DESCRIPTIVE MEMORANDUM

FPSO
(Floating Production Storage and Offloading)

PETROBRAS P- XXXIV
Summary

1. CONTENT 5
2. INTRODUCTION 5
   2.1 Main Characteristics 5
   2.2 Main Characteristics of Oil to be Processed 13
3. PROCESSING SYSTEMS 13
   3.1 OIL PRODUCTION, PROCESSING AND TREATMENT 13
      3.1.1 General Description 13
      3.1.2 Main Details 14
   3.2 GAS PROCESSING AND COMPRESSION 19
      3.2.1 System Description 19
      3.2.2 Main Details 20
      3.2.3 GAS DEHYDRATION 21
      3.2.4 LIFT GAS SYSTEM 21
   3.3 OILY WATER PROCESSING 21
      3.3.1 System Description 22
      3.3.2 Main Details 22
      3.3.3 Production Separator Hydrocyclone (CI-533101) 22
      3.3.4 Test Separator Hydrocyclone (CI-533102) 23
      3.3.5 Oil Dehydrator Hydrocyclone (CI-533103) 23
      3.3.6 Gas Flotation Unit (FL-533101) 23
      3.3.7 Produced Water Cooler (P-533101) 23
      3.3.8 Degasser Vessel (V-533101) 24
      3.3.9 Produced Water Pump (B-533101A/C) 24
      3.3.10 Oily Waste Cooler (P-533601) 25
      3.3.11 Oily Waste Vessel (V-533601) 25
      3.3.12 Oily Waste Pump (B-533601A/B) 25
   3.4 CHEMICAL INJECTION FOR OIL, GAS AND PRODUCED WATER 26
3.4.1 Inverted emulsion (Demulsifier) – UQ-126201
3.4.2 Incrustation Inhibitor (Scale Inhibitor) – UQ-126202
3.4.3 Antifouling Unit for Sea Water – UQ-126203
3.4.4 Chemical Injection Unit for Production and Test Separators – UQ-126204
3.4.5 Chemical Injection Unit for Turret
3.4.6 Chemical Injection Unit for Antifouling (UQ-126101)
3.4.7 Chemical Injection Unit of Demulsifying (UQ-126102)
3.4.7 RELIEF SYSTEM

4 DRAINAGE AND OIL RECOVERY
4.1 Open Drainage
4.2 Closed Drainage

5. NON-ELECTRICAL UTILITIES SYSTEM
5.1 COMPRESSED AIR SYSTEMS
5.1.1 AIR-START SYSTEM
5.1.2 INSTRUMENTATION AIR SYSTEM
5.1.3 COMPRESSED AIR SYSTEM OF SERVICE
5.2 Blanketing System per Nitrogen
5.3 SEA WATER CATCHMENT AND ELECTRO CHLORINATION
5.4 Seawater Distribution
5.4.1 Seawater Collection Pump (B-511104)
5.4.2 Seawater Collection Filter (FT-511104)
5.4.3 Seawater collection discharge filter (FT-511105A/B)
5.5 DRINKING WATER PRODUCTION UNIT
5.6 SEWAGE PROCESSING
5.7 HOT WATER SYSTEM
5.7.1 Hot Water Expansion Vessel (V-512502)
5.7.2 Hot Water Circulation Pump (B-512502A/C)
5.7.3 Hot Water Furnace (F-512502)
5.7.4 Heat Recovery Unit of Turboblower (WHRU-P-UC-1223201)
5.7.5 Pots for chemical injection

6 ELECTRICAL GENERATION SYSTEM
6.1 MAIN GENERATION SYSTEM
6.2 AUXILIARY GENERATION SYSTEM
1. CONTENT

This Descriptive Memorandum aims to describe systems comprised by FPSO P-34 on general basis.

2. INTRODUCTION

2.1 Main Characteristics

P-34 is a FPSO based on a converted tanker. This FPSO was restored for operation in 1993, and installed at Barracuda Field in 1997. It was reformed to perform Phase I of Jubarte Field development in 2005.

FPSO P-34 was adapted for in 1,355 meters depth operation.

Four wells will be connected to the existing Turret to produce 60,000 BLPD.

P-34 processing was adapted for Jubarte Field (90°C in spacer and 140°C in oil dehydrator), and for fluid’s new features, as well as the new oil-water separation system, and specification (oil heater, oil dehydrator, hydrocyclone and flotation unit), including new equipment, control, automation and utilities for a three-phase separation, gas treatment and compression.

The current compression system for lift gas has been modified to achieve 150 abs discharge pressure of kgf/cm² and 600,000 Nm³/d design flow. The platform has a third compression stage in its compression system. Gas produced in separators is utilized for lift gas, as fuel gas and inert gas for cargo tanks blanketing. All surplus gas will be burned in torch.

Accommodation capacity of 90 people.

GENERAL DESCRIPTION OF VESSEL

MAIN CHARACTERISTICS

<table>
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<th>Unit Name:</th>
<th>PETROBRAS XXXIV</th>
</tr>
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<td>Panamá</td>
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<tr>
<td>Registration Port:</td>
<td>Panamá</td>
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<tr>
<td>Registration No.:</td>
<td>14435S</td>
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<td>Prefix IMO:</td>
<td>5284221</td>
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<td>IRIN:</td>
<td>HP8990</td>
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<td>Unit Type:</td>
<td>Floating Production Storage and Offloading (F.P.S.O)</td>
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<tr>
<td>Designer:</td>
<td>Verolme United Shipyards, Rotterdam, Holland</td>
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<tr>
<td>Construction Year:</td>
<td>1959</td>
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<tr>
<td>Converted by:</td>
<td>Mitsubishi Heavy Industries Ltd., Japan</td>
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<tr>
<td>Year of Conversion:</td>
<td>1976</td>
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</table>
Converted by: Indústria Verolme Ishibras S.A. – IVI, Rio de Janeiro, Brazil
Year of Conversion: 1997

Converted by: GDK, Vitória, Brazil
Year of Conversion: 2006

Classification Society: Bureau Veritas
Class notation: Offshore Service Barge/Production Unit Oil Storage Unrestricted Navigation SOUTH ATLANTIC SEA “JUBARTE FIELD” + AUTO; + INWATERSURVEY; POSA + HULL + MACH

Light displacement: 17241.50 t
Full Load displacement: 62236.60 t

Type of anchoring and amount and type of mooring lines.

Anchors: Six (6) sets of 16 tons (each)
Catenary: consisting of:
Moorings – Six (6) moorings of 1020 m, with diameter 3.50" (89 mm) each
Rises Cables - Six (6) cables of 900 m each, with diameter of 3.375" (86 mm); Moorings of Lifting – Six (6) mooring of 85 m each, with 875" diameter (98 mm);

Water depth: 1335 m
Lightweight: 17.241 t

Discharge capacity Oil produced from the pump: 46,000 t/24 hrs.

MAIN DIMENSIONS

Total Length: 240,300 m
Length between perpendiculars: 231,100 m
Breadth Molded: 26,000 m
Depth Molded: 16,870 m
Draught Molded of Project: 12,677 m
Draught for Extreme Summer: 12,762 m
Extreme Tropical Draught: 13,027 m
Longitudinal position in Gravity Center: -5.90m (fwd of midship)
Vertical Position in Gravity Center: 14.92 m (above base line)
Freeboard: 4,189 m
PRIMARY STRUCTURE OF VESSEL

HULL STRUCTURE

The structure is made of steel and divided into "the fore and the aft" compartments.

- One (1) collision tank at the fore;
- Moon pool, where Turret is installed;
- Five (5) hydrocarbon cargo tanks, divided along on starboard, port and central, except for ballast tank 3 (BB/BE);
- Two (2) leftovers tanks (slop tanks);
- Pump Room, where cargo pumps are installed;
- Machine Room, where the main equipment such as generators set, air compressor, seawater pumps, fire pumps, distillation set, among others are installed;
- One (1) collision tank at aft;

UNIT SUBDIVISION

Cargo region is comprised of 5 center tanks, 8 side cargo tanks, 2 slop tanks, and 2 ballast side tanks. Aft-pike tank is utilized as ballast, and in pumps region there are two ballast side tanks. Fore-pike tank is utilized as empty space and bunker. The region around turret is utilized as an empty space.

STORAGE CAPABILITIES

Density of fluids used in the following tables:

- Oil of cargo \( (\gamma = 0.884 \text{ t/m}^3) \)
- Salty water \( (\gamma = 1.025 \text{ t/m}^3) \)
- Diesel fuel \( (\gamma = 0.900 \text{ t/m}^3) \)

### LUB OIL TANKS

<table>
<thead>
<tr>
<th>LUB. OIL</th>
<th>CODE</th>
<th>LOCATION</th>
<th>VOL. 100%</th>
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<th>WEIGHT 98%</th>
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<tbody>
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<td>LUB OIL B</td>
<td>LUBOILB.P</td>
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### CARGO OIL TANKS

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<td>433 424</td>
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<td>PEAK TANK BALLAST</td>
<td>AFTPEAK.C</td>
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**DIESEL FUEL TANK**

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<th>CODE</th>
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<th>m³</th>
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**FRESHWATER TANK**

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</table>

**HELIPAD DESCRIPTION**

The helipad is located in the central part of FPSO vessel, having the following features to enable the following helicopter to land under any FPSO operating conditions.

- **Dimensions:** 30 x 27 m (891 m²)
- **Helicopter model:** Sikorsky S-61N
- **Capacity:** 13 t
- **Material:** Common steel

**DECKS HEIGHT**

- Superstructure at Aft:
  - 2nd deck: elev. 14700 mm;
  - Deck of vessels: elev. 20810 mm;
  - Upper deck: elev. 23660 mm;
  - Top deck: elev. 27960 mm.
- Superstructure of Midships:
  - Upper deck: elev. 20365 mm;
  - Deck of vessels: elev. 22855 mm;
  - Gangway: elev. 25625 mm;
  - Tijupá: elev. 25625 mm.
- Main deck: elev. 16870 ~ 17320 mm
ACCOMMODATION SECTOR LOCATION

SUPERSTRUCTURE AT AFT

The unit can accommodate 90 people in rooms distributed in four (4) decks as shown in the following documents:

ROOMS AND ROOMS SPACES

2nd Deck:

- 42 cabins
- Laundry
- Hydraulic Pump Room
- Bunkers No. 1, 2 and 5
- Diesel-Hydraulic Fire Pump Room
- Closet of Clean Clothes
- Access to cargo pump room and Engine Room casing.

Main Deck:

- JK Memorial Room (Library, Dining Room, Screening Room)
- Care Room
- Hospital
- Playroom
- Telephone Booth
- Changing Room
- Newsstand
- Kitchen
- Provisions Room
- Air Conditioning Room
- Storeroom of Electrical Parts
- CO2 Room
- Engine Room casing.

Deck of Vessels:

- Control Room
- Office of the Operations Coordinator
- Whaling
- Bathroom
- Video Conference Room
- Technical Documentation Room
- Main Office
- Security Room and Reception
- Supervisor Cabin
- Living Room of the Supervisor
- Supervision Office
• Workshop of Instrumentation
• Battery Charging Room of Telecom
• Play area
• Radio Room
• Telecom Room and
• Engine Room Casing.

Upper Deck:

• Storage area of lubricating oil barrels
• Emergency power generator room
• Ventilation equipment room
• Batteries room
• Battery Charger room
• Pool
• Engine Room Casing and Chimney

All cabins have bathroom with washbasin, shower and shower stall; some of them are shared.

Accommodation rooms have air conditioning system designed to maintain a suitable temperature for the crew to feel comfortable. Accommodations rooms have firefighting system (foam, CO2, salty water)

MIDSHIP DECKHOUSE

Amidship deckhouse of has the following service spaces:
• CO2 Room
• Paint Storeroom
• No. 2 storeroom for mechanical spares
• Electrical spares Storeroom
• Salvage material Storeroom
• Rescue boat
• Pumping Storeroom
• Lamps and cables Storeroom
• Master storeroom
• Foam tank
• Charging devices storeroom
• No. 6 storeroom
• No. 7 storeroom
• No. 8 storeroom
• No. 9 storeroom
• No. 10 storeroom
• No. 11 storeroom
• Heater of tank cleaning
• No. 1 control panels room
• No. 2 control panels room
• PLC remote room
• Weld workshop
• Oxyacetylene cutting and welding unit
• Air conditioning compressor unit
• Auxiliary generator module supplying the following rooms: auxiliary generator room, electrical panels room and VAC room.

FENDERS LOCATION

There are five fenders installed in P34: three (3) located in BE aft, in the cave 67, between caves 72 and 73, and cave 76, and two (2) located in BB fore, between caves 83 and 84, and between caves 86 and 87.

ANCHOR SYSTEM CHARACTERISTICS – SPM (SINGLE POINT MOORING)

General

Different mooring systems were analyzed in an effort to minimize the overall system load, loads on each anchor line, maximum unit round, and to ensure non-interference among mooring lines and risers. The project consists of a system with six catenary symmetrical lines.

SPM (Single Point Mooring – Catenary Configuration)

PULL EYE FOR TOWING

The towing pull eye of towboat must not exceed 120 t, which is the towing system design load.

MOORING

The mooring system was designed for auxiliary vessels mooring to FPSO (only portside), and towing operations.

MOORING EQUIPMENT AND ACCESSORIES CHARACTERISTICS

The following equipment and accessories are positioned on the upper deck:

• Two (2) sets: auxiliary winch (10 ton)
• Six (6) sets: Bitt (nom. 400)
• Eight (8) sets: Bitt (nom. 300)
• Four (4) sets: Bitt (nom. 450)
• Two (2) sets: Horn (nom 350 x 500)
• Eight (8) sets: Horn (nom. 200 x 250)
• Four (4) sets: Horn (nom. 250 x 400)
• Two (2) sets: Horn (nom 300 x 400)
• Two (2) sets: Horn (nom 300 x 250)
- Two (2) sets: Horn (nom 350 x 250)
- One (1) set: Special horn (870 x 870)
- Two (2) sets: Bitt crosswise (nom. 150)
- Two (2) sets: Davit of fenders (only portside)
- Four (4) sets: Roller chock (nom. 400)
- One (1) set: Snatch block (10 ton)
- One (1) set: Pull eye (16 ton)

The following equipment and accessories are positioned on Deck Castle:

- One (1) set: Auxiliary winch (10 ton)
- Two (2) sets: Towing bracket (nom. 90 ton)
- Two (2) sets: Horn (nom 500 x 650)
- Two (2) sets: Horn (nom 250 x 300)
- Two (2) sets: Roller chock (nom. 400)

**TURRET**

F.P.S.O. mooring is performed by turret, which is located forward of cargo tanks and have the following characteristics:

- Diameter: 13.6 m
- Risers: 15 risers, four (4) risers for each of the five (5) oil wells.
- Turret support structure is composed by four decks:
  - Connection Deck or Risers: where flexible risers are supported and connected to rigid connections. This deck is considered as a dry deck in every possible draught of FPSO.
  - Pull-in Deck: where there are pull-in operations. This deck should be cleaned during pull-in/out operations for safe movement of cargo.
  - Manifold Deck: Deck where manifolds for valve operations, underwater hydraulic valve controls, well manifold, and pig launchers and receivers are installed.
  - Swivel Deck: Deck where swivel ball-and socket joint are located.

* Support structure is equipped with walkways and stairs to access risers, turret components and pipelines and/or hoses. Moreover, the structure is provided with handrails around the upper deck and walkways.

  - Rotary set: Rotary set structure is designed to allow rotation free, transmitting mooring loads/riser through bearing and supporting mooring table loads. An adjustable brake mechanism is provided with sufficient friction to eliminate rotational set movements under mild weather conditions; however, it will not restrict the rotations if necessary.
- Swivel multi-product: Stackable and comprises eight (8) independent ways - two (2) fluid ways of produced oil, one (1) fluid way for spare, two (2) ways for gas injection, one (1) way for deluge system, one (1) hydraulic with door of 6 x 1", and one (1) electric.

- A SDW system (spool drum weather free) to send electrical power to two (2) ESPs (submersible electrical pumps).

- Two (2) chemical injection unit: one (1) for scaling inhibitor and one (1) for demulsifier.

  - The swivel pipeline allows manual selection of any function or fluid spare way, without the equipment disconnection.

### 2.2 Main Characteristics of Oil to be Processed

Water depth varies from 1000 to 1500 m. The field contains oil with density of 0.95 g/cm³, and viscosity of 14 cP at saturation pressure.

**Fluid Characteristics:**

- API: 17.1
- Viscosity (dry): 1411 cP at 30°C; 357 cP at 50°C;
- BSW: 0 to 50 %;
- Maximum viscosity (emulsion at 40% of BSW – live oil): 2016 cP at 36°C

### 3. PROCESSING SYSTEMS

#### 3.1 OIL PRODUCTION, PROCESSING AND TREATMENT

##### 3.1.1 General Description

The three-phase mixture of oil, gas and water from remote subsea wells is collected and heated prior to separation of gas, oil and water to oil production stabilized for storage at atmospheric pressure. This thermal energy is provided by exchanging heat between water, hot produced, and stabilized crude oil, and supplemented with the mean to heating system (hot water). Processing Plant has two trains for oil receiving: production and test. Production system has a total capacity of 9,539 m³/d (60,000 blpd) of oil with 200,000 Nm³/d of gas (maximum oil), and 4,770 m³/d (30,000 blpd) of produced water (maximum water). Oil treatment system is comprised of two trains of separation:
Production train, with capacity of 40,000 blpd, and with two stages: pre-heated oil/water for heating (P-122309A/B) and re-heating of oil/oil (P-122304A/B). Test train, with capacity of 20,000 blpd and only 1 heating stage: testing heater (P-122303) whose heat source is hot water. In both preheating systems, the crude oil is heated from 36°C to 90°C.

Fluid from well undergo the Production/Test Separators, which separates oil, gas and produced water. Oil-rich phase is heated up to 140°C in oil dehydrator heater (P-122310A/B), using hot water as heating mean. After, the crude oil is sent to Pressure Vessel of dehydrator (V-TO-122301), allowing gas separation, produced by oil heating up to 140°C, before oil entering in the oil electrostatic dehydrator (TO-122301). The stabilized and dehydrated oil is sent to Crude Oil Measuring System Controller (COMS controller), then to oil cooler (P-122305A/B), lowering the temperature at less than 50°C to allow oil storage in cargo tanks.

Chemical injection systems for fouling inhibiting, anti-foaming and demulsifying are provided at production trains entrance to facilitate oil separation.

### 3.1.2 Main Details

Oil receiving and processing system is represented in the following flow and process equipment, and it is comprised by the following equipment:

#### TABLE 1: Oil System Equipment

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<tr>
<th>TAG</th>
<th>DESCRIPTION</th>
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<tr>
<td>LP-122301/4</td>
<td>PIG LAUNCHERS</td>
</tr>
<tr>
<td>RP-122301</td>
<td>PIG RECEIVERS</td>
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<tr>
<td>P-122304A/B</td>
<td>PRE-HEAT OIL-OIL</td>
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<td>P-122309A/B</td>
<td>PRE-HEAT OIL-WATER</td>
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<td>SG-122304</td>
<td>PRODUCTION SEPARATOR</td>
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<tr>
<td>P-122305A/B</td>
<td>OIL COOLER</td>
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Process data for each piece of equipment below:

#### 3.1.2.1 PRE-HEATING OIL/WATER (P-122309A/B)

#### TABLE 2: P-122309A/B

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<th>Hot side</th>
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<td>Flow (kg/h)</td>
<td>138620</td>
<td>97605</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Cold side</th>
<th>Hot side</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Input</td>
<td>Output</td>
</tr>
<tr>
<td>Fluid</td>
<td>Oil</td>
<td>Produced water</td>
</tr>
</tbody>
</table>
Oil/water heat exchangers operate simultaneously, 2 x 50%. Their function is to recover the heat produced after water treatment, produced in hydrocyclone, and preheat the three-phase mixture supplying in the production header. The temperature at the output of oil/water heat exchangers depends on the amount of water produced, which varies according to production curve.

3.1.2.2 PRE-HEATING OF OIL/OIL (P-122304A/B)

**TABLE 3:** P-122304A/B Case 1 – Maximum heat load

<table>
<thead>
<tr>
<th>Hull side</th>
<th>Pipe side</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fluid</strong></td>
<td>Stabilized oil</td>
</tr>
<tr>
<td><strong>Flow (kg/h)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Temperature (ºC)</strong></td>
<td>140</td>
</tr>
<tr>
<td><strong>Pressure (KPag)</strong></td>
<td>340</td>
</tr>
<tr>
<td><strong>Design temperature (ºC)</strong></td>
<td>170</td>
</tr>
<tr>
<td><strong>Design pressure (KPag)</strong></td>
<td>536</td>
</tr>
<tr>
<td><strong>Heat exchange (W)</strong></td>
<td>4.34 x 10⁶</td>
</tr>
</tbody>
</table>

Manufacturer: CBC

This case shows the maximum heat load, disregarding the heat exchange in P-122309A/B, a BSW 0% case.

**TABLE 4:** P-122304A/B Case 2 – Maximum viscosity

<table>
<thead>
<tr>
<th>Hull side</th>
<th>Pipe side</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fluid</strong></td>
<td>Stabilized oil</td>
</tr>
<tr>
<td><strong>Flow (kg/h)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Temperature (ºC)</strong></td>
<td>140</td>
</tr>
<tr>
<td><strong>Pressure (KPag)</strong></td>
<td>340</td>
</tr>
<tr>
<td><strong>Design temperature (ºC)</strong></td>
<td>170</td>
</tr>
<tr>
<td><strong>Design pressure (KPag)</strong></td>
<td>536</td>
</tr>
<tr>
<td><strong>Heat exchange (W)</strong></td>
<td>2.43 x 10⁶</td>
</tr>
</tbody>
</table>

Manufacturer: CBC

This case considers the maximum operation of P-122309A/B.

In both case, the heat exchangers operate simultaneously, 2 x 50%.
Temperature control in these exchangers is performed through a control valve (TV-1223779), which bypasses the heat exchangers, controlling the stabilized hot oil input flow, according to crude oil output temperature.

### 3.1.2.3 Test heater (P-122303)

TABLE 5: P-122303

<table>
<thead>
<tr>
<th>Hull side</th>
<th>Pipe side</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fluid</strong></td>
<td><strong>Flow (kg/h)</strong></td>
</tr>
<tr>
<td>Crude oil</td>
<td>Hot water</td>
</tr>
<tr>
<td><strong>Temperature (ºC)</strong></td>
<td></td>
</tr>
<tr>
<td>36</td>
<td>90</td>
</tr>
<tr>
<td>180</td>
<td>130</td>
</tr>
<tr>
<td><strong>Pressure (KPag)</strong></td>
<td></td>
</tr>
<tr>
<td>930</td>
<td>783</td>
</tr>
<tr>
<td>1370</td>
<td>1280</td>
</tr>
<tr>
<td><strong>Design temperature (ºC)</strong></td>
<td></td>
</tr>
<tr>
<td>120</td>
<td>210</td>
</tr>
<tr>
<td><strong>Design pressure (KPag)</strong></td>
<td></td>
</tr>
<tr>
<td>1503</td>
<td>2150</td>
</tr>
<tr>
<td><strong>Heat exchange (W)</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.91 x 10⁶</td>
</tr>
</tbody>
</table>

Manufacturer: CBC

The purpose of this heat exchanger is to pre-heat the fluid from test header, until reaching test separator operating temperature (SG-122301).

### 3.1.2.4 Production Separator (SG-122304)

The horizontal three-phase separator is designed for 0-50% of BS&W. The vessel is equipped with horizontal plates and a demister, vane type, at gas output. The oil/water phase passes through a set of two plates modules, which produces a variable field - VIEC when shaken (for details about this system, see manufacturer's operating manual – VETCO) with total residence time of 10 minutes. Operating conditions are 783 KPag to 90ºC.

The oil-rich phase (maximum 15% of water) and the water-rich phase (maximum 1000 ppm of oil) are separated by gravity increased through coalescent effect provided by VIEC action. The water produced is sent to Production Separator Hydrocyclone, CI-533101, which reduces the oil content to 20-100 ppm. A level control valve in the produced water output from Production Separator Hydrocyclone controls the oil/water interface level.

Oil with a 15% water content, at most, is sent to the oil dehydrator. The oil level of production separator is controlled by LV-1223731, which regulates the flow in separator output, upstream of oil dehydrator heater. The liquid total level in separator is not controlled, being a result of overflow by spillway. At oil output of production separator is installed a measuring system (COMS operational), which measures the produced oil content in the equipment.

Gas leaves vessel through a demister, vane type, and is cooled in Safety Gas Cooler (P-122307), then is fed by Safety Gas K.O. Drum, whose function is to reduce the liquid amount in the gas, which will be sent to the compressor.
System pressure is controlled by adjusting the compressor and relieving the gas through the pressure control valve (PV-1223758) to torch.

**TABLE 6: Operating Data of SG-122304**

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Note (*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>Carbon steel internally coated with Derakane</td>
</tr>
<tr>
<td>Operational temperature</td>
<td>90ºC</td>
</tr>
<tr>
<td>Design temperature</td>
<td>120ºC</td>
</tr>
<tr>
<td>Operational pressure</td>
<td>783 KPag</td>
</tr>
<tr>
<td>Design pressure</td>
<td>1305 KPag</td>
</tr>
<tr>
<td>Heat insulation</td>
<td>38 mm</td>
</tr>
</tbody>
</table>

Manufacturer: Petreco/Bardella

**Note (*)**:
Gas design flow: 700,000 m³/d (20°C and 101.3 kPa abs).
Liquid design flow: 6360 m³/d in standard condition. (40,000 bbl/day)
Maximum Oil: 6360 Sm³/day (5780 oil + 580 water) (BSW of a 10% input)
Maximum water: 6360 Sm³/day (3180 oil + 3180 water) (BSW of a 50% input)

3.1.2.5 Testing the Separator (SG-122301)

Separation process in test separator is similar to the production separator. The water produced in test separator is sent to a test separator hydrocyclone, CI-533102, and the processing flow is 50% lower than the production separator. The main operational difference between both separators is in the separation of liquid phase with VIEC.

**TABLE 7: Operating Data of SG-122301**

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Note (*)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>Carbon steel internally coated with Derakane</td>
</tr>
<tr>
<td>Operational temperature</td>
<td>90ºC</td>
</tr>
<tr>
<td>Design temperature</td>
<td>120ºC</td>
</tr>
<tr>
<td>Operational pressure</td>
<td>783 KPag</td>
</tr>
<tr>
<td>Design pressure</td>
<td>1305 KPag</td>
</tr>
<tr>
<td>Heat insulation</td>
<td>38 mm</td>
</tr>
</tbody>
</table>

Manufacturer: Petreco/Bardella

**Note (*)**:
Gas design flow: 360000 m³/d (20°C and 101.3 abs of kPa).
Liquid design flow: 3180 m³/d in standard condition.
Maximum Oil: 3180 m³/d (2890 oil + 290 water) (BSW of a 10% input)
Maximum water: 3180 m³/d (1590 oil + 1590 water) (BSW of a 50% input)
3.1.2.6 Heater of Oil Dehydrator (P-122310A/B)

TABLE 8: P-122310A/B

<table>
<thead>
<tr>
<th></th>
<th>Hull side</th>
<th>Pipe side</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Input</td>
<td>Output</td>
</tr>
<tr>
<td>Fluid</td>
<td>Crude oil</td>
<td>Hot water</td>
</tr>
<tr>
<td>Flow (kg/h)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature (ºC)</td>
<td>90</td>
<td>140</td>
</tr>
<tr>
<td>Pressure (KPag)</td>
<td>500</td>
<td>340</td>
</tr>
<tr>
<td>Design temperature (ºC)</td>
<td>170</td>
<td>210</td>
</tr>
<tr>
<td>Design pressure (KPag)</td>
<td>1305</td>
<td>2150</td>
</tr>
<tr>
<td>Heat exchange (W)</td>
<td></td>
<td>7.27 x 10^6</td>
</tr>
</tbody>
</table>

Manufacturer: CBC

This heat exchanger aims heating crude oil of production/test separators up to 140°C, to feed the oil dewatering system, which separates water from oil by electrostatic forces. Both heat exchangers operate simultaneously (2 x 50%).

3.1.2.7 Oil dehydrator (TO-122301) and Pressure Vessel of oil dehydrator (V-TO-122301)

Oil dehydrating system is comprised by pressure vessel of oil dehydrator (V-TO-122301), and by oil dehydrator (TO-122301), put together as an associated package, with all pipeline and instrumentation required for its operation supplied by Kværner.

TABLE 9: Oil, water and gas flow at TO-122301 input.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>OIL FLOW (m³/d)</th>
<th>WATER FLOW (m³/d)</th>
<th>GAS FLOW (m³/d)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>8586</td>
<td>954</td>
<td>104010</td>
</tr>
<tr>
<td>2006</td>
<td>7346</td>
<td>2194</td>
<td>85815</td>
</tr>
<tr>
<td>2007</td>
<td>7441</td>
<td>2099</td>
<td>62979</td>
</tr>
</tbody>
</table>

* Flow at 20°C and 101.3 kPa abs.

Operating conditions and oil dehydrator project, BSW maximum of 23% is expected in the input stream of oil dehydrator. However, under unusual circumstances, BSW index may reach 30%. In both cases, the oil dehydrator ensures the following specification:

- BSW maximum of 0.5% at output
- Maximum oil salinity: 200 ptb (570 mg/L)
- Maximum salinity of produced water: 120,000 mg/L

- Temperature:
  - Operation: 140°C
  - Project: 170°C
- Pressure:
  - Operation: 340 kPa g
  - Project: 536 kPa g
  - Manufacturer: Kværner for this package.

### 3.1.2.8 Oil Cooler (P-122305A/B)

#### TABLE 10: P-122305A/B

<table>
<thead>
<tr>
<th></th>
<th>Cold side</th>
<th>Hot side</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Input</td>
<td>Output</td>
</tr>
<tr>
<td>Fluid</td>
<td>Seawater</td>
<td>Oil</td>
</tr>
<tr>
<td>Flow (kg/h)</td>
<td>1022</td>
<td></td>
</tr>
<tr>
<td>Temperature (ºC)</td>
<td>29</td>
<td>39</td>
</tr>
<tr>
<td>Pressure (KPag)</td>
<td>270</td>
<td>170</td>
</tr>
<tr>
<td>Design temperature (ºC)</td>
<td>130</td>
<td></td>
</tr>
<tr>
<td>Design pressure (KPag)</td>
<td>912</td>
<td></td>
</tr>
</tbody>
</table>

Manufacturer: Tranter

These heat exchangers are designed to cool crude oil, which leaves the oil dehydrator to be stored in cargo tanks. Both plate-type heat exchangers operate simultaneously (2 x 50%).

### 3.1.2.9 Crude Oil Measurement System (COMS)

Once the crude oil is dehydrated and stabilized, in oil dehydrator at 140°C, it is used for heat recovery in oil/oil heat exchanger (P-122304A/B), which preheats oil from producing wells. The oil TAN is measured for tax purposes in crude oil measuring system (COMS) before oil final cooling (at P-123305) for storage. COMS is designed in accordance with the National Agency of Petroleum, Natural Gas and Biofuels (ANP – *Agência Nacional do Petróleo Brasileiro*) for regularization of oil and natural gas measuring (ref. ANP/INMETRO No. 1 of June 19th, 2000).

COMS is supplied as a complete package, comprising BSW analyzer and automatic sampler.

COMS calibration is performed through master flow measurer, installed in series with two standards measurers, operating in each other stand-by (2 x 100%). Master flow measurer is subject to ANP supervision. COMS valves operation procedure is double lock and full-flow. See Emerson documentation for more information about crude oil measurement system (COMS).

### 3.2 GAS PROCESSING AND COMPRESSION

#### 3.2.1 System Description
Gas produced in process plant is used for three purposes:

a) Lift Gas  
b) Fuel Gas  
c) Gas for oil cargo tanks blanketing  

All exceeding gas produced by process plant is burned at the Torch. Gas separation occurs in SG-122304 and SG-122301, from where gas is sent to gas cooler (P-122307) to be cooled up to 40°C. Gas/liquid mix produced with temperature reduction goes to in Safety Gas K.O. Drum, V-122301, where the liquid is separated and sent to P-122304A/B through production train. This operation is performed through the level control of V-122301. Most part of V-122301 gas is sent to gas compression unit, for Lift Gas practice, and its smaller part is sent to Fuel Gas K.O. Drum (V-310). The gas separated from oil and water in process plant is used to supply the processing system of fuel gas. After reducing the liquid content at V-310, the gas is distributed to processing plant and other consumers as auxiliary generator (GE-526201), floating (FL-533101), gas compression unit (UC-122301), oily waste vessel (V-533601), storage tanks (for blanket), TEG unit, hot water furnace (F-512501) and torch.

3.2.2 Main Details

3.2.2.1 Safety Gas Cooler (P-122307)

<table>
<thead>
<tr>
<th>Hull side</th>
<th>Pipe side</th>
<th>Fluid</th>
<th>Input</th>
<th>Output</th>
<th>Input</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow (kg/h)</td>
<td>24,000 Kg/h</td>
<td>Gas</td>
<td>29</td>
<td>39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>90</td>
<td>40</td>
<td>69</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure (KPag)</td>
<td>783</td>
<td>755</td>
<td>170</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design temperature (°C)</td>
<td>120</td>
<td>1305</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design pressure (KPag)</td>
<td>912</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat exchange (W)</td>
<td>1.96 x 10^6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Manufacturer: Jaraguá

3.2.2.2 K.O. Drum Safety Gas (V-122301)

K.O. Drum Safety Gas is a current vessel that was kept with the new system. This vessel operates at a pressure of 755 KPag and temperature of 40°C, with design pressure of 1305 KPag and design temperature of 70°C.

3.2.2.3 K.O. Drum Fuel Gas (V-310)

K.O. Drum Fuel Gas is a current vessel that was kept with the new system. This vessel operates at a pressure of 700 KPag and temperature of 40°C, with design pressure of 875 KPag and design temperature of 70°C.
3.2.2.4 Gas Compression Unit

The gas used for Lift Gas and platform consumption, leaving Test and Production Separators towards to Safety Gas K.O. Drum (current V-122301), passing through P-122307 (Safety Gas Cooler). The gas is sent to the existing compression unit (UC-122301), which was reformulated to compress the gas up to 150 kgf/cm² g, with a design capacity of 600,000 Nm³/day (20°C and 1 atm). According to Compression Unit consumption requirements, the exceeding gas produced in separators is burned in L.P. Torch along with the gas produced in pressure vessel of oil dehydrator (V-TO-122301). Gas Compression Unit was provided separately as a skid fully assembled by Nuovo Pignone.

Note: Compression control panel parts were removed and the system is now incomplete.

3.2.3 GAS DEHYDRATION

Wet gas from Compression Unit is dehydrated in TEG Contactor tower, for condensate removal. The separated gas passes through packed columns, and is washed with triethylene glycol (TEG) to absorb the water contained in the gas. The contactor is designed to dehydrate 600,000 Nm³/d of gas, in order to reach a -10°C water dew point in 14707 KPag. Dehydration system is designed to handle with 100% of plant capacity. Water rich in TEG produced in contactor is regenerated in TEG regeneration unit by using electricity and stripping gas. The dehydrated gas of contactor is sent to lift gas system through a fiscal measurement unit of gas.

3.2.4 LIFT GAS SYSTEM

One of the oil lift systems is the injection of gas produced in the well. Gas is injected into the well and its smaller density related to the liquid column promotes gas lift. Consequently, limiting the internal pressure of wells, and limiting the additional drop pressure, it is possible to increase oil production. The minimum flow of project per well is 100,000 Nm³/d and maximum of 250,000 Nm³/d per well. The maximum flow of project for all wells is 600,000 Nm³/d. See Operation Manual of SOFEC for a more complete description of the system.

3.3 OILY WATER PROCESSING
### 3.3.1 System Description

Unspecified produced water from production/testing separator and oil dehydrator is treated in dedicated hydrocyclones (CI-533101/02/03) for each separator and oil dehydrator. After passing through hydrocyclones, the produced water is passes through P-122309A/B, where it exchanges heat with the oil entering in the platform, and then it is sent to gas flotation unit (FL-533101), cooled in P-533101 before being forwarded to degasser vessel (V-533101), where a possible dissolved gas is separated, and the water is discharged to the sea.

The oil-rich phase from the flotation unit and hydrocyclones is forward to oily water waste vessel (V-533601), where the process will return by pumping. Condensed oil is recovered by gas processing, which is recycled and heated in oil dehydrator heater (P-122310A/B) to be returned to Oil Dehydration Unit.

Water treatment is performed in two stages based on water output composition produced in each piece of equipment. Hydrocyclones are designed to reduce oil content from 1000 ppm to 20-100 ppm, while Flotation Unit will ensure an oil content of 20 ppm in produced water to be discharged in the sea.

Produced water system consists of the main equipment, which are:

#### TABLE 12: Oily Water System Equipment

<table>
<thead>
<tr>
<th>TAG</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-FL-533101-01A/B</td>
<td>RECIRCULATION PUMP OF PRODUCED WATER</td>
</tr>
<tr>
<td>CI-533101</td>
<td>PRODUCTION SEPARATOR HYDROCYCLONE</td>
</tr>
<tr>
<td>CI-533102</td>
<td>TEST SEPARATOR HYDROCYCLONE</td>
</tr>
<tr>
<td>CI-533103</td>
<td>OIL DEHYDRATOR HYDROCYCLONE</td>
</tr>
<tr>
<td>FL-533101</td>
<td>GAS FLOTATION UNIT</td>
</tr>
<tr>
<td>P-533101</td>
<td>PRODUCED WATER COOLER</td>
</tr>
<tr>
<td>V-533101</td>
<td>DESANDER VESSEL</td>
</tr>
<tr>
<td>V-533601</td>
<td>WASTE VESSEL OF OILY WATER</td>
</tr>
<tr>
<td>B-533601A/B</td>
<td>WASTE PUMP OF OILY WATER</td>
</tr>
<tr>
<td>P-122309A/B</td>
<td>WATER/OIL HEATER</td>
</tr>
</tbody>
</table>

### 3.3.2 Main Details

Operating and design data for each piece of equipment is contained in their respective data sheets; however, a brief description of each equipment is shown below.

### 3.3.3 Production Separator Hydrocyclone (CI-533101)

#### TABLE 13: CI-533101

<table>
<thead>
<tr>
<th>Flow</th>
<th>Minimum</th>
<th>11 m³/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum</td>
<td>110 m³/h</td>
<td></td>
</tr>
<tr>
<td>Maximum waste</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>Operational temperature</td>
<td>90°C</td>
<td></td>
</tr>
<tr>
<td>Design temperature</td>
<td>120°C</td>
<td></td>
</tr>
<tr>
<td>Input pressure</td>
<td>732 KPag</td>
<td></td>
</tr>
<tr>
<td>Design pressure</td>
<td>1305 KPag</td>
<td></td>
</tr>
</tbody>
</table>
3.3.4 Test Separator Hydrocyclone (CI-533102)

**TABLE 14: CI-533102**

<table>
<thead>
<tr>
<th>Flow</th>
<th>Minimum 4.6 m³/h</th>
<th>Maximum 46 m³/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum waste</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>Operational temperature</td>
<td>90°C</td>
<td></td>
</tr>
<tr>
<td>Design temperature</td>
<td>120°C</td>
<td></td>
</tr>
<tr>
<td>Input pressure</td>
<td>732 KPag</td>
<td></td>
</tr>
<tr>
<td>Design pressure</td>
<td>1305 KPag</td>
<td></td>
</tr>
</tbody>
</table>

3.3.5 Oil Dehydrator Hydrocyclone (CI-533103)

**TABLE 15: CI-533103**

<table>
<thead>
<tr>
<th>Flow</th>
<th>Minimum 9.2 m³/h</th>
<th>Maximum 92 m³/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum waste</td>
<td>5%</td>
<td></td>
</tr>
<tr>
<td>Operational temperature</td>
<td>140°C</td>
<td></td>
</tr>
<tr>
<td>Design temperature</td>
<td>170°C</td>
<td></td>
</tr>
<tr>
<td>Input pressure</td>
<td>700 KPag</td>
<td></td>
</tr>
<tr>
<td>Design pressure</td>
<td>1305 KPag</td>
<td></td>
</tr>
</tbody>
</table>

3.3.6 Gas Flotation Unit (FL-533101)

**TABLE 16: FL-533101**

<table>
<thead>
<tr>
<th>Input flow</th>
<th>199 m³/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil content at entrance</td>
<td>20 a 100 ppm</td>
</tr>
<tr>
<td>Oil content at output</td>
<td>20 ppm</td>
</tr>
<tr>
<td>Operational temperature</td>
<td>66°C</td>
</tr>
<tr>
<td>Design temperature</td>
<td>105°C</td>
</tr>
<tr>
<td>Input pressure</td>
<td>154 KPag</td>
</tr>
<tr>
<td>Design pressure</td>
<td>343 KPag</td>
</tr>
</tbody>
</table>

3.3.7 Produced Water Cooler (P-533101)

**TABLE 17: P-533101**
### Cold side

<table>
<thead>
<tr>
<th>Fluid</th>
<th>Seawater</th>
<th>Produced water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow (m³/h)</td>
<td>500</td>
<td>200</td>
</tr>
<tr>
<td>Temperature (ºC)</td>
<td>29</td>
<td>39</td>
</tr>
<tr>
<td>Pressure (KPag)</td>
<td>270</td>
<td>170</td>
</tr>
<tr>
<td>Design temperature (ºC)</td>
<td>130</td>
<td></td>
</tr>
<tr>
<td>Design pressure (KPag)</td>
<td>912</td>
<td>343</td>
</tr>
<tr>
<td>Heat exchange (W)</td>
<td>$5.95 \times 10^6$</td>
<td></td>
</tr>
</tbody>
</table>

Manufacturer: Tranter

### 3.3.8 Degasser Vessel (V-533101)

#### TABLE 18: V-533101

<table>
<thead>
<tr>
<th>Total capacity</th>
<th>1.24 m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Useful capacity</td>
<td>0.82 m³</td>
</tr>
<tr>
<td>Material</td>
<td>Carbon steel coated with derakane</td>
</tr>
<tr>
<td>Operational temperature</td>
<td>40ºC</td>
</tr>
<tr>
<td>Design temperature</td>
<td>70ºC</td>
</tr>
<tr>
<td>Operational pressure</td>
<td>atm</td>
</tr>
<tr>
<td>Design pressure</td>
<td>343 KPag</td>
</tr>
</tbody>
</table>

Manufacturer: Jaraguá

### 3.3.9 Produced Water Pump (B-533101A/C)

#### TABLE 19: B-533101A/C

<table>
<thead>
<tr>
<th>Capacity</th>
<th>46 m³/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>46 m</td>
</tr>
<tr>
<td>Type</td>
<td>Rotary</td>
</tr>
<tr>
<td>Power</td>
<td>Electrical</td>
</tr>
<tr>
<td>Operational temperature</td>
<td>140ºC</td>
</tr>
<tr>
<td>Design temperature</td>
<td>170ºC</td>
</tr>
<tr>
<td>Discharge pressure</td>
<td>755 KPag</td>
</tr>
<tr>
<td>Design pressure (PSV Set)</td>
<td>1155 KPag</td>
</tr>
</tbody>
</table>

Manufacturer: Netzsch
3.3.10 Oily Waste Cooler (P-533601)

TABLE 20: P-533601

<table>
<thead>
<tr>
<th></th>
<th>Cold side</th>
<th>Hot side</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Input</strong></td>
<td><strong>Output</strong></td>
<td><strong>Input</strong></td>
</tr>
<tr>
<td>Fluid</td>
<td>Seawater</td>
<td>Oily waste</td>
</tr>
<tr>
<td>Flow (m³/h)</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Temperature (ºC)</td>
<td>29</td>
<td>39</td>
</tr>
<tr>
<td>Pressure (KPag)</td>
<td>270</td>
<td>170</td>
</tr>
<tr>
<td>Design temperature (ºC)</td>
<td>69</td>
<td>170</td>
</tr>
<tr>
<td>Design pressure (KPag)</td>
<td>912</td>
<td>536</td>
</tr>
<tr>
<td>Heat exchange (W)</td>
<td></td>
<td>1.8 x 10⁵</td>
</tr>
</tbody>
</table>

Manufacturer: Jaraguá

3.3.11 Oily Waste Vessel (V-533601)

TABLE 21: V-533601

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total capacity</td>
<td>4.9 m³</td>
</tr>
<tr>
<td>Useful capacity</td>
<td>4.31 m³</td>
</tr>
<tr>
<td>Material</td>
<td>CARBON STEEL INTERNALLY COATED WITH DERAKANE</td>
</tr>
<tr>
<td>Operational temperature</td>
<td>90ºC</td>
</tr>
<tr>
<td>Design temperature</td>
<td>120ºC</td>
</tr>
<tr>
<td>Operational pressure</td>
<td>105 KPag</td>
</tr>
<tr>
<td>Design pressure</td>
<td>343 KPag</td>
</tr>
<tr>
<td>Heat insulation</td>
<td>CALCIUM SILICATE – 38 mm</td>
</tr>
</tbody>
</table>

Manufacturer: CBC

3.3.12 Oily Waste Pump (B-533601A/B)

TABLE 22: B-533601A/B

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>11 m³/h</td>
</tr>
<tr>
<td>Head</td>
<td>98.2 m</td>
</tr>
<tr>
<td>Type</td>
<td>Progressive cavity</td>
</tr>
<tr>
<td>Power</td>
<td>Electric</td>
</tr>
<tr>
<td>Operational temperature</td>
<td>90ºC</td>
</tr>
<tr>
<td>Design temperature</td>
<td>120ºC</td>
</tr>
<tr>
<td>Discharge pressure</td>
<td>KPag 1158</td>
</tr>
<tr>
<td>Design pressure</td>
<td>KPag 1305</td>
</tr>
</tbody>
</table>

Manufacturer: Netzsch
3.4 CHEMICAL INJECTION FOR OIL, GAS AND PRODUCED WATER

Process plant is equipped with chemical injection units allowing injection of additives to help separating oil, water, and gas, in order to make it operational under minimal of drastic conditions (temperature and pressure) or under uncommon conditions.

Injecting a series of chemicals is considered a possibility to improve plant performance, or even, they are needed in some particular situations. Chemical injection unit incorporates, compactly, operating systems for the following products:

- Inverted Emulsion (Demulsifier)
- Incrustation Inhibitor (Scale Inhibitor)
- Hydrate Inhibitor
- Corrosion Inhibitor
- Antifoam
- H2S scavenger

3.4.1 Inverted emulsion (Demulsifier) – UQ-126201

3.4.2 Incrustation Inhibitor (Scale Inhibitor) – UQ-126202

Unit Supplier - Lewa.

3.4.3 Antifouling Unit for Sea Water – UQ-126203

3.4.4 Chemical Injection Unit for Production and Test Separators – UQ-126204

3.4.5 Chemical Injection Unit for Turret

Two new chemical injection units were installed in Turret, one for demulsifying and another for scale inhibitor.

3.4.6 Chemical Injection Unit for Antifouling (UQ-126101)

This is a new anti-fouling unit consisting of an 11.52-m³ tank capacity, and five dosing pumps with 0.4 to 12 L/h capacity. Each pump operates for each well, and the fifth is a spare pump for the other three. Chemical product injection in wells is performed by means of an umbilical. This is a continuous operation system with design pressure of 16.080 KPag.
3.4.7 Chemical Injection Unit of Demulsifying (UQ-126102)

This is a new unit consisting of a 7.2 m³ tank capacity, and three dosing pumps with 0.3 to 15 L/h capacity. The pumps operate one for each well, and the third is the other two reserves. Chemical product injection in wells is performed by means of an umbilical. This is a continuous operation system with design pressure of 16.080 KPag. For more information on these chemical injection systems, please refer to the existing operating manual.

3.4.7 RELIEF SYSTEM

3.4.7.1 System Description

The platform is provided with three relief systems for collection and gases and steam release into the atmosphere.

3.4.7.2 High Pressure Torch (HP Flare)

High-pressure torch system collects gas from pressure control valves, pressure relief valves and blowdown valves of equipment with pressure operating generally above 198.7 KPag. Gases are collected by a 14" header (new), and then sent to H.P Flare K.O. Drum (V-541201). V-541201 gases are sent to Torch burners, where they are burned.

3.4.7.3 Low Pressure Torch (LP Torch)

Low pressure torch system collects gas from pressure control valves, pressure relief valves and blowdown valves of equipment with pressure operating generally below 30 KPag, and also those requiring a low-back pressure, e.g., after depressurization to HP Flare. Gases are collected by a 8" header (new), and then sent to H.P Flare K.O. Drum (V-541202). V-541202 gases are sent to Torch burners, where they are burned.

3.4.7.4 Emergency Vent System of Cargo Tanks

This is an existing system; for more information, please refer to the current operating manual of P-34. A flame arrestor and a rupture pin valve in parallel with the existing flame arrestor were added to this system. These premises were reallocated in order to obtain a better dispersion of gases in atmosphere.

3.4.7.5 Equipment

All equipment from the relief system exists, except for burners and torch ignition panel. Torch manifolds of high and low pressure were also replaced due to their poor storage conditions. For more information, see the Operating Manual of the new torch equipment (John Zink).
3.4.7.6 System Depressurization

Torch system will be used whenever a PSV or BDV are in operation. PSVs operate in accordance with their respective set pressures. They are relieved for high and low-pressure torch without operator intervention. The system high pressure main causes are:

- Thermal expansion
- Blocked flow
- Fire
- Failure in cooling water system
- Heat exchanger tube rupture
- Operational failure
- Control failure

BDVs operate automatically when there is ESD2 or more, or when the operator wants to depressurize the system.

3.4.7.7 Relief Valves (PSVs)

They are composed by PSVs.

3.4.7.8 Blowdown Valves

Blowdown valves will be remotely operated by the Central Control Room in ESD2 situation, or automatically in ESD4 situation.

The process plant is divided in the following depressurization systems:

- Production Separator (SG-122304)
- Test Separator (SG-122301)
- Safety Gas K.O. Drum (V-122301);
- Glycol Unit (T-123302);
- Fuel Gas (V-310);
- Compression Unit (UC-122301);

**TABLE 23: Depressurization System**

<table>
<thead>
<tr>
<th>VALVE TAG</th>
<th>SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>BDV-1223701</td>
<td>SG-122304</td>
</tr>
<tr>
<td>BDV-1223721</td>
<td>SG-122301</td>
</tr>
<tr>
<td>BDV-1223055</td>
<td>V-122301</td>
</tr>
<tr>
<td>BDV-1223907</td>
<td>T-122302/TEG</td>
</tr>
<tr>
<td>BDV-5135002</td>
<td>V-310</td>
</tr>
<tr>
<td>BDV-1223205</td>
<td>UC-122301-1st STAGE</td>
</tr>
<tr>
<td>BDV-1223209</td>
<td>UC-122301-2nd STAGE</td>
</tr>
<tr>
<td>BDV-1223213</td>
<td>UC-122301-3rd STAGE</td>
</tr>
</tbody>
</table>
4 DRAINAGE AND OIL RECOVERY

4.1 Open Drainage

The current open drainage system is comprised by a 14" header, which collects all skid trays, samplers and pancake drainage. This header is connected to slop structural tank (TQ-33601/02) through a 3" line. A 12" line discharges the drainage excess flow to overboard in order to avoid Slop tanks overloading.

Current Open-Drain System

The pressure inside Slop tanks is maintained constant at 7.5 kPag through blanket system operation. The drainage system is equipped with two water seals represented by two siphons in order to prevent gas return and flame propagation. The first is located at the beginning of the 3" line mentioned above, with 200 mm water height. The second is located inside Slop tanks, and works with 200 mm of water. At P-34, there is no water treatment in slop tanks. New pumps will be installed in the engine room to return produced water stored in slop tank for process plant. This alignment will be manually performed for Floater (FL-531101) when produced water presents oil levels within this equipment specification for Production Header when produced water present high oil content. All drainage is collected in an existing header.

4.2 Closed Drainage

Closed drainage is collected in header, which is forwarded to some vessel cargo tanks. The existing closed drainage system consists of a 6" header, which forwards the closed drainage to 1C (TQ-631102), 2S (TQ-631104), 2C (TQ-631105) and 2P of cargo (TQ-631106) tanks. All equipment with closed drainage has valves with dual-lock with an eight-shape configuration among them.

5. NON-ELECTRICAL UTILITIES SYSTEM

5.1 COMPRESSED AIR SYSTEMS

5.1.1 AIR-START SYSTEM

Two (2) air-start compressors are supplied to provide air to air-start cylinder, which distributes compressed air to diesel engines of the main generators, diesel engines of cargo pumps, emergency generator room, process plant area, and instrumentation and control of air system line of control valves.
Two (2) safety valves are provided for air-start cylinder, and pressure switches are also installed to remotely indicate the measured value in control room (ECOS system).

Two (2) pressure switches are installed on a supply line of air cylinder in order to trigger the "start" of air-start compressor, and also one (1) pressure switch is installed on the same line shutdown the compressors when they exceed a certain pressure.

Alternatively, a pressure-reducing valve is provided for supplying the air distribution service. Safety valve is installed on reduction valve bottom.

This system comprises the following components:

- Two (2) sets of air-start compressors, electric motor, vertical piston, air cooled, 12 Nm3 x 2451.6 kPa (static head)
- One (1) air-start cylinder, 1.0 m3 x 2451.6 kPa (static head)

### 5.1.2 INSTRUMENTATION AIR SYSTEM

Two (2) air-dryer units are installed to receive compressed air from service line, and to provide instrumentation air cylinder, which will distribute the use of essential and unessential, and also supply a compensation instrumentation air cylinder to ensure enough air volume for fifteen (15) minutes, when the compressor fails.

Two (2) safety valves are installed on instrumentation air cylinder, and a pressure switch for remote indication of pressure, and low-pressure alarm in the control room (ECOS system).

Two (2) safety valves are also provided for compensation instrumentation air cylinder.

In addition, two (2) pressure switches are provided to trigger the unessential air operation cutting, and service lines with set pressure, although two (2) piston valves installed in both air supply lines are driven.

Also two (2) pressure switches are installed in essential air lines to trigger the low pressure alarm in the control room (ECOS system), and to activate ESD partial system at level 3.

This system comprises the following components:

- Two (2) air-dryer units, self-regenerative absorption type, 800 Nm3/h
- One (1) cylindrical vessel for instrument air, 9.5 Nm3 x 980.6 KPa. (static head)
- One (1) cylindrical vessel for instrument air, 9.0 Nm3 x 980.6 KPa. (static head)

### 5.1.3 COMPRESSED AIR SYSTEM OF SERVICE

Two air compressor units to supply the instrumentation air systems and service, and service cylinder, which distributes air to all outlets of engine room, main deck, accommodation space, hydrophore tank and dryer units.

One (1) branched air supply line from air-start system may alternatively supply the instrumentation air system.
One (1) piston valve is provided on service air line to cut air supply when the pressure exceeds the set pressure value.
This system comprises the following components:
- Two (2) centrifugal air compressor units, operated by electric motor, 817 Nm³/h x 980.6 kPa, for instrumentation air and service.
- One (1) air cylindrical vessel of service.

5.2 Blanketing System per Nitrogen

Blanketing system (N2) is comprised of cylinders battery of N2, which distributes inert gas for a new 1 ½” distribution header. This inert gas is distributed for utilities stations and some piece of equipment, and it is used for intervention in vessels and tank, and to purge fuel gas lines when necessary. A N2 generating unit will be installed on board and interconnected to the system.

5.3 SEA WATER CATCHMENT AND ELECTRO CHLORINATION

A new additional seawater system is composed of a centrifugal pump, filters and new consumer of plant process. This is an open circuit capturing water from sea chests, which is sent to the sea after use. This system is responsible for cooling the air conditioning system, auxiliary generator, hydraulic units of pumps, heat exchangers of plates, and hull, tubes, and samples coolers. Seawater is considered when the temperature is up to 29°C for feeding. The water maximum temperature to be discharged into the sea is 40°C.
It is provided a new and unique system of corrosion inhibitor injection, ensuring the seawater quality and avoiding corrosion.
Seawater system is described in utilities diagram and its main equipment is:

**TABLE 24: Seawater System Equipment (including consumers)**

<table>
<thead>
<tr>
<th>TAG</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-511104</td>
<td>SEAWATER CATCHMENT PUMP</td>
</tr>
<tr>
<td>FT-511104</td>
<td>SEAWATER CATCHMENT FILTER</td>
</tr>
<tr>
<td>FT-511105A/B</td>
<td>SEAWATER CATCHMENT DISCHARGE FILTER</td>
</tr>
<tr>
<td>GE-526201</td>
<td>AUXILIARY GENERATOR</td>
</tr>
<tr>
<td>P-122305A/B</td>
<td>OIL COOLER</td>
</tr>
<tr>
<td>P-122307</td>
<td>GAS COOLER</td>
</tr>
<tr>
<td>P-123305</td>
<td>TEG COOLER</td>
</tr>
<tr>
<td>P-533101</td>
<td>PRODUCED WATER COOLER</td>
</tr>
<tr>
<td>P-533601</td>
<td>WASTE COOLER</td>
</tr>
<tr>
<td>UC-122301</td>
<td>AIR COMPRESSION UNIT</td>
</tr>
<tr>
<td>P-UC-122301-01</td>
<td>AIR COMPRESSION UNIT – FIRST STAGE AFTER COOLING</td>
</tr>
<tr>
<td>P-UC-122301-02</td>
<td>AIR COMPRESSION UNIT – SECOND STAGE AFTER COOLING</td>
</tr>
<tr>
<td>P-UC-122301-03</td>
<td>AIR COMPRESSION UNIT – THIRD STAGE AFTER COOLING</td>
</tr>
</tbody>
</table>
5.4 Seawater Distribution

Seawater captured from sea chests by B-511104 and B-511101A/B pumps (for more information on B-511101A/B pumps, please see the manual), passes through a suction filter (2000 µm), then feeds the header of seawater distribution (24”) at temperature of 29°C. After heat exchange with consumers, and eventual pressure loss in the system, the water returns to the header (24”) at temperature of 39°C. Seawater system is controlled by pressure control valve – PV-5111704, which controls the differential pressure between supply and return of consumers, trying to maintain a pressure difference of 150 kPa among them.

Main Details

Operating and design data for equipment are in their respective data sheets; however, a brief description of each piece of equipment is shown below.

5.4.1 Seawater Collection Pump (B-511104)

**TABLE 25: B-511104**

<table>
<thead>
<tr>
<th>Capacity</th>
<th>1550 m³/h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head</td>
<td>58 m</td>
</tr>
<tr>
<td>Type</td>
<td>Horizontal centrifuge</td>
</tr>
<tr>
<td>Power</td>
<td>Electric</td>
</tr>
<tr>
<td>Operational temperature</td>
<td>29°C</td>
</tr>
<tr>
<td>Design temperature</td>
<td>59°C</td>
</tr>
<tr>
<td>Discharge pressure</td>
<td>544 KPag</td>
</tr>
<tr>
<td>Design pressure</td>
<td>912 KPag</td>
</tr>
</tbody>
</table>

Manufacture: Sulzer

On-off valves in pump suction and discharge are interlocked with pump operation, so these valves are open/closed automatically. The pump will only work if on-off valve in its suction is effectively open. XV located at pump discharge is equipped with position indicator, allowing progressive observation in the opening during trigger.

5.4.2 Seawater Collection Filter (FT-511104)

**TABLE 26: FT-511104**
Seawater collection filter is installed in suction of seawater collection pump (B-511104).

5.4.3 Seawater collection discharge filter (FT-511105A/B)

In this case, a filter is the spare of another (2 x 100%). These filters are installed in seawater collection pump discharge (B-511104).

<table>
<thead>
<tr>
<th>TABLE 27: FT-511105A/B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
</tr>
<tr>
<td>Type</td>
</tr>
<tr>
<td>Minimum size of particle retained</td>
</tr>
<tr>
<td>Operational temperature</td>
</tr>
<tr>
<td>Design temperature</td>
</tr>
<tr>
<td>Maximum loss of cargo</td>
</tr>
<tr>
<td>Maximum pressure of entrance</td>
</tr>
<tr>
<td>Design pressure</td>
</tr>
</tbody>
</table>

5.5 DRINKING WATER PRODUCTION UNIT

A current unit connected to an current drinking water distribution system. A pump was installed (B-UD-512202-01) on saltwater entrance of the unit in order to increase and achieve the required pressure provided by Alfa-Laval. The unit produces drinking water with the following characteristics:

- Required capacity of drinking water: 40 m³/d
- Salinity of drinking water (maximum): 2.0 ppm
- pH of drinking water: 7.0
- Installed power: 60 kilowatts

Project Conditions

- Pressure: 1017 kPag
- Temperature: 100°C

Utilities Available
• Salty water:
  • Pressure - Normal/Design: 390/912 kPag
  • Temperature - Normal/Design: 29/59°C
  • Index of Cl⁻: up to 3 ppm
• Compressed Air:
  • Pressure - Normal/Design: 833 kPa g
  • Temperature - Normal/Design: 30/60° C

Conditions of drinking water

• Pressure: maximum of 100 kPag.
• Temperature: 30°C
• Drinking water unit was provided as skid by Alfa-Laval.

5.6 SEWAGE PROCESSING

The existing system of sewage treatment (Z-531201), able to treat sewage of 30 people was replaced by a new one, with capability to treat sewage of 90 people (Z-531202). All collection facilities of waste and treated material discard were performed.

A new sewage collector tank was also installed (TQ-531201), with storage capacity of 6 m³.

The new unit provided by ECAV (model ORCAIIA 500) consists of a transfer pump (B-Z-531202-01), which transfers the waste to be treated from collector tank to treatment unit. In addition to sewage treatment module (Z-531202), an electro chlorination unit is also part of EVAC supply (EU-Z-531202-01A/B), which produces sodium hypochlorite from seawater. This hypochlorite is sent to the treatment unit, where the sewage is treated and disposed in the sea.

5.7 HOT WATER SYSTEM

Hot water system is a closed circuit, where water is heated up to 180°C in the furnace (F-512502) and in heat recovery unit of compressor turbine (WHRU - P-UC-1223201), and then distributed to their consumers in process plant (test heater P-122303 and oil dehydrator heater - P-122310A/B). After heat exchange, the hot water returns to a header at 130°C and it is heated again to 180°C.

The water returns to 130°C, and it is reintroduced into the circuit by hot water circulation pumps (B-5125012A/C).

Liquid expansion is performed on hot water expansion vessel, V-512501, located at the highest point of the system. The vessel is pressurized with air-start to keep the system under high pressure, and hot water in liquid phase. Vessel additional pressure is released to the atmosphere.

The main equipment, which is part of this system, is listed in the table below:
TABLE 28: Hot Water System Equipment

<table>
<thead>
<tr>
<th>Equipment ID</th>
<th>Equipment Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>V-512502</td>
<td>HOT WATER EXPANSION VESSEL</td>
</tr>
<tr>
<td>B-512502A/C</td>
<td>HOT WATER RUNNING PUMP</td>
</tr>
<tr>
<td>P-122303</td>
<td>TEST SEPARATOR HEATER</td>
</tr>
<tr>
<td>P-122310A/B</td>
<td>OIL DEHYDRATOR HEATER</td>
</tr>
<tr>
<td>P-UC-122301</td>
<td>HEAT RECOVERY UNIT OF TURBOCHARGER</td>
</tr>
<tr>
<td>F-512502</td>
<td>HOT WATER FURNACE</td>
</tr>
<tr>
<td>SP-F-512502-01A/B</td>
<td>HOT WATER FURNACE FAN</td>
</tr>
</tbody>
</table>

Main Details

Operating and design data are represented in their respective data sheets; however, a brief description of each equipment is shown below.

5.7.1 Hot Water Expansion Vessel (V-512502)

TABLE 29: V-512502

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total capacity</td>
<td>7.9 m³</td>
</tr>
<tr>
<td>Useful capacity</td>
<td>6.28 m³</td>
</tr>
<tr>
<td>Material</td>
<td>Carbon steel</td>
</tr>
<tr>
<td>Operational temperature</td>
<td>130ºC</td>
</tr>
<tr>
<td>Design temperature</td>
<td>210ºC</td>
</tr>
<tr>
<td>Operational pressure</td>
<td>1100 KPag</td>
</tr>
<tr>
<td>Design pressure</td>
<td>1350 KPag</td>
</tr>
<tr>
<td>Heat insulation</td>
<td>Calcium silicate – 89 mm</td>
</tr>
</tbody>
</table>

Hot water expansion vessel (V-512502) is responsible for maintaining the HW system pressurized, injecting compressed air and relieving the excess to the atmosphere. This vessel is installed at the highest point of the system to allow atmospheric supply of the system.

5.7.2 Hot Water Circulation Pump (B-512502A/C)

TABLE 30: B-512502A/C

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>200 m³/h</td>
</tr>
<tr>
<td>Head</td>
<td>40.8 m</td>
</tr>
<tr>
<td>Type</td>
<td>Centrifuge</td>
</tr>
<tr>
<td>Power</td>
<td>Electric</td>
</tr>
<tr>
<td>Operational temperature</td>
<td>130ºC</td>
</tr>
<tr>
<td>Design temperature</td>
<td>210ºC</td>
</tr>
<tr>
<td>Discharge pressure</td>
<td>1584 KPag</td>
</tr>
<tr>
<td>Design pressure</td>
<td>2150 KPag</td>
</tr>
</tbody>
</table>

These pumps were designed to circulate 200 m³/h each, usually two operate simultaneously, (2 x 50%) and one is spare.
5.7.3 Hot Water Furnace (F-512502)

Hot water furnace (F-512502) is responsible for heating the water returned from process plant, from 130°C to 180°C. This equipment uses natural gas from fuel gas system as main fuel. Furnace temperature is maintained at 180°C by controlling fuel flow, and burning control is performed by regulating the amount of air admitted in the burners. This system has a 1450 kPag operating pressure, a 2000 kPag design pressure and design temperature of 210°C. Hot water design flow in F-512502 must be maintained in 250 m3/h. Equipment provided by (Combustol).

5.7.4 Heat Recovery Unit of Turboblower (WHRU-P-UC-1223201)

WHRU increases fluid temperature circulating inside from 130°C to 180°C. It is a current equipment with design pressure of 1816 KPag and design temperature of 210°C.

5.7.5 Pots for chemical injection

This pot is a vertical cylindrical vessel with 50 liters capacity. This vessel operates with hot water recirculation from hot water pump.

6 ELECTRICAL GENERATION SYSTEM

Main Generator Set – Three (3) main generator set; Model 4R32GD; 1480KW/720rpm and ALRC710LA10 -1600KVA/60Hz/480V/1925A, installed at engine room, to supply normal loads of FPSO; with air-start;

Auxiliary Generator Set – One (1) gas generator set; Model SPW710 – SERIAL NUMBER 135369; 3750KVA/60HZ/4160V/900rpm/520A installed to provide electrical power for underwater electric pumps ESP-01 and ESP-02; with air-start;

Emergency Generator Set – Two (2) Diesel moto generator; Model 3412DITA - 467KW/1800rpm and KATO-400KW; installed outside the engine room and at aft superstructure for emergency generation services; with air-start.

6.1 MAIN GENERATION SYSTEM

GENERAL DESCRIPTION

The main voltage of power supply available on FPSO is:

- 480 VAC, 3-phase, 60 Hz
- 220 VAC, 3-phase, 60 Hz
- 127 VAC, 3-phase, 60 Hz
The main power supply is generated at 480V, 3-phase, 60 Hz, by three (3) sets of diesel generators and such machines are installed in engine room (Main Deck level). Distribution of 480 VAC is performed by PN514001 distribution frame with two (2) distribution busbars. Distribution frame (PN-514001) is composed by:

- 18 feeding drawers with air circuit breakers;
- 3 inputs with air circuit breakers for the main generator;
- 3 feeders for soft start panels for engines with power higher than 100 kW.

Electric motors with rated power below 100 kW are supplied/controlled by engine control panels as PN-514002, PN-514005A, PN-514005B, and PN-514007.

In order to reduce the short-circuit levels; these CCMs are equipped with limiting reactor at its input circuits, except for PN-514007. PN-514005A, PN-514005B are dedicated to provide 480V for ship's service equipment, PN-514002 is dedicated to provide 480V for Process Plant Equipment, and PN-514007 is dedicated to provide 480V for Auxiliary Generator System.

At normal conditions, PN-514001 feeds the fire system equipment through PN-514003 distribution panel, and feeds the essential equipment through PN-514004 panel, by a new limitation reactor (RLC-514004B). PNCR-514004 remote control panel, receives power from PN-514001 panels in normal operations, or from PN-514003 when the emergency generating system is working, and controls when PN-514004 is energized.

The 220V supply system for ship service consumer is obtained by two (2) 100 KVA, 480/220V, 3-phase, 60Hz (TL514001A/TL514001B) transformers, which are supplied by PL-514005A and PL-514005B respectively. The secondary side of these transformers is connected to PL-514002 distribution panel, which has two busbars, one for each transformer. These busbars are interconnected by a circuit breaker, which will not be closed while both transformers are feeding their busbars, avoiding the parallelism of transformers.

One (1) 25 KVA, 480/127V, 3-phase, 60Hz TL-514004 transformer, which is supplied by PN514005B, feeds the systems of 127 V for general use of receptacles.

220V supply system for Process Plant consumer is obtained by two (2) 25 KVA, 480/220V, 3-phase, 60Hz transformers (TL514002A/TL514002B), which are energized by PN514002. The 220V supply system for Process Plant Equipment is obtained by the Process Plant panel of 220V (PL-514021) supplied through a 30kVA, 480/220V, 3-phase, 60Hz transformer (TL-SG-122301), which is supplied by the PN-514002.

Generator control shows the following characteristics:

- Automatic start of diesel generator, in case of charge increased, blackout or failure of diesel generator operation;
- Automatic stop of generator due to failure;
- Automatic synchronization of diesel generator, charge sharing and frequency regulation;
- Monitoring (safety device).
MAIN ELECTRICAL EQUIPMENT

Main electrical equipment connected to the main generation system are:

- Three (3) 1600KVA, 480V, 3-phase (GE514001A/GE514001B/GE514001C) diesel generators
- One (1) 480V (PN514001) distribution panel
- Six (6) 480V (PN514002, PN514005A, PN514005B, PN-514007, PN-514009 and PN514051) motor control centers
- Three (3) (PN-514008A, PN-514008B and PN-514008C) soft start panels
- Two (2) 25KVA, 480/120V, 3-phase TL514002A/TL514002B) dry transformers
- One (1) 30KVA, 480/220V, 3-phase (TL-SG-122301) dry transformers
- One (1) 12.5 KVA, 480/120V, 3-phase (TL514002C) dry transformers
- One (1) 220V distribution panel for main lighting (PL514001) for general service.
- One (1) 127V distribution panel for main lighting (PL514005) for receptacles.
- One (1) 220V distribution panel for main lighting (PL514002) for Process Plant.

6.2 AUXILIARY GENERATION SYSTEM

GENERAL DESCRIPTION

The auxiliary system consists of one (1) gas generator set of 3750KVA, installed on MD03P50 (Module of Auxiliary System). This generator can provide 4160V, 3-phase, 60Hz for distribution panel (PN-526201), which eliminates two (2) BCS pumps (ESP-01 and ESP-02) through frequency inverters, CF-124301 and CF-124302, respectively.

The medium voltage system is powered by the auxiliary generator GE-526201 activated by gas.

Before starting the auxiliary generator, the distribution panel of medium voltage will be energized by PN-514001 through a power transformer TF-514001, which is a power supply to start a BCS pump.

MAIN ELECTRICAL EQUIPMENT

- One (1) gas generator 3750KVA, 4160V, 3 phase (GE-526201)
- One (1) power transformer 480/4160V, 3 phases, 60Hz (TF-514001)
- One (1) auxiliary distribution panel 4160V (PN-526201)
- Two (2) frequency inverters 4160V (CF-124301 and CF-124302)
- Two (2) BCS electrical pumps (ESP-01 and ESP-02)

Note: This system is decommissioned and out of operation.
6.3 EMERGENCY GENERATING SYSTEM

DESCRIPTION

The emergency generation system consists of two (2) diesel generator sets of 500KVA, installed in Emergency Generator Room. These generators may provide 480V, 3-phase, 60Hz for distribution panel (PN-514003), which feeds (2) firefighting pumps and CCMs (motor control center) for essential charges (PN-514004, in case the main generating system fails and PN-514006). CCM PN-514004 supplies CCM PN-514010.

In case of main generation system failure, the emergency diesel generator will automatically start and supply the distribution panel (PN-514003) and this panel will power PN-514004 panel through PN-CR-514004.

The 220V emergency generation power supply for ship's service consumers is obtained by two (2) 45KVA, 460/220V, 3-phase, 60Hz (TL-514003A/TL-514003B) transformers, energized by PN-514004. The secondary sides of these transformers are connected to distribution panels (PL-514003 and PL-514004), respectively.

In case of failure on the emergency power supply, the DC auxiliary power will provide enough energy for special consumers, those who must keep working.

The auxiliary DC power supply is available in three voltage levels, 24VDC, 48VDC and 125VDC.

24VDC power supply system is obtained by four (4) battery chargers/rectifiers, divided into two (2) sets, one set (CB514001A and CB514001B) for ship service charges and the other (CB-514001C and CB-514001D) for process plant charges.

In addition to the above described, there is another 24VDC power supply for radio console system (CB-551003 and CB-551004).

48VDC power supply system is obtained by one (1) battery charger/rectifier (CB-551002), for exclusive use of intercom system (TELECOM).

48VDC power supply system is obtained by one (1) battery charger/rectifier (CB-551001), which supplies the PABX telephone system, broadband and narrowband (TELECOM).

125VDC power supply system is obtained by two (2) battery chargers/rectifier (CB-514002A and CB-514002B), which supplies the air circuit breakers control in (PN514001 and PN-514003) panels, and navigation auxiliary system. The new 125Vcc power supply system is obtained by two (2) battery chargers/rectifier (CB-514002C and CB-514002D), which supplies the air circuit breakers control in PN-526201, PN-GE-526201 and JBDC-TO-122301 panels.

All battery chargers/rectifier mentioned above are energized in 480V of PN-5144058, except for CB-551001 and CB-551002, which are supplied in 220V by QCA551001, CB-514003 and CB-514004, which in turn are supplied in 220V by QCA-551003 and QCA-551004, respectively.

The lighting system is supplied by six (6) uninterruptible power supplies (UPS), with 30 minute autonomy to supply lamps under emergency conditions, such as failure in emergency power supply and ship abandonment.
Feedback power supply device from PN514003 to PN514001 works to allow by key frame: S1 provided in the main distribution panel (PN514003) to the corresponding position (FEEDBACK). This maneuver is possible due to the 480V (PN514001) distribution panel if any main generators do not power it.

**MAIN ELECTRICAL EQUIPMENT**

- Two (2) 500KVA, 480V, 3-phase diesel generators
- One (1) 480V (PN514003) essential distribution panel
- Four (4) 480V (PN514004, PN514006, PN514010 and PN514057) motor control centers
- Two (2) 45KVA, 480V/220V (TL514003A and TL514003B) transformers
- Two (2) 220V lighting distribution panels
- Four (4) (UPS) 4.5 KVA uninterruptible power supplies
- Two (2) (UPS) 10 KVA uninterruptible power supplies
- Four (4) battery chargers/rectifiers 24V/200A (CB514001A, CB514001B, CB514001C and CB514001D)
- Four (4) battery chargers/rectifiers 125V/50A (CB514002A, CB514002B, CB514002C and CB514002D)
- Two (2) battery chargers/rectifiers 48V/30A (CB551001 and CB551002)
- Two (2) battery chargers/rectifiers 24V/20A (CB551003 and CB551004)
- Two (2) UPS of ECOS 120VAC/292A (CB-514401A, CB-514401B)
- One (1) Telecom transformers of 45KVA, 480/220V (TL-551001)
- Two (2) battery chargers/rectifiers 24VDC/250A (CB-GE-514002A, CB-GE-514002B).

**7 OIL AND BALLAST LOADING SYSTEM**

**7.1 OIL LOADING SYSTEM**

FPSO is equipped with processed oil load and unload systems, consisting of the following equipment:

- Three (3) Cargo pumps: Diesel Engine, Horizontal, Centrifugal 1000 m3 x 120 mTH
- One (1) Drain and Sewage Pump: electric engine, Horizontal, Alternative 20 m3/h x 30 mTH
- Two (2) Cargo Eductors: Driven by water/oil, 200 m3 x 180 mTH
- One (1) Tank Cleaning Heater: Horizontal, Approx. 200 m3/h

The system was designed to transfer the volume of 50,000 m3 of processed oil for 24 hours, through the three oil cargo pumps specified above for shuttle tanker.
Essential valves installed in oil cargo tanks, slop tanks and Pumps Room, including the main deck, is operated remotely from the Control Room, through ECOS system. Processed oil load and unload operations are performed simultaneously or independently, using selected pipelines from cargo tanks segregation, according to sequential program of each operation.

7.2 BALLAST SYSTEM

F.P.S.O contains five (5) ballast tanks distributed as follows:

- No. 3 W.B.T. (BB/BE) in cargo area
- W.B.T. Deep Tank (BB/BE) at Engine Room
- Collision Tank at Aft;

Total capacity of ballast tanks is approximately 5.128 m³. Ballast system consists of the following equipment:

- One (1) Ballast Water Pump: Electric Engine, Vertical, Centrifugal 125 m³/h x 95 m TH
- One (1) Cleaning Tank: Electric Engine, Vertical, Centrifugal Water Pump of 125 m³/h x 120 m TH
- Two (2) Ballast Eductors: Driven by water, 100 m³/h

Ballasting and/or deballasting operations are simultaneously performed during loading and/or unloading operations to ensure structural stability and integrity in accordance with sequential program.

8 FAN AND AIR CONDITIONING SYSTEM

8.1 FAN SYSTEM

Ventilation ducts system distributes fresh air to compartments with damper and flaps control to adjust the volume of airflow. Fans are operated by ECOS system in the Control Room, on ships deck, within aft accommodation. In case of fire, fans will switch off and dampers will close automatically.

All inputs are monitored by gas detectors with voting logical criteria of two-by-two monitor all air input. Smoke detectors are connected to addressable fire detection system, and are located on refrigerator (2), on panel rooms 1 and 2 (4), at Museum (2), on PLC room (2), and in Telecom/UPS room (2).

Ventilation system consists of fans in different locations:
<table>
<thead>
<tr>
<th>Compartment</th>
<th>Ventilation System</th>
<th>Qty. of fans</th>
<th>Facility Location</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storehouse</td>
<td>VE-525143</td>
<td>-</td>
<td>Except kitchen storeroom</td>
<td></td>
</tr>
<tr>
<td>Storeroom No. 1 &amp; 2 kiosk &amp;</td>
<td>Vent Natural.</td>
<td>-</td>
<td>Upper deck (aft superstructure)</td>
<td>Supply of A/C for kiosk and electrical</td>
</tr>
<tr>
<td>electrical equipment room</td>
<td>Ex. Mechanic.</td>
<td>1 x axial fan VE 525144</td>
<td>-</td>
<td>equipment room</td>
</tr>
<tr>
<td>Dressing room, bathroom,</td>
<td>Vent Natural.</td>
<td>-</td>
<td>Upper deck (aft superstructure)</td>
<td>-</td>
</tr>
<tr>
<td>washbasin</td>
<td>Ex. Mechanic.</td>
<td>1 x axial fan VE 525145</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Laboratory and tools workshop</td>
<td>Vent Natural.</td>
<td>-</td>
<td>Upper deck (aft superstructure)</td>
<td>Supply of A/C for each room</td>
</tr>
<tr>
<td>Laundry &amp; clothing storeroom</td>
<td>Vent Natural.</td>
<td>-</td>
<td>Ship deck (aft superstructure)</td>
<td>Supply of additional A/C for laundry</td>
</tr>
<tr>
<td>Air conditioning room,</td>
<td>Vent Natural.</td>
<td>-</td>
<td>Ship deck (aft superstructure)</td>
<td></td>
</tr>
<tr>
<td>hydraulic pump room,</td>
<td>Ex. Mechanic.</td>
<td>1 x axial fan VE 525148</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>storeroom No. 4 &amp; 5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital and care room</td>
<td>Vent Natural.</td>
<td>-</td>
<td>Ship deck (aft superstructure)</td>
<td></td>
</tr>
<tr>
<td>2nd deck, washbasin unit &amp;</td>
<td>Ex. Mechanic.</td>
<td>1 x axial fan VE 525149</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>port restroom</td>
<td>Vent Natural.</td>
<td>-</td>
<td>Ship deck (aft superstructure)</td>
<td></td>
</tr>
<tr>
<td>2nd deck, washbasin unit &amp;</td>
<td>Ex. Mechanic.</td>
<td>1 x axial fan VE 525150</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>starboard restroom</td>
<td>Vent Natural.</td>
<td>-</td>
<td>Ship deck (aft superstructure)</td>
<td></td>
</tr>
<tr>
<td>Compartment for Garbage CO2 room</td>
<td>Ex. Mechanic.</td>
<td>1 x axial fan VE 525151</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vent Natural.</td>
<td>-</td>
<td>Ship deck (aft superstructure)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ex. Mechanic.</td>
<td>1 x axial fan VE 525152</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vent Natural.</td>
<td>-</td>
<td>Ship deck (aft superstructure)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ex. Mechanic.</td>
<td>1 x axial fan VE 525153</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Cables Storeroom</td>
<td>Vent Natural.</td>
<td>-</td>
<td>Ship deck (aft superstructure)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ex. Mechanic.</td>
<td>1 x axial fan VE 525154</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Storeroom No. 13</td>
<td>Vent Natural.</td>
<td>-</td>
<td>Main deck (aft superstructure)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ex. Mechanic.</td>
<td>1 x axial fan VE 525154</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>CO2 room</td>
<td>Vent Natural.</td>
<td>-</td>
<td>Castle deck</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ex. Mechanic.</td>
<td>1 x axial fan VE 525155</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Compartment for Garbage CO2 room</td>
<td>Vent Natural.</td>
<td>-</td>
<td>Ship deck (aft superstructure)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ex. Mechanic.</td>
<td>1 x axial fan VE 525156</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Compartment</td>
<td>Ventilation system</td>
<td>Qty. of fans</td>
<td>Facility location</td>
<td>Note</td>
</tr>
<tr>
<td>-------------</td>
<td>--------------------</td>
<td>--------------</td>
<td>------------------</td>
<td>------</td>
</tr>
<tr>
<td>Paint, cargo equipment, foam, amidship superstructure storeroom</td>
<td>Vent</td>
<td>Mechanic.</td>
<td>1 X Axial fan VE 525115</td>
<td>Upper deck (amidship superstructure)</td>
</tr>
<tr>
<td>Storeroom No. 8&amp; 9</td>
<td>Vent</td>
<td>Mechanic.</td>
<td>1 X Axial fan VE 525116</td>
<td>Upper deck (amidship superstructure)</td>
</tr>
<tr>
<td>Upper deck compartment of amidship superstructure</td>
<td>Vent</td>
<td>Mechanic.</td>
<td>1 X Axial fan VE 525117</td>
<td>Upper deck (amidship superstructure)</td>
</tr>
<tr>
<td>Weld workshop</td>
<td>Vent</td>
<td>Mechanic.</td>
<td>2 X fan/centrifuge VT 525452 A/B</td>
<td>Ceiling of weld room 2x50%</td>
</tr>
<tr>
<td>Auxiliary generator room</td>
<td>Vent</td>
<td>Mechanic.</td>
<td>2 X fan/centrifuge VT 525452 A/B</td>
<td>Ceiling of weld room 2x50%</td>
</tr>
<tr>
<td>Air exhaust of panels room No. 2</td>
<td>Vent</td>
<td>Mechanic.</td>
<td>1 X Axial fan EXT-525559</td>
<td></td>
</tr>
<tr>
<td>Air exhaust of panels room No. 1</td>
<td>Vent</td>
<td>Mechanic.</td>
<td>2 X FAN/CENTRIFUGE VT 525457 A/B</td>
<td></td>
</tr>
<tr>
<td>Air supply of panels room No.. 1&amp;2</td>
<td>Vent</td>
<td>Mechanic.</td>
<td>1 X BOXES OF FAN VT-525456</td>
<td></td>
</tr>
<tr>
<td>Refrigerator</td>
<td>Vent</td>
<td>Mechanic.</td>
<td>2 X Axial fan EXT-52554 A/B</td>
<td></td>
</tr>
<tr>
<td>Air exhaust of gas piping system of double wall</td>
<td>Vent</td>
<td>Mechanic.</td>
<td>1 X Axial fan EXT-525453 A/B</td>
<td></td>
</tr>
<tr>
<td>Fire water pump</td>
<td>Vent</td>
<td>Mechanic.</td>
<td>2 X Axial fan EXT-52553 A/B</td>
<td></td>
</tr>
</tbody>
</table>

8.2 AIR CONDITIONING SYSTEM

8.2.1 AFT ACCOMMODATIONS SPACE

Two (2) air conditioning units are installed in the air conditioning room of main deck, where one (1) unit is operated as stand-by (VE-AC-525201A/B).
Two (2) cooling plants R-134a (C-AC-525201A/B) are installed in the engine room, on second Deck, where one (1) is operated as stand-by.

In case of failure on air conditioning units, the emergency cooling from Control Room is supplied immediately by the Emergency Air Conditioning, activated from Control Room, and this unit consists of one (1) air conditioning R-134a as condensing unit (C-CA-525203) and two (2) Fan-Coil units (VE-AC-525203A/B), and no fresh air is provided. This equipment is installed at aft accommodation space on ships deck.

8.2.2 REPEAT ROOM

Two (2) air-conditioning unit sets are installed to repeat room, and each set consists of one (1) R-134a air chilling condenser unit, and one (1) set of cooling fan unit, and one (1) set of two units for use as stand-by.
Condensing units (C-AC-525202A/B) are installed on gangway deck, and fan-coil units (VE-AC-525202A/B) are installed at repeat room on ships deck of midship accommodation space. Fresh air is provided by mechanical ventilation (VE-525117).

8.2.3 PANELS ROOM OF MAIN GENERATOR

An air conditioning system was installed – four split air conditioners (AC-525252 A/B/C/D).
Evaporation unit installed indoors, near the ceiling, and below cable tray, along transverse bulkheads.
Condensing units, as cooling water-type, are installed outside and close to the room in the existent Storeroom No. 1.

8.2.4 ELECTRICAL PANELS ROOM

The room, located on the elev. 26183 in auxiliary gas generator module, is supplied by two independent units of cooling by water, where one is a spare (AC-525251 A/B), installed at VAC room, located on the elev. 30483 above electrical panels room.

A duct provided with a drop eliminator, at outer end, and regulation and tight dampers, located at the inner end of VAC room, take external air for renewal and pressurization.
The return air will be aspirated by two ways:
Gratings located on the bottom and on the sides of a duct installed parallel to longitudinal axis of the room;
Through frequency oscillators panels CF-124301 and CF-124302. These panels are provided with internal extraction fans. The air enters through the panel openings, cooling electrical devices, and then is aspirated by internal fans and unloaded in two outputs. A duct for return duct connects an output, and the other output discharges the air directly into the room, being aspirated through gratings.

9 DIESEL FUEL SYSTEM SERVICE

Diesel fuel is supplied from service tank and supplies three (3) main diesel generators, three (3) oil charge pumps with diesel engine, and pump of hot water furnace.
Diesel fuel cooler is installed in diesel fuel return line for diesel engine of main generator.
Two (2) different outputs are provided in diesel fuel service tank, with flow meter to control diesel fuel consumption of main generators, charge pumps and hot water furnace.
In case of an emergency, diesel engines of main generator will be supplied directly from storage tanks.
This system comprises the following components:
• One (1) 7.0 m³ diesel fuel service tank
• One (1) 29.05 kW diesel fuel cooler

9.1 TRANSFER SYSTEM AND DIESEL FUEL PURIFICATION

Diesel fuel is stored in four (4) tanks, two (2) are located in the double bottom, and the other two (2) tanks are located under the second deck at Engine Room. Safety valves are installed in diesel fuel filling lines with overflow lines, carrying to overflow tank at Engine Room.

Two (2) transfer pumps are installed to transfer diesel fuel from storage tank to sedimentation tank.

In case of an emergency, it is possible to transfer diesel fuel directly from storage tank to service tank, and may be transfer from storage tanks to diesel tank of emergency generator.

All diesel fuel storage tanks are equipped with level transmitters.

Overflow tanks are designed to receive the drainage of sedimentation tank or a possible overflow.

Two (2) diesel fuel purifiers, and two (2) purifiers supply pumps are installed to transfer purified diesel fuel from sedimentation tank to service tank continuously, and overflowed oil returns to sedimentation tank.

Diesel fuel purifiers are automatic self-cleaning by adequate control of unloading.

This system comprises the following components:

• Two (2) sets of diesel fuel transfer pump, horizontal screw, 9.0 m³ x 50 mTH
• Two (2) sets of diesel fuel purifiers, electric motorized, bucket disc centrifugal, 200 l/h capacity
• One (1) set of electric heater, diesel fuel purifier, 2000 l/h capacity
• Two (2) sets of supply pumps of diesel fuel purifier, 2.0 m³/h capacity
• One (1) 7.0 m³ diesel fuel sedimentation tank
• One (1) 7.0 m³ diesel fuel service tank
• Two (2) 133.6 m³ diesel fuel storage tanks
• Two (2) 106 m³ and 55 m³ diesel fuel storage tanks (each)
• One (1) 13.1 m³ diesel fuel overflow tank

10 LUBE OIL SYSTEM

Lube oil system is supplied from two (2) lube oil storage tanks for main engine generators, engines collector tank of main generators by gravity, and also one (1) lube oil storage tank to supply diesel engines of cargo pumps.

In addition to the above mentioned, diesel fuel storage tanks are provided to supply some equipment as air conditioning compressors and air compressors.

Lube oil drainage can be unloading from crankcase of diesel engines of the main generators, and cargo pumps by lube oil pump, and discharge pipes
installed close to funnel, which connects the pump discharge output with drainage line through a rubber hose.

This system comprises the following components:

- Two (2) lube oil storage tanks for 6.0 m$^3$ and 7.0 m$^3$ generator engines (each)
- Three (3) 1.0 m$^3$ lube oil tank
- One (1) tank with 0.22 m$^3$ lube oil
- One (1) lube oil tank for 0.22 m$^3$ air conditioning compressor
- One (1) lube oil tank for 1.0 m$^3$ emergency engine generator
- One (1) lube oil tank for 1.0 m$^3$ air compressor unit

11 COOLING SYSTEM

11.1 SEAWATER COOLING SYSTEM

Three (3) seawater cooling pumps are installed to distribute seawater (the document K4000104 – Seawater/Freshwater Distribution Table is used for proper operating condition) for freshwater generator and cooler of high and low (final discharge to the sea). Seawater suction may be performed apart by sea chests port or starboard by crossover installed between them. Pressure switches are installed on the side of discharges of each seawater-cooling pump, for an automatic change in case of low pressure (stand-by function).

Starting/stop operation and/or stand-by is performed remotely from control room (ECOS system).

A lift pump of “A” seawater performs emergency sewage suction from engine room.

Electro-chlorination unit is provided for sea chests in the following locations:

- Engine room (one at port and another at starboard)
- Emergency fire pump room (one at port and another at starboard)
- Cargo pumps room (at port)
- A flow meter is provided in each seawater line connected to sea chests.
- Two (2) lift pumps for seawater will provide cooled seawater for process plant.

This system comprises the following components:

- Three (3) seawater cooling pumps, vertical, centrifugal, 180 m$^3$/hx 25 mTH
- Two (2) lift pumps for seawater, vertical, centrifugal, 850 m$^3$/hx 62 mTH
- One (1) chlorination unit (hypochlorite solution), 5 m$^3$/h.

11.2 LOW TEMPERATURE FRESHWATER COOLING SYSTEM

Two (2) freshwater coolers of low-temperature are provided for freshwater cooling, which is surrounded by three (3) freshwater pumps under low
temperature according to operating conditions specified in the design: "Seawater/Freshwater Distribution Table" – K4000104.
Pressure switch is installed in freshwater cooling pump discharge for low temperature, and automatically triggers the change of pumps function in case of low pressure.
Functions selection of starting/stop and stand-by is performed remotely from control room (ECOS system).
A temperature control device, measuring the temperature at coolers output, controls freshwater flow passing through coolers.
Pressure control valve is installed to keep freshwater pressure through the main engine generator.
Low temperature freshwater expansion tank is installed to complete the system, and to be used as a desander. An additive tank is also installed to add different additives to the system.
Freshwater in low temperature is circulated in air coolers of the main generators, lube oil coolers, and diesel fuel of the main engine generators, air compressors instrumentation, and service air, condensers of air conditioning units, and high temperature freshwater coolers for diesel engines oil of cargo pumps.
Circulation cooling pump is used to mix additives in freshwater cooling system of low and high temperatures.
Plates with orifice are installed in suitable locations of the system to control each customer flow capacity.
Cooling freshwater drainage tanks are provided to collect the drain and treated freshwater.
This system comprises the following components:

- Three (3) vertical pumps of low temperature freshwater cooling, 200 m$^3$/h x 25 mTH centrifugal
- Two (2) low temperature freshwater coolers, plate-type, 2870 Mcal/h
- One (1) freshwater cooling circulation pump, 3.0 m$^3$/h x 40 mTH
- One (1) low temperature expansion tank, 1.0 m$^3$
- One (1) additive tank, 0.5 m$^3$
- One (1) cooling freshwater drainage tank, 68.7 m$^3$

### 11.3 HIGH TEMPERATURE FRESHWATER COOLING SYSTEM

High temperature freshwater cooling system provides water for cooling the engine liner of diesel generators by using diesel engine pump only (for proper operating condition of this pump, refer to document Dwg. K4000104 – Seawater/Freshwater Distribution Table). Freshwater heating unit of diesel engine is utilized to preheat water for stopped diesel engines.
Freshwater expansion tank of high temperature is installed to complete the system and to be used as a desander.
In addition, there are two (2) high temperature freshwater cooler for cooling system, and three (3) oil cargo pumps driven by diesel engines, incorporated with an adequate independent system of high temperature freshwater cooling.
This system comprises the following components:
• Two (2) high temperature freshwater coolers, plate-type, 904.4 Mcal/h
• One (1) freshwater heating unit with diesel engine of 8.0 m$^3$
• One (1) high temperature freshwater expansion tank, 1.0 m$^3$

11.4 FRESHWATER, DRINKING WATER AND HOT WATER SYSTEMS

Three (3) freshwater tanks are planned for storage, including two (2) hydrophore pumps and hydrophore tank of freshwater. Two (2) pressure switches are installed in hydrophore tank of freshwater to control starting/stopping operations of hydrophore pumps to certain pressures. Connection valves of freshwater hoses are provided in Engine Room (in four different places).

Freshwater hydrophore system supplies the diesel fuel system and washers devise of compressor turbo of diesel engine of main generator.

One (1) washbasin with taps is planned for the workshop, in Engine Room to receive fresh and hot water.

One (1) freshwater transfer pump is installed for freshwater supply, and it may provide freshwater for hydrophore tank as an alternative.

Freshwater produced by freshwater generator supplies three (3) freshwater tanks and two (2) expansion tanks (low and high).

Cold freshwater of service is provided to all taps and showers of bathrooms. Drinking water is produced from water in the freshwater tank, supplied to mixers of bathrooms, washbasin, showers and kitchen appliances, and washbasin of accommodation areas through treatment by UV sterilization unit.

In addition, hot water is supplied to mixers of bathrooms, bedrooms and washbasin, showers, and kitchens utilities through electrical water heaters.

This system comprises the following components:

• Two (2) freshwater hydrophore pumps, 10 m$^3$/h x 40 mTH
• One (1) freshwater transfer pump, 10 m$^3$/h x 40 mTH
• Two (2) electrical sterilizers of 30 m$^3$/h
• One (1) electric water heater, 1.000 l/h
• One (1) freshwater hydrophore tank of 1.5 m$^3$
• Three (3) freshwater tank of 142.6 m$^3$, 136.8 m$^3$ and 216.4 m$^3$ (each)

11.5 SEAWATER SYSTEM FOR GENERAL SERVICES

One (1) general service pump is provided to distribute seawater for all systems of the general services in engine room and pool, and also for drains and scuppers cleaning of accommodations areas.

General Service pump may be operated alternately for sewage suction and oily sewage service, and must be discharged into the oily water tank (for operation details, see sewage system description).

This system comprises the following components:

• One (1) vertical pump of general services, electrical engine and centrifugal, 110 m$^3$/h x 35 mTH
12 SEWAGE SYSTEM

Three (3) bilge wells are installed in Engine Room (port, starboard and aft), with level alarms for starting/stop automatic command of sewage pump operation, and the sewage of emergency fire pump room can be removed by sewage pump as well.

Sewage pumps transfer oily water for dirty oil tank, oily water tank, slop tank (port), or discharges for ground connection.

In addition, the sewage pump may remove sewage from dirty oil tank, oily water tank, and bilge wells, fore cofferdam, freshwater cooler drain tank, and seawater through crossover line.

Alternatively, to sewage suction of bilge wells, fore cofferdam, and freshwater cooler drain tank can be performed by general service pump or seawater cooling pump.

Oily water transfer from dirty oil tank to ground connection or slop tank (port) can be performed by dirty oil transfer pump.

All sludge from diesel fuel purifying is discharged into oily water tank.

Water and oil separator is incorporated to sewage system according to requirements of IMO antipollution.

Sewage accumulated in cables storeroom, and access to fire pumps room is discharged by gravity through two (2) self-closing valves for aft sump in Engine Room.

This system comprises the following components:

- One (1) sewage pump as piston, vertical, electrical, of 30 m$^3$ x 25 mTH
- One (1) dirty oil transfer pump, horizontal, screw type,
  - of 12.3 m$^3$ x 40 mTH
- One (1) centrifugal pump, electrical engine, vertical, 110 m$^3$/h x 35 mTH
- One (1) centrifugal pump, electrical engine, vertical 180 m$^3$/h x 25 mTH
- One (1) water and oil separator of 2.5 t/h
- One (1) dirty oil tank with 18.7 m$^3$
- One (1) oily water tank of 29.6 m$^3$
- One (1) freshwater cooling tank of 68.9 m$^3$

13 FIREFIGHTING SYSTEM BY SALTWATER

The main fire line conducted through the main deck and deckhouses provides the water utilized in this system.

The current fire water supply system follows the following configuration:

- First pump set:
  A diesel-hydraulic unit of fire water pumping (UB-542001).
  *Booster* pump is installed in a dedicated Fire Pumps Room, whose arrangement is in accordance with SOLAS, Chapter II-2, Regulation 4, paragraphs 3.3.2.6 to 3.3.2.8. Lift pump is submerged and installed in a camera inserted in the hull. The pump has a design capacity of 1200 m$^3$/h (100% of fire water demand).
• Second pump set:
  Two electrical fire pumps (B-542001 A/B), installed on Fire Pump Room. Each pump has a design capacity of 300 m³/h (25% of firewater demand).

• Third pump set:
  Two electrical fire pumps (B-542002 A/B) are installed on Fire Pump Room. Each pump has a design capacity of 300 m³/h (25% of the new firewater demand).

Fire pumps sets are operated as described below:

• Automatic operation:
  * Signal from the low pressure switch installed in the main line of fire;
  * Signal of fire detection system installed in the Turret and in process area.
  * Signal from pressure switch installed in each ADV fuse plug in the self-deluge net system.

• Manual Operation:
  * From fire control room (ECOS System)
  * On site

This system comprises the following components:

a) Fire Pumps
   Four (4) pumps (centrifugal, driven by electrical motor) of 300 m³/h, and one (1) diesel-hydraulic unit of firewater pump of 200 m³/h. The first pump set is the main use, and the second and third sets are in stand-by use.

b) Booster pumps (seawater lifting pump)
   Two (2) pumps (vertical, centrifugal, driven by electrical engine) of 850 m³/h x 62 m TH to pressurize the main line of fire ("Main Ring") in the main deck.

c) Consumption System
   This system is connected directly to the main ring and comprises the following elements:

   • Deluge System:
     Branches controlled by ADVs (deluge automatic valves), opened manually, or by fuse plug net, UV + IR sensors (for the Turret and process area) installed on processes equipment with fire hazard due to the use of flammable liquids.

   • Hydrants:
     Manual opening branches, working with 15m fire hoses. It is distributed, so that all points of FPSO (accommodation space, process plant and service area) are protected by two (2) hydrants (one up to 15 m distance...
and the other up to 30 m distance), at least, according to Rule requirements.

- **Water Monitors:**
  Two (2) self-oscillating water monitors with 2000 l/min. x 7.0 kg/cm² are installed for Turret protection, in the area in front of castle deck. These monitors may be opened manually.
  One (1) water monitor of manual operation, with 2000 l/min. x 7.0 kg/cm², is installed on vessels deck, within aft accommodation, for offloading station protection and gas manifold area.
  One (1) water monitor of manual operation, with 2000 l/min. x 7.0 kg/cm², is installed in the process plant for equipment protection with fire hazard, due to the use of flammable liquids.

13.1 **FIREFIGHTING SYSTEM BY FOAM**

The fixed system of fire-fighting by foam is provided for fire-fighting on the main deck, above cargo tanks and helipad.

The system is designed so that the foam and seawater mixture supplied by fire pumps, will be performed in the proportioner installed in the foam tank, and the mixture is carried through the independent line of foam, for foam monitors and/or foam sprinklers in the main deck (and in areas under the process plant platform).

On monitor and/or foam sprinkler output, the mixture will be a perfect foam, which may protect the material flame surface, and isolated it from atmosphere.

The solution is 3% and foam tanks are installed in the deckhouses midship (2000 l), and in hydraulic power room (1000 l) respectively, and combined with fire pumps.

Foam piping lines are usually filled with seawater and pressurized, and foam mixture discharge may be released remotely as follows:

- Foam system for cargo tank – press the button on control room of protection area
- Foam system for helipad protection – valves of three (3) lines located in helipad.

Besides foam fixed monitors, foam mobile applicators are also provided for cargo tank protection. Foam mobile applicators are stored on fire-fighting equipment locker, near foam hydrant, with one (1) hoses set of 18m.

13.2 **FIREFIGHTING SYSTEM BY DELUGE**

Water spray deluge system is installed aiming at cooling the equipment surface, piping and electrical cables to prevent its collapse and damage caused by excessive heat due to fire.

Automated deluge system is installed for the following classified areas:

- Process Plant (3 zones)
Protected areas in FPSO are divided into five (5) classified areas, and water consumption of each area is determined according to the area it serves. Automatic deluge valves (ADV) are installed in accessible points of each area, classified for manual operation to allow quick and easy access to these valves in case of fire. Firewater application flow is in accordance with NFPA-15, including the following additions:

### Table 32: Fire-Fighting System

<table>
<thead>
<tr>
<th>Accessories</th>
<th>Flow (l/min.m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flammable fluid pumps, ESD valves</td>
<td>20.4</td>
</tr>
<tr>
<td>Cable tray</td>
<td>6.1</td>
</tr>
<tr>
<td>Cases not covered by NFPA-15</td>
<td>10.2</td>
</tr>
</tbody>
</table>

A plug fuse of pressurized net is installed for each area classified above, in order to operate the quick automatic opening of deluge valve and seawater release in case of fire, as well as the operation of an automatic deluge valve in turret area, which is connected to UV + IR sensors of fire detection system instead of a fuse plug. When low-pressure switches are installed, the plug fuse operates by triggering the fire pump, and sounding the low pressure alarm of ECOS system. Automatic deluge valve operation is confirmed by opening alarms and indication in ECOS system.

### 13.3 CO2 FIXED SYSTEM

This system is used in places where firefighting products must be inert to electricity (electric panel room, transformers, switchgear, electrical and rotating equipment), in enclosed areas containing flammable materials such as paper, wood, paints and fabric; specific equipment, such as gears using flammable fuel liquids, and places containing hazardous solids. Dispersion is performed by dispersing nozzles distributed in enclosure space or around hazardous area of protected compartments. Battery dimension is based on gas demand of the largest protected compartment, but does not consider two simultaneous occurrences of utilization. CO2 distribution into protected compartment is performed by directional valves installed in distribution ducts, and it can be remotely operated by button and manually operated by lever locally. Cylinders are divided in groups for all protected rooms to receive adequate volume of CO2. Pilot cylinders for each group has a control valve operated manually or electrically, and activated to release a cylinders group of the room or affected area by fire incident. Each group of CO2 cylinders is divided in sub-groups of check valves, in order to allow the protection of diverse compartments as discriminated by "Fire Zone."
Each subgroup of CO2 cylinders have two pilot cylinders, equipped with electrical release system for remote operation, and lever for manual operation to open CO2 bottles in protected compartments.
For all compartments protected by CO2 firefighting system, CO2 release will be activated through the following devices:

- Manual/remote release: Trigger the release button located outside the protected compartments (near the door);
- Manual/remote release: Trigger the button on PLC panel (PN-540001) at Control Room;

Ps.: Local batteries have no manual remote release in control room.

CO2 release is preceded by CO2 deluge operation alarm installed in their compartment, and this alarm (intermittent siren) is sounded for 20 seconds prior to CO2 release in the protected compartment.
In addition to the above release devices, a rotary alarm is installed in a visible place, and alert on CO2 release for protected compartment, such as engine room, pump room, generator room, and fire pumps room. This warning light is activated by a signal sent from PLC. Each compartment protected by CO2 system is provided with a warning light, installed under a warning sign with the following words, placed as close as possible to the access door from outside of protected compartment.
"Do not enter when the light is flashing. Area flooded with CO2"
Pressure switch is installed downstream of each directional valve, in collecting pipes to control the CO2 release, and confirm CO2 normal system operation. In case of CO2 manual release by lever, a limiter installed in directional valve and in pilot cylinder will activate the local alarm of CO2 flooding.
Alarm signal should be adequate to alert people employed anywhere of protected compartment, and be clearly audible when auxiliary machines are in operation.

Manual or remote operation of system release of CO2 flooding is interconnected with fans and dampers control, which must be absolutely stopped and closed by a signal sent through a limit switch by PLC before CO2 release in protected compartments.
In addition, access doors to each protected compartment have an audible alarm switch in the control room (ECOS system), indicating whether the corresponding door is not closed within a 20-second interval.

CO2 fixed system of firefighting consists of the following amount of CO2 cylinders (main and spare) of 45 kg.

- Two (2) groups of 90 cylinders each, stored in CO2 room, aft of accommodation;
- Two (2) groups of 4 cylinders each, stored in CO2 room, within midship accommodation;
- One (1) group of 13 cylinders, stored in CO2 room, in the process area.
• Oven, exhaust fan and filters – Total of two CO2 cylinders (main and spare)
• Ventilation system – Total of four CO2 cylinders (main and spare)
• Hood of turbocharger (UC-122301) – Total of twelve CO2 cylinders (main and spare)
• Places with alternated noise (UC-122303) – two CO2 cylinders.

13.4 GAS DETECTION SYSTEM

The gas detection system in FPSO is designed to provide an early warning of flammable gases presence by using electrocatalytic sensors. In process plant (hazardous area), gas detectors are installed in sets of 3 units, following 2 to 3 logical criteria. In accommodations, gas detectors are installed in air ventilation entrance with 2 to 2 logical criteria. E.g.: Kitchen (four detectors are installed, where two of them is in each air ventilation entrance). Detectors are calibrated between 20% and 60% of the lower explosive limit (LEL).
An operation of a single sensor indicating a concentration of 20% or 60% of LEL, so the gas will be defined as one warning in the main control room. Simultaneous operation of two sensors indicating a concentration of 60% of LEL for gas will confirm the presence of flammable of 60% LEL gases, and must initiate appropriate control measures in accordance with the situation, such as:

• Sound the general alarm;
• Sound the alarm in the Main Control Room;
• Electrical equipment disconnection, those not suitable for use in presence of gas;
• Shutdown hydrocarbons flow to the affected area;
• Activation of emergency shutdown system (ESD-3);

Hydrocarbon sensors are installed in exhaustion ducts of battery room. Activation of a sensor indicating 20% LEL, must be signaled in control room, and auxiliary exhaust fans should be triggered. Gas detection by two sensors at a level of 60% LEL shall also inhibit battery-charging system, and start ventilation and auxiliary exhaustion.

14 SALVAGE EQUIPMENT

Lifeguards Vessels

• Two (2) x 10.155 m totally enclosed whaleboats (oil tanker version)
• Model: JYN 100F, oil tanker version
• Capacity: 90 people, each
• Location: one (1) in each side of the unit, on vessels deck at aft accommodation area.

Rescue Boat
• One (1) x FRP Diesel/Waterjet reversible, SCHAT WATERCRAFT
• Model: R6 MK II
• Capacity: 6 people
• Propulsion: VOLVO TAMD engine, 130 BHP, diesel engine with water cooling
• Localization: Upper Deck (deck houses amidships)

15 REMARKS ON THIS DESCRIPTION

Most of the equipment related to production facilities is out of operation for three (3) years. It is expected that many of them are damaged due to this standstill state.