PETROBRAS	**TECHNICAL SPECIFICATION**	**Nº:** I-ET-3010.2Q-1200-500-P4X-002	
	CLIENT: MARLIM LESTE E MARLIM SUL		**SHEET:** 1 of 20
	JOB: BASIC DESIGN - REVIT I		
	AREA: MARLIM LESTE E SUL		
SRGE	**TITLE:** **MATERIAL SPECIFICATION FOR HULL SYSTEMS PRESSURE VESSELS AND TANKS**		INTERNAL
			ESUP

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SUMMARY

1. OBJECTIVE

This document covers the material specification for pressure vessels, filters and tanks of HULL SYSTEMS to be supplied to BUYER for MARLIM LESTE E SUL FPSO P-86 unit. Any other equipment not covered by this specification, material selection shall follow I-ET-3010.2D-1200-940-P4X-001 – MATERIAL SELECTION PHILOSOPHY FOR DETAILED DESIGN, applicable mechanical datasheet, and applicable Package Technical Specifications.

The requirements herein listed apply to all players which will perform any activity related to the scope of this unit, including manufacturers, packagers, main contractor, subcontractors, 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).

All calculations and mechanical datasheets shall be submitted to BUYER approval by SELLER.

2. NORMATIVE REFERENCES

All equipment shall comply with the requirements of this technical specification and references stated below. All equipment parts and details not complying with any of these requirements shall be informed on a “Deviation List”. Otherwise, they will be considered as “Agreed”, and so required.

2.1. CLASSIFICATION SOCIETY

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

2.1.2. SELLER is responsible for submitting to the Classification Society all 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 that, through reference herein, constitute provisions of this specification. The latest issue of the references shall be used unless otherwise agreed.

2.2.2. Other recognized international standard may be used, whether they meet or exceed the requirements of the standards referenced below. Formal approval from BUYER and from the Classification Society is also required.

Table 1: Codes and Standards

ASME/BPVC SEC II	- Materials Specifications
ASME/BPVC SEC. VIII	- Rules for Construction of Pressure Vessels
ASME/BPVC SEC. X	- Fiber Reinforced Plastic Pressure Vessels
ASTM	- American Society for Testing and Materials
ISO 21457	- Materials selection and corrosion control for oil and gas production systems
ISO 15156 (all parts)	- Petroleum and Natural Gas Industries – Materials for use in H2S Containing Environments in Oil and Gas Production

2.3. GOVERNMENT REGULATION

2.3.1. Brazilian Government regulations are mandatory and shall prevail, if more stringent, over the requirements of this specification and other references herein.

Table 2: Brazilian Regulatory Standard and Government Regulation

NR-13	Brazilian Regulatory Standard – Boilers, Pressure Vessels, Pipes and Metallic Storage Tanks
NR-26	Brazilian Regulatory Standard – Safety Signaling
NR-37	Brazilian Regulatory Standard – Safety and Health in Petroleum Platforms

2.4. DESIGN SPECIFICATIONS

Table 3: Design Specifications

DR-ENGP-M-I-1.3	SAFETY ENGINEERING GUIDELINE
DR-ENGP-I-1.15	COLOR CODING
I-ET-3010.00-1200-940-P4X-002	GENERAL TECHNICAL TERMS
I-ET-3010.00-1200-431-P4X-001	THERMAL INSULATION FOR MARITIME INSTALLATIONS
I-ET-3010.00-1200-251-P4X-001	REQUIREMENTS FOR BOLTING MATERIALS
I-ET-3010.2E-1200-200-P4X-001	PIPING SPECIFICATION FOR HULL
I-ET-3010.00-1200-956-P4X-002	GENERAL PAINTING
I-ET-3010.00-1200-540-P4X-001	REQUIREMENTS FOR PRESSURE VESSELS DESIGN AND FABRICATION
I-ET-3010.00-1200-510-P4X-001	METALLIC TANKS DESIGN FOR TOPSIDE
I-ET-3010.00-1200-500-P4X-001	NON-METALLIC TANKS AND PRESSURE VESSELS DESIGN
I-ET-3010.00-1200-751-P4X-001	ANODES SPECIFICATION FOR MECHANICAL EQUIPMENT
I-ET-3010.2Q-1200-940-P4X-001	MATERIAL SELECTION PHILOSOPHY FOR DETAILED DESIGN
I-FD-3010.2Q-5111-660-P4X-001	ENGINE ROOM SEAWATER FILTER (FT-5111501A/B)
I-FD-3010.2Q-5111-561-P4X-001	SEA WATER LIFT FILTER (FT-5111001A/E)
I-FD-3010.2Q-5111-561-P4X-002	START-UP SEA WATER LIFT FILTER (FT-5111002)
I-FD-3010.2Q-5120-510-P4X-001	EXPANSION TANK FOR ENGINE ROOM CENTRAL FRESH WATER COOLING SYSTEM (TQ-5120501)
I-FD-3010.2Q-5120-660-P4X-001	ENGINE ROOM CENTRAL FRESH WATER COOLING FILTER (FT-5120501)

I-FD-3010.2Q-5120-510-P4X-002	ENGINE ROOM FRESH WATER COOLING CHEMICAL INJECTION VESSEL (V-5120502)
I-FD-3010.2Q-5121-660-P4X-001	FRESH WATER FILTER (FT-5115501)
I-FD-3010.2Q-5121-560-P4X-001	SEA WATER ELECTROCHLORINATION UNIT (UE-5121501)
I-FD-3010.2Q-5133-660-P4X-001	DIESEL OIL FILTER (FT-5133501A/B)
I-FD-3010.2Q-5133-660-P4X-003	DUPLEX FILTER FOR DIESEL OIL SERVICE SYSTEM (FT-5133502)
I-FD-3010.2Q-5133-660-P4X-002	DUPLEX FILTER FOR DIESEL OIL WELL TRANSFER SYSTEM (FT-5133503)
I-FD-3010.2Q-5330-660-P4X-001	SLUDGE PUMP FILTER (FT-5330503)
I-FD-3010.2Q-5330-660-P4X-002	AUXILIARY BILGE PUMP FILTER (FT-5330509A/B)
I-FD-3010.2Q-5336-660-P4X-001	DUPLEX SLOP TREATMENT FILTER (FT-5336501)

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 SELLER may revert to BUYER 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.

3.2. ABBREVIATIONS

CA	-	Corrosion Allowance
CRA	-	Corrosion Resistant Alloy
CS	-	Carbon Steel
DSS	-	Duplex Stainless Steel
GRP	-	Glass – Reinforced plastic
LTCS	-	Low Temperature Carbon Steel
P&ID:	-	Piping & Instrumentation Diagram
SDSS	-	Super Duplex Stainless Steel
SS	-	Stainless Steel

4. GENERAL REQUIREMENTS

4.1. DESIGN

4.1.1. SELLER shall design and fabricate the equipment for a minimum lifetime of 25 years.

4.1.2. The design of the vessels, filter and tanks shall be in accordance with I-ET-3010.00-1200-540-P4X-001 – REQUIREMENTS FOR PRESSURE VESSELS DESIGN AND FABRICATION; I-ET-3010.00-1200-510-P4X-001 – METALLIC TANKS DESIGN FOR TOPSIDE and I-ET-3010.00-1200-500-P4X-001 – NON-METALLIC TANKS AND PRESSURE VESSELS DESIGN.

4.1.3. SELLER is responsible detailing the materials selection in accordance with this specification. In all cases, SELLER shall submit the detailed material list, including all equipment and their components, for BUYER approval prior manufacture activities.

4.1.4. In case of any equipment not specified in this document, the material selection shall be based on I-ET-3010.2Q-1200-940-P4X-001 - MATERIAL SELECTION PHILOSOPHY FOR DETAILED DESING and ISO 21457.

5. MATERIAL SELECTION

5.1. GENERAL

5.1.1. Material selection for pressure vessels, tanks, and any other static equipment shall be performed in accordance with I-ET-3010.2Q-1200-940-P4X-001 - MATERIAL SELECTION PHILOSOPHY FOR DETAILED DESIGN, and therefore also in accordance with ISO 21457, with the additional requirements herein listed.

5.1.2. The material selection of Hull Pressure Vessels, filter, and Tanks are defined on items 9 and 10 of this document. The ANNEX A presents the equipment materials selection gathered in a single spreadsheet for easy reference.

5.1.3. The use of stress ratio factors to exempt the material from impact testing is not allowed.

5.2. PRESSURE RETAINING PARTS MATERIAL SELECTION

5.2.1. Parts of the equipment in contact with the process fluid (e.g.: shells, heads, tubesheet, welded internals, nozzle necks, flanges, blind flanges) and externally added reinforcements for openings shall be selected as the same material quality as selected for the shell (i.e., material from the same group from items below).

5.3. PERMANENT ATTACHMENTS MATERIAL SELECTION

5.3.1. Permanent attachments (internal and external) welded directly to pressure retaining parts, including reinforcing pads, shall be of the same material quality as selected for the pressure retaining parts.

5.4. EQUIPMENT SUPPORT MATERIAL SELECTION

5.4.1. The equipment skirt type support material shall be the same nominal chemistry as the equipment wall base material for a minimum distance below the equipment-to-skirt connection line in accordance with Equation (1) or 300 mm (12 in), whichever is larger.

Minimum length of skirt support: $$L = 1{,}8 \times \sqrt{D_s \times T_s} \qquad (1)$$

Where:
D_S is the skirt outside diameter.
T_S is the skirt nominal thickness.

5.4.2. Lug or bracket type support material shall be as the same nominal chemistry as the equipment and shall be appropriate for the equipment MDMT. A reinforcement pad of the same material as the equipment shall be provided prior to welding the lug.

5.4.3. Leg type support and saddle type support materials shall be appropriate for the MDMT of the equipment. A reinforcement pad of the same material as the equipment shall be provided prior to welding the leg/saddle.

6. SPECIFIC MATERIAL REQUIREMENTS

6.1. CARBON STEEL FOR PRESSURE RETAINING PARTS (CS)

6.1.1. This material quality may be used only where the minimum design metal temperature for the equipment is above 0°C, and the conveyed fluids are non-flammable (e.g., water, air, nitrogen). When the conditions above are not met and Carbon Steel is assigned to the equipment, LTCS shall be used as per item 6.2.

6.1.2. Where carbon steel is indicated for pressure retaining parts (e.g., shell, heads, nozzles, tubesheets, flanges) the material specification selected shall fulfill the following requirements:

- The steel must be fully killed.
- Minimum corrosion allowance must be 3.2 mm, unless otherwise specified.

6.1.3. Due to thickness and weight constraints, the minimum mechanical properties for the equipment shell and heads shall be as follows:

- Tensile strength, MPa [ksi]: 485 [70].
- Yield strength, MPa [ksi]: 260 [38].

6.1.4. The above requirements are usually fulfilled by the following set of material specifications:

- SA-516 Grade 70, for plates.
- SA-106 Grade B, for seamless pipes.
- API 5L Grade B, for seamless and welded pipes.
- SA-672 Grade C60, for welded pipes.
- SA-234 Grade WPB, for wrought fittings.
- SA-105, for forgings.
- SA-266 Gr. 2, for forgings.
- SA-179, for tubes.

6.2. LOW TEMPERATURE CARBON STEEL FOR PRESSURE RETAINING PARTS (LTCS)

6.2.1. Where low temperature carbon steel is indicated for pressure retaining parts (e.g., shell, heads, nozzles, tubesheets, flanges) the material specification selected shall fulfill the following requirements:

- The steel must be fully killed.
- The steel must be made to fine grain practice (fine austenitic grain size requirement).
- The steel must be normalized.
- Minimum corrosion allowance must be 3.2 mm, unless otherwise specified.

6.2.2. Where the minimum temperature for the equipment part is below 0°C, impact test of the material is mandatory. Impact test reports shall include the percentage of shear fracture for the test coupons. Energy acceptance criteria shall be as specified in the design code, with the exception that minimum average and minimum individual energy values shall not be less than 27J and 20J respectively, even when the design code allows it.

6.2.3. Due to thickness and weight constraints, the minimum mechanical properties for shell, head and tubesheet components shall be as follows:

- Tensile strength, MPa [ksi]: 485–620 [70–90].
- Yield strength, MPa [ksi]: 260 [38].

6.2.4. The above requirements are usually fulfilled by the following set of material specifications:

- SA-516 Grade 70N, for plates.
- SA-333 Grade 6, for seamless pipes.
- SA-671 Grade CC60, for welded pipes.
- SA-420 Grade WPL6, for wrought fittings.
- SA-350 Grade LF2, for forgings.
- SA-266 Gr. 2, for forgings.

6.2.5. Material that are obtained by different heat treatments routes (e.g., quenched and tempered, thermo-mechanical rolling) may be accepted in lieu of normalized steel for equipment parts that will not be subject to any heat treatment at a later stage (e.g., normalization of formed parts, PWHT).

6.3. AUSTENITIC STAINLESS STEEL FOR PRESSURE RETAINING PARTS (SS)

6.3.1. Where austenitic stainless steel is indicated for pressure retaining parts, the material specification selected shall fulfill the following requirements:

- The material minimum quality shall be as per grade 316. Grades with a lower PRE number, free machining grades, and grades with a lower Mo content are not allowed.
- The material shall be dual certificate type (316/316L), i.e. the chemical composition shall be as for the low carbon grade (316L), while the mechanical properties shall be as for the regular grade (316).
- Mo content shall be adjusted for 2.5% minimum [recommended practice].

6.3.2. The above requirements are usually fulfilled by the following set of material specifications:

- SA-240 Grade 316, for plates.
- SA-312 Grade TP316, for seamless and welded pipes.
- SA-358 Grade TP316, for welded pipes.
- SA-403 Grade WP316, for wrought fittings.
- SA-182 Grade F316, for forgings.
- SA-213 Grade TP316, for tubes.

6.4. DUPLEX STAINLESS STEEL FOR PRESSURE RETAINING PARTS (DSS)

6.4.1. Where duplex stainless steel (22Cr) is indicated for pressure retaining parts, the material specification selected shall fulfill the following requirements:

- The material minimum quality shall be as per grade 31803. Grades with a lower PRE number, free machining grades, and grades with a lower Mo content are not allowed.
- Grade 32205 is considered as a substitute for the grade 31803.

6.4.2. Impact test of the material is mandatory. Impact test reports shall include the percentage of shear fracture for the test coupons. Energy acceptance criteria shall be the highest of the following values:

- Minimum specified by the design code.
- Minimum specified in ISO 17781, Quality Level II.

6.4.3. Unless otherwise specified, the impact test temperature shall be -46°C.

6.4.4. Unless otherwise specified, there is no corrosion allowance to be added to the equipment design.

6.4.5. The above requirements are usually fulfilled by the following set of material specifications:

- SA-790 UNS S31803, for seamless pipes.

- SA-928 UNS S31803, for welded pipes.
- SA-815 UNS S31803, for wrought fittings.
- SA-182 Grade F51, for forgings.
- SA-240 UNS S31803, for plates.
- SA-789 UNS S31803, for tubes.

6.5. SUPER DUPLEX STAINLESS STEEL FOR PRESSURE RETAINING PARTS (SDSS)

6.5.1. Where super duplex stainless steel (25Cr) is indicated for pressure retaining parts, the material specification selected shall fulfill the following requirements:

- The material minimum quality shall be as per grade 32750. Grades with a lower PRE number, free machining grades, and grades with a lower Mo content are not allowed.
- Grade 32760 is considered as a substitute for the grade 32750.

6.5.2. Impact test of the material is mandatory. Impact test reports shall include the percentage of shear fracture for the test coupons. Energy acceptance criteria shall be the highest of the following values:

- Minimum specified by the design code.
- Minimum specified in ISO 17781, Quality Level II.

6.5.3. Unless otherwise specified, the impact test temperature shall be -46°C.

6.5.4. Unless otherwise specified, there is no corrosion allowance to be added to the equipment design.

6.5.5. The above requirements are usually fulfilled by the following set of material specifications:

- SA-790 UNS S32750, for seamless pipes.
- SA-928 UNS S32750, for welded pipes.
- SA-815 UNS S32750, for wrought fittings.
- SA-182 Grade F53, for forgings.
- SA-240 UNS S32750, for plates.
- SA-789 UNS S32750, for tubes.

6.6. LOW ALLOY NICKEL STEEL FOR PRESSURE RETAINING PARTS (LA NICKEL STEEL)

6.6.1. Where low alloy nickel steel is indicated for pressure retaining parts (e.g., shell, heads, nozzles, tubesheets, flanges) the material shall be in accordance with one of the following specifications:

- SA-333 Grade 3, for seamless pipes.
- SA-671 CFE 70, for welded pipes.
- SA-420 WPL3, WPL3W, for wrought fittings.
- SA-350 LF3, for forgings.
- SA-765 Grade III, for large body forgings.
- SA-203 Grade D, E, for plates

6.6.2. Impact test of the material is mandatory. Impact test reports shall include the percentage of shear fracture for the test coupons.

6.6.3. The steel quality shall be as stated in the material specification.

6.6.4. Minimum corrosion allowance must be 1.6 mm, unless otherwise specified.

6.6.5. When these materials are subject to sour service, the additional requirements from I-ET-3010.00-1200-900-P4X-001 - ADDITIONAL REQUIREMENTS FOR SOUR SERVICE 3.5% NICKEL STEEL shall be met.

6.7. LOW ALLOY CHROMIUM STEEL FOR PRESSURE RETAINING PARTS (LA CHROMIUM STEEL)

6.7.1. Where low alloy chromium steel is indicated for pressure retaining parts (e.g., shell, heads, nozzles, tubesheets, flanges) the material shall be in accordance with one of the following specifications:

- SA-335 P22, for seamless pipes.
- SA-691 2¼ Cr, for welded pipes.
- SA- 234 WP22, for wrought fittings.
- SA-182 F22, for forgings.
- SA-387 Grade 22, for plates.
- SA-213 Grade T22, for tubes.

6.7.2. Impact test of the material is mandatory. Impact test reports shall include the percentage of shear fracture for the test coupons. Unless more stringent requirements are determined by the design code or the service-related code, the average impact values at -29°C of three Charpy V-notch test specimens shall not be less than 40 ft-lb (55 J) with no single value below 35 ft-lb (48 J).

6.7.3. The steel quality shall be as stated in the material specification.

6.7.4. Minimum corrosion allowance must be 1.6 mm, unless otherwise specified.

6.7.5. For design temperatures above 370°C, the chemical compositions of all materials shall be restricted to comply with the following J factor [WATANABE]:

$$J = (Si + Mn)\ x\ (P + Sn)\ x\ 10^4 \leq 150\ (Si, Mn, P\ and\ Sn\ in\ wt\%) \qquad (2)$$

$$Cu \leq 0{,}20\ wt\%\ and\ Ni \leq 0{,}30\ wt\%$$

6.8. INCONEL 625

6.8.1. Unless otherwise stated, Inconel 625 shall be supplied in the annealed condition.

6.8.2. Chemical composition and mechanical properties shall be as stated in the material specification, which are usually one of the following:

- SB-443 Grade 1 (UNS N06625), for plates.
- SB-444 Grade 1 (UNS N06625), for pipes and tubes.
- SB-564 UNS N06625, for forgings.
- SB-705 Grade 1 (UNS N06625), for welded pipes.

6.8.3. Unless otherwise specified, there is no corrosion allowance to be added to the equipment parts manufactured in Inconel 625.

6.9. COPPER-NICKEL 90/10 (CU-NI 90/10)

6.9.1. Unless otherwise stated Copper-Nickel alloys shall be supplied in the annealed condition.

6.9.2. Chemical composition and mechanical properties shall be as stated in the material specification, as required for welding applications.

6.9.3. Material specifications are usually one of the following:

- SB-111 UNS C70620, for tubes.
- SB-171 UNS C70620, for plates.
- SB-283 UNS C70620, for forgings.
- SB-395 UNS C70620, for U-bend tubes.
- SB-466 UNS C70620, for pipes.
- SB-467 UNS C70620, for welded pipes.

6.9.4. Unless otherwise specified, there is no corrosion allowance to be added to the equipment parts manufactured in Copper-Nickel 90/10.

6.10. GLASS REINFORCED PLASTIC EQUIPMENT (GRP)

6.10.1. Where glass reinforced plastic is indicated for pressure retaining parts (e.g., shell, heads, nozzles, tubesheets, flanges) the material selected by SELLER shall be suitable for the fluid and the operational conditions.

6.10.2. Unless otherwise stated, an internal chemical resistant layer shall be applied to all wetted surfaces.

6.10.3. External liner or protective layer (topcoat) with a minimum thickness of 2.0 mm and anti-UV additives shall be applied to all environment exposed surfaces.

6.10.4. When GRP is indicated for pressure retaining parts, the additional requirements of I-ET-3010.00-1200-500-P4X-001 – NON METALLIC TANKS AND PRESSURE VESSELS DESIGN shall be met.

7. ADDITIONAL EQUIPMENT/MATERIAL REQUIREMENTS

7.1. CLADDED EQUIPMENT

7.1.1. For equipment to which cladding is indicated, the base material shall fulfill the requirements as stated in the applicable above item (e.g., carbon steel, low temperature carbon steel, low alloy steel).

7.1.2. When H_2S service is applicable, the requirements of ISO-15156 shall be applied for both base metal and clad material.

7.1.3. Clad plates shall be in accordance with one of the following specifications (as applicable to the selected clad alloy):

- SA-263 Specification for Stainless Chromium Steel-Clad Plate
- SA-264 Specification for Stainless Chromium-Nickel Steel-Clad Plate
- SA-265 Specification for Nickel and Nickel-Base Alloy-Clad Steel Plate

7.1.4. Weld overlay, where applicable, shall be performed as prescribed in I-ET-3010.00-1200-955-P4X-001 - Welding, matching the same nominal composition as specified for the clad.

7.1.5. Minimum thickness for cladding and overlay shall be 3mm after any machining operation.

7.1.6. Weld overlay shall be performed with two layers minimum.

7.1.7. Cladding/overlay shall extend through all internally wet surfaces of the equipment, including flange faces.

7.1.8. For Cu-Ni weld overlay, a first layer in Nickel shall be deposited before the Cu-Ni overlay, which shall then be deposited in two additional layers.

7.2. COATED EQUIPMENT

7.2.1. For equipment to which coating (internal and external) is indicated, the base material shall fulfill the requirements as stated in the applicable above item (e.g., carbon steel, low temperature carbon steel, low alloy steel).

7.2.2. Coating shall be performed as prescribed in I-ET-3010.00-1200-956-P4X-002 -GENERAL PAINTING.

7.2.3. Flange faces shall be protected by clad/overlay, as predicted in I-ET-3010.00-1200-956-P4X-002 -GENERAL PAINTING.

7.2.4. Unless otherwise specified, corrosion allowance for carbon steel and low alloys steels shall be 3mm minimum.

7.2.5. Color code adopted shall be in accordance with DR-ENGP-I-1.15 – COLOR CODING.

7.3. INSULATED EQUIPMENT

7.3.1. For equipment to which thermal insulation is indicated, the base material shall fulfill the requirements as stated in the applicable above item (e.g., carbon steel, low temperature carbon steel, low alloy steel).

7.3.2. Except otherwise indicated, equipment that will receive external thermal insulation shall also be externally coated.

7.3.3. The thermal insulation requirements shall be in accordance with latest revision of I-ET-3010.00-1200-431-P4X-001 – THERMAL INSULATION FOR MARITIME INSTALLATIONS.

7.4. EQUIPMENT INTERNALS

7.4.1. Internal accessories in cladded equipment shall be of the same nominal chemistry as for the clad.

7.4.2. Unless otherwise stated, internal accessories for all other cases shall be selected in corrosion resistant alloy (minimum quality 316 stainless steel).

7.5. FLANGES AND GASKETS

7.5.1. Flanges materials shall be compatible with the shell and heads materials, except where explicit mentioned in this document.

7.5.2. In case of flange materials which are specified for low temperature requirement (bellow 0°C), the use of clad or weld overlaid is only possible if base material presents the required impact proprieties.

7.5.3. The type of nozzles flanges and flanges gaskets shall be compatible with the connected piping flange (shown in P&ID and defined in I-ET-3010.2Q-1200-200-P4X-001 – PIPING SPECIFICATION FOR TOPSIDE). Different types of flanges and gaskets may be acceptable, under BUYER approval, in the following cases:

- If the pressure rating of the nozzle flange is higher than the pressure rating of the pipe flange;
- For CLADED/COATED piping specification.
- If flange manufacture is unfeasible;

7.5.4. For equipment operating with water service (hot, fresh, cooling or seawater) gaskets with graphite are unacceptable.

7.5.5. For equipment operating with seawater the gasket shall be of insulating type when the connecting flange materials are dissimilar.

7.5.6. In all cases of conflict, the SELLER shall inform BUYER of the conflict and seek clarification.

7.6. BOLTS AND NUTS

7.6.1. All Fasteners (studs, bolts, tightening bolts and nuts) shall follow the requirements of I-ET-3010.00-1200-251-P4X-001 – REQUIREMENTS FOR BOLTING MATERIALS

7.6.2. When the flange connection is specified for a low temperature special service, the bolt material shall be compatible with this condition.

7.6.3. The material for internal bolts shall have the same corrosion resistance of removable internals.

7.6.4. When the pressure vessel is specified for sour service, the bolts in contact with fluid shall meet the requirements of ISO 15156.

8. SPECIAL SERVICE REQUIREMENTS

8.1. SPECIAL SERVICE – H_2S

8.1.1. When sour service is indicated, all CRA materials shall comply with the requirements of ISO 15156 part 3.

8.1.2. When sour service is indicated, all carbon and low alloy steel materials shall comply with the requirements of ISO 15156 part 2 when the calculated H_2S partial pressure exceeds 0.3 kPa (0.05 psi).

8.1.3. H_2S partial pressure shall be calculated from the equipment design pressure, and the worst-case scenario H_2S content for the equipment. If the partial pressure exceeds the stated limit (0.3 kPa), the material selection/testing shall be as defined for SSC severity for region 3.

8.1.4. When sour service is applicable the requirements of ISO 15156-2 are applicable to the base materials and welding procedures even when the equipment is cladded, and the requirements of ISO 15156-3 are applicable to the cladding material, overlay and cladding restoration welding procedures.

8.1.5. HIC testing is only applicable for rolled plates in the condition established in Table 4 below or if determined at project specific document. HIC testing is not applicable for seamless pipes, castings, and forgings components. HIC testing is not applicable for wrought accessories, unless they are fabricated from products that originate from rolled plates. HIC testing need not be applied for parts that will be fully protected by a weld overlay or clad.

Table 4: HIC requirements for static equipment components

pH	Partial pressure of H_2S in the gas phase (MPa/psia)		
	< 0.0003 MPa / 0.05 psia	> 0.0003 MPa / 0.05 psia	
	Aqueous phase total sulfide (ppmw)		
	<50	50-2000	>2000
<4	NA	Clean steel required	Clean steel and HIC test required
4 to 7.6	NA	NA	Clean steel required
>7.6	NA	Clean steel required if HCN-present	Clean steel and HIC testing required

8.1.6. Where Table 4 indicates the need for HIC testing, one plate per lot shall be HIC tested in accordance with NACE TM0284, using test solution A.

8.1.7. Where Table 4 indicates the use of a clean steel, the following requirements applies for the steel plates:

- Be vacuum degassed.
- Be fully killed, made to fine grain practice.
- Either normalized, TMCP or Q&T.
- Maximum sulfur (S) content of 0.001 wt%.
- Maximum phosphorus (P) content of 0.010 wt%.
- Inclusion shape control shall be applied.

8.1.8. The acceptance criteria for HIC testing for sour service shall be in accordance with the following:

- CLR lesser than or equal to 15% per specimen.
- CTR lesser than or equal to 5% per specimen.
- CSR lesser than or equal to 2% per specimen.
- 5 mm (0.2 in) maximum individual crack length.
- Ultrasonically tested as per ASTM A578 S1, S2.1 or EN 10160 quality classes S2 (plate) E3 (edge).

8.2. SPECIAL SERVICE – LOW TEMPERATURE

8.2.1. When the minimum design metal temperature is below 0°C the material shall follow the requirements of low temperature service, even for base materials in cladded equipment.

8.3. SPECIAL SERVICE – AMINE

8.3.1. If amine service is indicated, all recommendations and practices from API RP 945 shall be followed.

8.3.2. For stainless steel materials, corrosion allowance of 3.2 mm minimum shall be considered, unless otherwise specified.

8.4. SPECIAL SERVICE – CAUSTIC

8.4.1. If caustic service is indicated, all recommendations and practices from NACE SP0403 shall be followed.

9. MATERIAL SPECIFICATION FOR HULL PRESSURE VESSELS

9.1. U-5111 - SEA WATER LIFT UNIT

FT-5111501A/B	ENGINE ROOM SEAWATER FILTER
COMPONENT	**MATERIAL**
Pressure Retaining Parts (shell, head, nozzles)	SDSS
Internal Coating / Cladding	Cathodic Protection (Anodes)
Corrosion Allowance	N/A
Removable Internals	SDSS
Special Service	N/A
Reference Document	I-FD-3010.2Q-5111-660-P4X-001

9.2. U-5115 - FRESH WATER UNIT

FT-5115501	FRESH WATER FILTER
COMPONENT	**MATERIAL**
Pressure Retaining Parts (shell, head, nozzles)	SS
Internal Coating / Cladding	N/A
Corrosion Allowance	N/A
Removable Internals	SS
Special Service	N/A
Reference Document	I-FD-3010.2E-5121-660-P4X-001

9.3. U-5120 - CENTRAL FRESH WATER-COOLING SYSTEM

FT-5120501	ENGINE ROOM CENTRAL FRESH WATER COOLING FILTER
COMPONENT	**MATERIAL**
Pressure Retaining Parts (shell, head, nozzles)	SS
Internal Coating / Cladding	N/A
Corrosion Allowance	N/A
Removable Internals	SS
Special Service	N/A
Reference Document	I-FD-3010.2Q-5120-660-P4X-001

V-5120502	ENGINE ROOM FRESH WATER COOLING CHEMICAL INJECTION VESSEL
COMPONENT	**MATERIAL**
Pressure Retaining Parts (shell, head, nozzles)	SS
Internal Coating / Cladding	N/A
Corrosion Allowance	N/A
Removable Internals	SS
Special Service	N/A
Reference Document	I-FD-3010.2Q-5120-510-P4X-002

9.4. U-5133 - DIESEL UNIT

FT-5133501A/B	DIESEL OIL FILTER (FT-5133501A/B)
COMPONENT	**MATERIAL**
Pressure Retaining Parts (shell, head, nozzles)	SS
Internal Coating / Cladding	N/A
Corrosion Allowance	N/A
Removable Internals	SS
Special Service	N/A
Reference Document	I-FD-3010.2Q-5133-660-P4X-001

FT-5133502	DUPLEX FILTER FOR DIESEL OIL SERVICE SYSTEM (FT-5133502)
COMPONENT	**MATERIAL**
Pressure Retaining Parts (shell, head, nozzles)	SS
Internal Coating / Cladding	N/A
Corrosion Allowance	N/A
Removable Internals	SS
Special Service	N/A
Reference Document	I-FD-3010.2Q-5133-660-P4X-003

FT-5133503	DUPLEX FILTER FOR DIESEL OIL WELL TRANSFER SYSTEM (FT-5133503)
COMPONENT	**MATERIAL**
Pressure Retaining Parts (shell, head, nozzles)	SS
Internal Coating / Cladding	N/A
Corrosion Allowance	N/A
Removable Internals	SS
Special Service	N/A
Reference Document	I-FD-3010.2Q-5133-660-P4X-002

9.5. U-5330 - BILGE, SLUDGE, BALLAST AND GENERAL SERVICE SEA WATER UNIT

FT-5330503	SLUDGE PUMP FILTER
COMPONENT	**MATERIAL**
Pressure Retaining Parts (shell, head, nozzles)	SS
Internal Coating / Cladding	N/A
Corrosion Allowance	N/A
Removable Internals	SS
Special Service	N/A
Reference Document	I-FD-3010.2Q-5330-660-P4X-001

FT-5330509A/B	AUXILIARY BILGE PUMP FILTER
COMPONENT	**MATERIAL**
Pressure Retaining Parts (shell, head, nozzles)	SS
Internal Coating / Cladding	N/A
Corrosion Allowance	N/A
Removable Internals	SS
Special Service	N/A
Reference Document	I-FD-3010.2Q-5330-660-P4X-002

9.6. DRAINAGE SYSTEM AND SLOP VESSEL MATERIAL SPECIFICATION (U-5336)

FT-5336501	DUPLEX SLOP TREATMENT FILTER
COMPONENT	**MATERIAL**
Pressure Retaining Parts (shell, head, nozzles)	DSS
Internal Coating / Cladding	N/A
Corrosion Allowance	N/A
Removable Internals	DSS
Special Service	ISO 15156 H2S Service
Reference Document	I-FD-3010.2Q-5336-660-P4X-001

10. MATERIAL SPECIFICATION FOR HULL TANKS

10.1. U-5120 – TANK FOR ENGINE ROOM FRESH WATER COOLING

TQ-5120501	EXPANSION TANK FOR ENGINE ROOM CENTRAL FRESH WATER COOLING SYSTEM
Material	SS
Internal Coating / Cladding	N/A
Corrosion Allowance	N/A
Special Service	N/A
Reference Document	I-FD-3010.2Q-5120-510-P4X-001

11. ANNEX A

Annex A presents the equipment materials selection gathered in a single spreadsheet for easy reference.

Annex A_Material Selection Hull Pressur