PETROBRAS	TECHNICAL SPECIFICATION N°. I-ET-3010.2Q-1200-450-P4X-001	
	CLIENT: MARLIM LESTE E SUL	SHEET: 1 of 30
	JOB: BASIC DESIGN - REVIT I	
	AREA: MARLIM LESTE E SUL	
SRGE	TITLE: **MATERIAL SPECIFICATION FOR HEAT EXCHANGERS**	INTERNAL
		ESUP

MICROSOFT WORD / V.2010 / I-ET-3010.2Q-1200-450-P4X-001_A.DOCX

INDEX OF REVISIONS

REV.	DESCRIPTION AND/OR REVISED SHEETS
0	ORIGINAL ISSUE
A	GENERAL REVISION

	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE	04/12/2024	06/14/2024							
DESIGN	ESUP	ESUP							
EXECUTION	HXG3	HXG3							
CHECK	CJH4	CSM0							
APPROVAL	U32N	CJH4							

SUMMARY

1 OBJECTIVE

This document covers the material specification for shell and tube, gasketed plate and printed circuit heat exchangers to be supplied to BUYER for BASIC DESIGN - REVIT I **P-86 FPSO** 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.

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

The requirements herein listed are applicable to all players performing such related activities within the scope of equipment furnish, 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

Equipment design and fabrication shall comply with the requirements of this specification, data sheets, rules, codes, standards, and the project specifications as stated below and those referred to herein.

2.1 CLASSIFICATION SOCIETY

2.1.1 SELLER shall perform the work in accordance with the requirements of the 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 which, 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 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.

Table 1: Codes and Standards

API Std 660	-	Shell and Tube Heat Exchangers.
API Std 667	-	Plate and Frame Heat Exchangers.
ASME BPVC SECTION II	-	Boiler and Pressure Vessel Code – Material Specifications.
ASME BPVC SECTION V	-	Boiler and Pressure Vessel Code – Non-Destructive Examination.
ASME BPVC SECTION VIII	-	Boiler and Pressure Vessel Code – Rules for Construction of Pressure Vessels – Div.1 and Div. 2.
ASME BPVC SECTION IX	-	Boiler and Pressure Vessel Code – Welding, Brazing and Fusing Qualifications.
ASME B16.5	-	Pipe Flanges and Flanged Fittings NPS ½ Through NPS 24 Metric/Inch Standard
IOGP S-614	-	Heat Exchangers – Shell and Tube to API Std 660
ISO 21457	-	Materials selection and corrosion control for oil and gas production systems
ISO 15156 (all parts)	-	Materials for use in H_2S 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 herein references.

Table 2: Brazilian Regulatory Standard and Government Regulation

NR-13	Brazilian Regulatory Standard – Boilers, Pressure Vessels, Pipes and Metallic Storage Tanks
NR-17	Brazilian Regulatory Standard – Ergonomic
NR-26	Brazilian Regulatory Standard – Safety Signaling
NR-37	Brazilian Regulatory Standard – Safety and Health in Petroleum Platforms
IBAMA	Brazilian IBAMA environmental regulations concerning the discharge of all types of effluents
INMETRO	INMETRO Resolution nº 115, March 21st 2022

2.4 REFERENCE DOCUMENTS

2.4.1 The latest issue of the reference documents listed on Table 3 shall be used unless otherwise agreed.

Table 3: Reference Documents

DR-ENGP-I-1.15	- COLOR CODING
DR-ENGP-M-I-1.3	- SAFETY ENGINEERING GUIDELINE
I-DE-3010.2Q-1200-942-P4X-002	- GENERAL ARRANGEMENT
I-DE-3010.2Q-1200-94A-P4X-001	- AREA CLASSIFICATION – GENERAL
I-ET-3010.00-1200-940-P4X-002	- GENERAL TECHNICAL TERMS
I-ET-3010.00-1200-251-P4X-001	- REQUIREMENTS FOR BOLTING MATERIALS
I-ET-3010.00-1200-431-P4X-001	- THERMAL INSULATION FOR MARITIME INSTALLATIONS
I-ET-3010.00-1200-956-P4X-002	- GENERAL PAINTING
I-ET-3010.2Q-1200-200-P4X-001	- PIPING SPECIFICATION FOR TOPSIDES
I-ET-3010.2Q-1200-200-P4X-002	- PIPING SPECIFICATION FOR HULL
I-ET-3010.2Q-1200-940-P4X-001	- MATERIAL SELECTION PHILOSOPHY FOR DETAILED DESIGN
I-ET-3010.00-1200-451-P4X-001	- REQUIREMENTS FOR SHELL AND TUBE HEAT EXCHANGER DESIGN AND FABRICATION
I-ET-3010.00-1200-456-P4X-001	- REQUIREMENTS FOR PLATE HEAT EXCHANGER DESIGN AND FABRICATION
I-ET-3010.00-1200-459-P4X-001	- REQUIREMENTS FOR PRINTED CIRCUIT HEAT EXCHANGER SPECIFICATION
I-ET-3010.00-1200-540-P4X-001	- REQUIREMENTS FOR PRESSURE VESSELS DESIGN AND FABRICATION
I-ET-3010.00-1200-900-P4X-001	- ADDITIONAL REQUIREMENTS FOR SOUR SERVICE 3.5% NICKEL STEEL
I-FD-3010.2Q-1223-451-P4X-001	- INTERSTAGE HEATER (P-1223001A/F)
I-FD-3010.2Q-1223-451-P4X-005	- INTERSTAGE HEATER (P-1223001A/F)
I-FD-3010.2Q-1223-451-P4X-002	- PRODUCTION HEATER (P-1223003A/F)
I-FD-3010.2Q-1223-451-P4X-006	- PRODUCTION HEATER (P-1223003A/F)
I-FD-3010.2Q-1223-451-P4X-003	- DILUTION WATER HEATER (P-1223004A/B)
I-FD-3010.2Q-1223-451-P4X-007	- DILUTION WATER HEATER (P-1223004A/B)
I-FD-3010.2Q-1223-451-P4X-004	- TEST HEATER (P-1223006)
I-FD-3010.2Q-1223-451-P4X-008	- TEST HEATER (P-1223006)

I-FD-3010.2Q-1225-451-P4X-001	- VRU 1st STAGE SUCTION COOLER (P-UC-1225001A/B-01)
I-FD-3010.2Q-1225-451-P4X-005	- VRU 1st STAGE SUCTION COOLER (P-UC-1225001A/B-01)
I-FD-3010.2Q-1225-451-P4X-002	- VRU 2nd STAGE SUCTION COOLER (P-UC-1225001A/B-02)
I-FD-3010.2Q-1225-451-P4X-006	- VRU 2nd STAGE SUCTION COOLER (P-UC-1225001A/B-02)
I-FD-3010.2Q-1231-451-P4X-002	- MAIN GAS COMPRESSOR 1st STAGE SUCTION COOLER (P-UC-1231001A/C-01)
I-FD-3010.2Q-1231-451-P4X-003	- MAIN GAS COMPRESSOR 1st STAGE DISCHARGE COOLER (P-UC-1231001A/C-02)
I-FD-3010.2Q-1231-451-P4X-004	- MAIN GAS COMPRESSOR 2nd STAGE DISCHARGE COOLER (P-UC-1231001A/C-03)
I-FD-3010.2Q-1233-451-P4X-001	- TEG INLET GAS COOLER (P-1233001A/B)
I-FD-3010.2Q-1233-451-P4X-006	- TEG INLET GAS COOLER (P-1233001A/B)
I-FD-3010.2Q-5125-451-P4X-001	- UTILITY HOT WATER HEATER (P-5125001)
I-FD-3010.2Q-5125-451-P4X-003	- UTILITY HOT WATER HEATER (P-5125001)
I-FD-3010.2Q-5135-451-P4X-001	- FUEL GAS HEATER (P-5135001)
I-FD-3010.2Q-5135-451-P4X-004	- FUEL GAS HEATER (P-5135001)
I-FD-3010.2Q-5135-451-P4X-002	- FUEL GAS SUPER HEATER (P-5135002)
I-FD-3010.2Q-5135-451-P4X-005	- FUEL GAS SUPER HEATER (P-5135002)
I-FD-3010.2Q-5135-451-P4X-003	- CONDENSATE HEATER (P-5135003)
I-FD-3010.2Q-5135-451-P4X-006	- CONDENSATE HEATER (P-5135003)
I-FD-3010.2Q-5147-451-P4X-001	- HOT WATER DUMP COOLER (P-5147001)
I-FD-3010.2Q-5147-451-P4X-004	- HOT WATER DUMP COOLER (P-5147001)
I-FD-3010.2Q-5271-451-P4X-001	- BUTTERWORTH HEATER (AQ-5271501)
I-FD-3010.2Q-5271-451-P4X-002	- BUTTERWORTH HEATER (AQ-5271501)
I-FD-3010.2Q-1223-456-P4X-001	- OIL/OIL PRE HEATER (P-1223002A/D)
I-FD-3010.2Q-1223-456-P4X-002	- OIL COOLER (P-1223005A/D)
I-FD-3010.2Q-1251-456-P4X-001	- INJECTION WATER RECYCLE COOLER (P-1251001A/B)
I-FD-3010.2Q-5120-456-P4X-001	- ENGINE ROOM CENTRAL FRESH WATER COOLER (P-5120501A/B)
I-FD-3010.2Q-5124-456-P4X-001	- PLATE HEAT EXCHANGER COOLING WATER – CLASSIFIED

	AREA (P-5124001A/E)
I-FD-3010.2Q-5124-456-P4X-002	- PLATE HEAT EXCHANGER COOLING WATER – NON-CLASSIFIED AREA (P-5124002A/C)
I-FD-3010.2Q-5331-456-P4X-001	- PRODUCED WATER COOLER (P-5331001A/D)
I-FD-3010.2Q-1231-459-P4X-001	- EXPORTATION GAS COMPRESSION DISCHARGE COOLER (P-UC-1231002A/C)

2.5 CONFLICTING REQUIREMENTS

2.5.1 In case of conflicting information between this Specification (ET) and other specific BUYER's document (data sheet) the specific BUYER's document shall prevail.

2.5.2 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

CLASS - Classification Society

CRA - Corrosion Resistant Alloy

CS - Carbon Steel

DSS - Duplex Stainless Steel

FPSO - Floating Production Storage and Offloading

GPHE - Gasketed Plate Heat Exchanger

GRP - Glass Reinforced Plastic

LTCS - Low Temperature Carbon Steel

MDMT - Minimum Design Metal Temperature

PCHE - Printed Circuit Heat Exchanger

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 shall be in accordance with I-ET-3010.00-1200-451-P4X-001 - REQUIREMENTS FOR SHELL AND TUBE HEAT EXCHANGER DESIGN AND FABRICATION, I-ET-3010.00-1200-456-P4X-001 - REQUIREMENTS FOR PLATE HEAT EXCHANGER DESIGN AND FABRICATION and I-ET-3010.00-1200-459-P4X-001 - REQUIREMENTS FOR PRINTED CIRCUIT HEAT EXCHANGER SPECIFICATION, as applicable.

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 heat exchangers 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 for the heat exchangers shall follow those indicated in item 9 for shell and tube heat exchangers, item 10 for gasketed plate heat exchangers and item 11 for printed circuit heat exchangers.

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: $L = 1{,}8 \times \sqrt{D_s \times T_s}$ (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 parts manufactured in DSS.

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 parts manufactured in SDSS.

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-A335 P22, for seamless pipes.
- SA-A691 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 HEAT EXCHANGER BAFFLES/TIE-RODS/SPACERS

7.1.1 Except otherwise indicated, for CRA tubes, bundle components (heat exchanger baffles, tie-rods and spacers) shall be selected in stainless steel grade 316.

7.1.2 For Carbon Steel tubes, baffles, tie-rods and spacers shall be selected in Carbon Steel.

7.1.3 For equipment operating with aerated seawater, baffles, tie-rods and spacers shall be selected in the same chemical composition as for the tubes.

7.2 CLADDED EQUIPMENT

7.2.1 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).

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

7.2.3 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

7.2.4 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.

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

7.2.6 Weld overlay shall be performed with two layers minimum.

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

7.2.8 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.

7.3 COATED EQUIPMENT

7.3.1 For equipment to which external coating 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 External coating shall be performed as prescribed in I-ET-3010.00-1200-956-P4X-002 - GENERAL PAINTING.

7.3.3 When internal coating is required as a corrosion solution, it shall be in the form of cladding (see item 7.2). Internal organic coating for heat exchangers is not acceptable.

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

7.4 INSULATED EQUIPMENT

7.4.1 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).

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

7.4.3 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.

7.5 FLANGES AND GASKETS

7.5.1 Flange 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 For shell and tube heat exchangers and Gasketed Plate Heat Exchangers (GPHE), the nozzles and flange material, shall be compatible with the connected piping flange specification, as defined in I-ET-3010.2Q-1200-200-P4X-001 - PIPING SPECIFICATION FOR TOPSIDES or I-ET-3010.2Q-1200-200-P4X-002 - PIPING SPECIFICATION FOR HULL, and specific P&ID (document provided by BUYER).

7.5.4 For Printed Circuit Heat Exchangers (PCHE), the nozzles and flanges material shall be compatible with the connecting header material.

7.5.5 Gaskets of plate heat exchangers shall be according to requirements of I-ET-3010.00-1200-456-P4X-001 - REQUIREMENTS FOR PLATE HEAT EXCHANGER DESIGN AND FABRICATION.

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

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

7.5.8 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 internal bolts shall meet the requirements of ISO 15156.

8 SPECIAL SERVICE REQUIREMENTS

8.1 SPECIAL SERVICE – H_2S

8.1.1 Where H_2S service is indicated in the tables from sections 9, 10 and 11, but with no mention to which equipment side, it shall be considered as applicable for both sides.

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

8.1.3 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).

8.1.4 H_2S partial pressure shall be calculated from the equipment design pressure, and the worst-case scenario H2S 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.

8.1.5 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.

8.1.6 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

8.1.7 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.

8.1.8 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.

8.1.9 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 SELECTION FOR SHELL AND TUBE HEAT EXCHANGERS

9.1 OIL COLLECTING AND SEPARATING (U-1223)

P-1223001A/F	INTERSTAGE HEATER
TEMA TYPE	AES
SHELL FLUID	Hot Water
TUBE FLUID	Crude Oil
COMPONENT	**MATERIAL**
SHELL PRESSURE RETAINING PARTS	CS
STATIONARY TUBESHEET	DSS
CHANNEL PRESSURE RETAINING PARTS	DSS
FLOATING TUBESHEET	DSS
FLOATING HEAD COVER	DSS
TUBES	DSS
SPECIAL SERVICE	ISO 15156 H2S Service
REFERENCE DOCUMENTS	I-FD-3010.2Q-1223-451-P4X-001 I-FD-3010.2Q-1223-451-P4X-005

P-1223003A/F	PRODUCTION HEATER
TEMA TYPE	BEU
SHELL FLUID	Crude Oil
TUBE FLUID	Hot Water
COMPONENT	**MATERIAL**
SHELL PRESSURE RETAINING PARTS	CS + Inconel 625 Clad
STATIONARY TUBESHEET	Inconel 625
CHANNEL PRESSURE RETAINING PARTS	CS
FLOATING TUBESHEET	N/A
FLOATING HEAD COVER	N/A
TUBES	Inconel 625
SPECIAL SERVICE	ISO 15156 H2S Service
REFERENCE DOCUMENTS	I-FD-3010.2Q-1223-451-P4X-002 I-FD-3010.2Q-1223-451-P4X-006

P-1223004A/B	DILUTION WATER HEATER
TEMA TYPE	BFU
SHELL FLUID	Fresh Water
TUBE FLUID	Hot Water
COMPONENT	**MATERIAL**
SHELL PRESSURE RETAINING PARTS	CS
STATIONARY TUBESHEET	SDSS
CHANNEL PRESSURE RETAINING PARTS	SDSS
FLOATING TUBESHEET	N/A
FLOATING HEAD COVER	N/A
TUBES	SDSS
SPECIAL SERVICE	N/A
REFERENCE DOCUMENTS	I-FD-3010.2Q-1223-451-P4X-003 I-FD-3010.2Q-1223-451-P4X-007

P-1223006	TEST HEATER
TEMA TYPE	BEU
SHELL FLUID	Crude Oil
TUBE FLUID	Hot Water
COMPONENT	**MATERIAL**
SHELL PRESSURE RETAINING PARTS	CS + Inconel 625 Clad
STATIONARY TUBESHEET	Inconel 625
CHANNEL PRESSURE RETAINING PARTS	CS
FLOATING TUBESHEET	N/A
FLOATING HEAD COVER	N/A
TUBES	Inconel 625
SPECIAL SERVICE	ISO 15156 H2S Service Low Temperature (-40°C)
REFERENCE DOCUMENTS	I-FD-3010.2Q-1223-451-P4X-004 I-FD-3010.2Q-1223-451-P4X-008

9.2 VAPOUR RECOVERY UNIT – VRU (U-1225)

P-UC-1225001A/B-01	VRU 1ST STAGE SUCTION COOLER
TEMA TYPE	BFU
SHELL FLUID	Cooling water
TUBE FLUID	Gas
COMPONENT	**MATERIAL**
SHELL PRESSURE RETAINING PARTS	CS
STATIONARY TUBESHEET	CS + Inconel 625 Weld Overlay
CHANNEL PRESSURE RETAINING PARTS	CS + Inconel 625 Weld Overlay
FLOATING TUBESHEET	N/A
FLOATING HEAD COVER	N/A
TUBES	Inconel 625
SPECIAL SERVICE	ISO 15156 H2S service tube side
REFERENCE DOCUMENTS	I-FD-3010.2Q-1225-451-P4X-001 I-FD-3010.2Q-1225-451-P4X-005

P-UC-1225001A/B-02	VRU 2ND STAGE SUCTION COOLER
TEMA TYPE	BFU
SHELL FLUID	Cooling water
TUBE FLUID	Gas
COMPONENT	**MATERIAL**
SHELL PRESSURE RETAINING PARTS	CS
STATIONARY TUBESHEET	CS + Inconel 625 Weld Overlay
CHANNEL PRESSURE RETAINING PARTS	CS + Inconel 625 Weld Overlay
FLOATING TUBESHEET	N/A
FLOATING HEAD COVER	N/A
TUBES	Inconel 625
SPECIAL SERVICE	ISO 15156 H2S service tube side
REFERENCE DOCUMENTS	I-FD-3010.2Q-1225-451-P4X-002 I-FD-3010.2Q-1225-451-P4X-006

9.3 MAIN GAS COMPRESSION SYSTEM (U-1231)

P-UC-1231001A/C-01	MAIN GAS COMPRESSOR 1ST STAGE SUCTION COOLER
TEMA TYPE	BFU
SHELL FLUID	cooling water
TUBE FLUID	gas
COMPONENT	**MATERIAL**
SHELL PRESSURE RETAINING PARTS	CS
STATIONARY TUBESHEET	CS + Inconel 625 Weld Overlay
CHANNEL PRESSURE RETAINING PARTS	CS + Inconel 625 Weld Overlay
FLOATING TUBESHEET	N/A
FLOATING HEAD COVER	N/A
TUBES	Inconel 625
SPECIAL SERVICE	ISO 15156 H2S service tube side
REFERENCE DOCUMENTS	I-FD-3010.2Q-1231-451-P4X-002

P-UC-1231001A/C-02	MAIN GAS COMPRESSOR 1ST STAGE DISCHARGE COOLER
TEMA TYPE	BFU
SHELL FLUID	cooling water
TUBE FLUID	gas
COMPONENT	**MATERIAL**
SHELL PRESSURE RETAINING PARTS	CS
STATIONARY TUBESHEET	CS + Inconel 625 Weld Overlay
CHANNEL PRESSURE RETAINING PARTS	CS + Inconel 625 Weld Overlay
FLOATING TUBESHEET	N/A
FLOATING HEAD COVER	N/A
TUBES	Inconel 625
SPECIAL SERVICE	ISO 15156 H2S service tube side
REFERENCE DOCUMENTS	I-FD-3010.2Q-1231-451-P4X-003

P-UC-1231001A/C-03	MAIN GAS COMPRESSOR 2ND STAGE DISCHARGE COOLER
TEMA TYPE	BFU
SHELL FLUID	cooling water
TUBE FLUID	gas
COMPONENT	**MATERIAL**
SHELL PRESSURE RETAINING PARTS	CS
STATIONARY TUBESHEET	CS + Inconel 625 Weld Overlay
CHANNEL PRESSURE RETAINING PARTS	CS + Inconel 625 Weld Overlay
FLOATING TUBESHEET	N/A
FLOATING HEAD COVER	N/A
TUBES	Inconel 625
SPECIAL SERVICE	ISO 15156 H2S service tube side
REFERENCE DOCUMENTS	I-FD-3010.2Q-1231-451-P4X-004

9.4 GAS DEHYDRATION SYSTEM (U-1233)

P-1233001A/B	TEG INLET GAS COOLER
TEMA TYPE	BEM
SHELL FLUID	Cooling water
TUBE FLUID	Gas
COMPONENT	**MATERIAL**
SHELL PRESSURE RETAINING PARTS	CS
STATIONARY TUBESHEET	SS
CHANNEL PRESSURE RETAINING PARTS	SS
FLOATING TUBESHEET	N/A
FLOATING HEAD COVER	N/A
TUBES	SS
SPECIAL SERVICE	ISO 15156 H2S Service
REFERENCE DOCUMENTS	I-FD-3010.2Q-1233-451-P4X-001 I-FD-3010.2Q-1233-451-P4X-006

9.5 HOT WATER SYSTEM (U-5125)

P-5125001	UTILITY HOT WATER HEATER
TEMA TYPE	BEU
SHELL FLUID	Fresh Water
TUBE FLUID	Process Hot Water
COMPONENT	**MATERIAL**
SHELL PRESSURE RETAINING PARTS	CS
STATIONARY TUBESHEET	CS
CHANNEL PRESSURE RETAINING PARTS	CS
FLOATING TUBESHEET	N/A
FLOATING HEAD COVER	N/A
TUBES	CS
SPECIAL SERVICE	N/A
REFERENCE DOCUMENTS	I-FD-3010.2Q-5125-451-P4X-001 I-FD-3010.2Q-5125-451-P4X-003

9.6 FUEL GAS SYSTEM (U-5135)

P-5135001	FUEL GAS HEATER
TEMA TYPE	DEU
SHELL FLUID	Hot water
TUBE FLUID	Fuel gas
COMPONENT	**MATERIAL**
SHELL PRESSURE RETAINING PARTS	CS
STATIONARY TUBESHEET	DSS
CHANNEL PRESSURE RETAINING PARTS	CS
FLOATING TUBESHEET	N/A
FLOATING HEAD COVER	N/A
TUBES	DSS
SPECIAL SERVICE	ISO 15156 H2S service tube side Low temperature at tube side (-29°C)
REFERENCE DOCUMENTS	I-FD-3010.2Q-5135-451-P4X-001 I-FD-3010.2Q-5135-451-P4X-004

P-5135002	FUEL GAS SUPER HEATER
TEMA TYPE	BEU
SHELL FLUID	Hot water
TUBE FLUID	Fuel gas
COMPONENT	**MATERIAL**
SHELL PRESSURE RETAINING PARTS	CS
STATIONARY TUBESHEET	DSS
CHANNEL PRESSURE RETAINING PARTS	CS
FLOATING TUBESHEET	N/A
FLOATING HEAD COVER	N/A
TUBES	DSS
SPECIAL SERVICE	ISO 15156 H2S service tube side Low temperature at tube side (-29°C)
REFERENCE DOCUMENTS	I-FD-3010.2Q-5135-451-P4X-002 I-FD-3010.2Q-5135-451-P4X-005

P-5135003	CONDENSATE HEATER
TEMA TYPE	DEU
SHELL FLUID	Hot water
TUBE FLUID	Condensate
COMPONENT	**MATERIAL**
SHELL PRESSURE RETAINING PARTS	CS
STATIONARY TUBESHEET	DSS
CHANNEL PRESSURE RETAINING PARTS	CS
FLOATING TUBESHEET	N/A
FLOATING HEAD COVER	N/A
TUBES	DSS
SPECIAL SERVICE	ISO 15156 H2S service tube side Low temperature at tube side (-29°C)
REFERENCE DOCUMENTS	I-FD-3010.2Q-5135-451-P4X-003 I-FD-3010.2Q-5135-451-P4X-006

9.7 TURBOGENERATOR UNIT (U-5147)

P-5147001	HOT WATER DUMP COOLER
TEMA TYPE	AES
SHELL FLUID	Hot Water
TUBE FLUID	Sea Water
COMPONENT	**MATERIAL**
SHELL PRESSURE RETAINING PARTS	CS
STATIONARY TUBESHEET	Cu-Ni 90/10
CHANNEL PRESSURE RETAINING PARTS	Cu-Ni 90/10
FLOATING TUBESHEET	Cu-Ni 90/10
FLOATING HEAD COVER	Cu-Ni 90/10
TUBES	Cu-Ni 90/10
SPECIAL SERVICE	N/A
REFERENCE DOCUMENTS	I-FD-3010.2Q-5125-451-P4X-001 I-FD-3010.2Q-5125-451-P4X-004

9.8 TANK CLEANING UNIT (U-5271)

AQ-5271501	BUTTERWORTH HEATER
TEMA TYPE	AES
SHELL FLUID	Hot Water
TUBE FLUID	Sea Water
COMPONENT	**MATERIAL**
SHELL PRESSURE RETAINING PARTS	CS
STATIONARY TUBESHEET	Cu-Ni 90/10
CHANNEL PRESSURE RETAINING PARTS	CS + Cu-Ni 90/10 Clad
FLOATING TUBESHEET	Cu-Ni 90/10
FLOATING HEAD COVER	Cu-Ni 90/10
TUBES	Cu-Ni 90/10
SPECIAL SERVICE	N/A
REFERENCE DOCUMENTS	I-FD-3010.2Q-5271-451-P4X-001 I-FD-3010.2Q-5271-451-P4X-002

10 MATERIAL SELECTION FOR GASKETED PLATE HEAT EXCHANGERS

10.1 OIL COLLECTING AND SEPARATING (U-1223)

P-1223002A/D	OIL/OIL PRE HEATER
COMPONENT	**MATERIAL**
Heat Transfer Plates	Titanium Gr.1
Fixed and movable covers plates	CS
Support stand	CS
Carrying bar and guide bar	SS
Flanges	According to item 7.5
Shroud Protection Shield	SS
Tie bolts	According to I-ET-3010.00-1200-251-P4X-001
Fluid Hot Side	Treated Oil
Fluid Cold Side	Crude Oil
Special Service	ISO 15156 H2S Service
Reference Documents	I-FD-3010.2Q-1223-456-P4X-001

P-1223005A/D	OIL COOLER
COMPONENT	**MATERIAL**
Heat Transfer Plates	Titanium Gr.1
Fixed and movable covers plates	CS
Support stand	CS
Carrying bar and guide bar	SS
Flanges	According to item 7.5
Shroud Protection Shield	SS
Tie bolts	According to I-ET-3010.00-1200-251-P4X-001
Fluid Hot Side	Treated Oil
Fluid Cold Side	Cooling Water
Special Service	ISO 15156 H2S Service
Reference Documents	I-FD-3010.2Q-1223-456-P4X-002

10.2 PRODUCED WATER SYSTEM (U-5331)

P-5331001A/D	PRODUCED WATER COOLER (P-5331001A/D)
COMPONENT	**MATERIAL**
Heat Transfer Plates	Titanium Gr.1
Fixed and movable covers plates	CS
Support stand	CS
Carrying bar and guide bar	SS
Flanges	According to item 7.5
Shroud Protection Shield	SS
Tie bolts	According to I-ET-3010.00-1200-251-P4X-001
Fluid Hot Side	Produced Water
Fluid Cold Side	Cooling Water
Special Service	ISO 15156 H2S Service
Reference Documents	I-FD-3010.2Q-5331-456-P4X-001

10.3 COOLING WATER SYSTEM (U-5124)

P-5124001A/E	PLATE HEAT EXCHANGER COOLING WATER - CLASSIFIED AREA
COMPONENT	**MATERIAL**
Heat Transfer Plates	Titanium Gr.1
Fixed and movable covers plates	CS
Support stand	CS
Carrying bar and guide bar	SS
Flanges	According to item 7.5
Shroud Protection Shield	SS
Tie bolts	According to I-ET-3010.00-1200-251-P4X-001
Fluid Hot Side	Cooling Water
Fluid Cold Side	Sea Water
Special Service	N/A
Reference Documents	I-FD-3010.2Q-5124-456-P4X-001

P-5124002A/C	PLATE HEAT EXCHANGER COOLING WATER - NON CLASSIFIED AREA
COMPONENT	**MATERIAL**
Heat Transfer Plates	Titanium Gr.1
Fixed and movable covers plates	CS
Support stand	CS
Carrying bar and guide bar	SS
Flanges	According to item 7.5
Shroud Protection Shield	SS
Tie bolts	According to I-ET-3010.00-1200-251-P4X-001
Fluid Hot Side	Cooling Water
Fluid Cold Side	Sea Water
Special Service	N/A
Reference Documents	I-FD-3010.2Q-5124-456-P4X-002

10.4 CENTRAL FRESH WATER COOLING SYSTEM (U-5120)

P-5120501A/B	ENGINE ROOM CENTRAL FRESH WATER COOLER
COMPONENT	**MATERIAL**
Heat Transfer Plates	Titanium Gr.1
Fixed and movable covers plates	CS
Support stand	CS
Carrying bar and guide bar	SS
Flanges	According to item 7.5
Shroud Protection Shield	SS
Tie bolts	According to I-ET-3010.00-1200-251-P4X-001
Fluid Hot Side	Cooling Water
Fluid Cold Side	Sea Water
Special Service	N/A
Reference Documents	I-FD-3010.2Q-5120-456-P4X-001

10.5 INJECTION WATER SYSTEM (U-1251)

P-1251001A/C	INJECTION WATER RECYCLE COOLER
COMPONENT	**MATERIAL**
Heat Transfer Plates	Titanium Gr.1
Fixed and movable covers plates	CS
Support stand	CS
Carrying bar and guide bar	SS
Flanges	According to item 7.5
Shroud Protection Shield	SS
Tie bolts	According to I-ET-3010.00-1200-251-P4X-001
Fluid Hot Side	Produced Water
Fluid Cold Side	Cooling Water
Special Service	ISO 15156 H2S Service
Reference Documents	I-FD-3010.2Q-1251-456-P4X-001

11 MATERIAL SELECTION FOR PRINTED CIRCUIT HEAT EXCHANGERS

11.1 EXPORTATION GAS COMPRESSION SYSTEM (U-1231)

P-UC-1231002A/C	EXPORTATION GAS COMPRESSION DISCHARGE COOLER
COMPONENT	**MATERIAL**
Core	SS
Sheath	DSS
Header	DSS
Flanges	DSS
Special Service	ISO 15156 H2S Service Low Temperature (-46°C)
Reference Documents	I-FD-3010.2Q-1231-459-P4X-001

12 ANNEX A

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

Annex A_Material Selection for Heat Exc