satisfactorily prior to the arrival of the PETROBRAS's representatives. SUPPLIER shall advise PETROBRAS of the test schedule before the planned test. Unless otherwise agreed, witnessed FATs require written confirmation of a successful preliminary test.

10.1.4 The dates and order of the tests in the FAT shall be submitted for approval by PETROBRAS at least 60 days before the first test.

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

10.1.6 If it is found necessary to dismantle or change 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 or after any change.

10.2 SRWIIS FAT Conditions

All tests in this section (10) shall be performed for each final SRWIIS with the respective final assembly and subcomponents, including the components described in items in 4, 5, 6, 7, 8 and 9 of this TS.

10.2.1 SUPPLIER shall be responsible for providing facilities, infrastructure, test fluids, power and utilities.

10.2.2 FAT shall be performed according to [36].

11 SUBSEA SEAWATER INTAKE AND SKIMMER : FEA ANALYSY, CFD ANALISYS, RISK ASSESSMENT, DETAIL DESIGN, MATIC STAGE, INTEGRITY MANAGEMENT PROGRAM AND DECOMISSIONING

11.1 SUBSEA SEAWATER INTAKE AND SKIMMER shall follow each requirement, stage, step and analysis in TS [29], including STEADY-STATE AND DYNAMIC SIMULATIONS (replaced by CFD and FEA), RISK ASSESSMENT, DETAIL DESIGN, MATIC STAGE, INTEGRITY MANAGEMENT PROGRAM AND DECOMISSINING.

11.2 During DETAIL DESIGN STAGE and during Manufacturing or Assembly in MATIC STAGE, CONTRACTOR shall submit to PETROBRAS each test operational procedure for comments. PETROBRAS and CONTRACTOR shall agree mutually the final version of these documents.