PETROBRAS	TECHNICAL SPECIFICATION	Nr: I-ET-3010.00-5241-424-P4X-001	
	CLIENT: -		SHEET: 1 of 24
	JOB: -		
	AREA: -		
	TITLE: HULL INERT GAS GENERATOR		INTERNAL
			ESUP

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INDEX OF REVISIONS

REV.	DESCRIPTION AND/OR REVISED SHEETS
0	ORIGINAL ISSUE
A	INCLUDED MAWP - MAXIMUM ALLOWABLE WORKING PRESSURE-REQUIREMENTS AT ITEM 6.1.14; DETAIL ABOUT DESIGN LIFETIME IN ITEM 4.1.1 and INSPECTION AND TEST PLAN DETAILS IN 8.5.1.

	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE	MAR/08/24	JUL/07/24							
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1. INTRODUCTION

1.1. OBJECTIVE

The purpose of this technical specification is to describe the minimum requirements for the design, manufacturing, assembly, supply, installation, commissioning, and tests of HULL INERT GAS GENERATOR in conformance with relevant regulations and basic design documentation.

1.2. DEFINITIONS

PACKAGE: It is defined as an assembly of equipment supplied interconnected, tested, and ready to operate, requiring only the available utilities from the Unit for the Package operation.

PACKAGER: It is defined as the responsible for project, assembly, construction, fabrication, testing and furnishing of the Package.

HULL INERT GAS GENERATOR: the PACKAGE name.

OWNER: PETROBRAS.

All definitions are found on I-ET-3010.00-1200-940-P4X-002 – GENERAL TECHNICAL TERMS.

1.3. ABBREVIATIONS

AIT…….. Oil Content Analyzer Indicator and Transmitter

CCR…....Central Control Room

CS……..…Classification Society

FAT……. Factory Acceptance Tests

FPSO…....Floating Production Storage and Offloading Unit

IGG……Inert Gas Generators

SOS……Supervisory and Operation System

SOS-HMI…Human Machine Interface of SOS

2. NORMATIVE REFERENCES

2.1. INTERNATIONAL CODES, RECOMMENDED PRACTICES AND STANDARDS

The equipment will be designed and manufactured in accordance with the following codes and standards, if not mentioned otherwise.

- ASME B31.3 – Process Piping

- ASME B16.5 – Pipe Flanges & Flanged Fittings
- AWS D1.1 – Structural Welding Code
- SOLAS Regulations Chapter II – 2 and with the IMO revised guidelines for inert gas system (MSC/circ. 353, as amended by MSC/circ. 387)
- IEC International Electrotechnical Commission
- Classification Society defined for the Hull scope.

2.2. BRAZILIAN CODES AND STANDARDS

- NRs – Brazilian Federal Government Regulatory Norms (Normas Regulamentadoras).
- NORMAM 201 – Normas da Autoridade Marítima para Embarcações Empregadas na Navegação em Mar Aberto;

2.3. CLASS APPROVAL AND CERTIFICATION

The PACKAGE shall be designed, manufactured, and tested according to the design reference documents, normative requirements and in accordance with the latest editions of Classification Society Rules, Regulations and Standards.

3. REFERENCE DOCUMENTS

3.1. HULL SYSTEMS REFERENCE DOCUMENTS

DOCUMENTO CODE (*)	DOCUMENT TITLE
HULL SYSTEMS	
I-DE- CLOSED VENTING SYSTEM	CLOSED VENTING SYSTEM
I-DE- LOADING SYSTEM	LOADING SYSTEM
I-DE- CARGO SYSTEM	CARGO SYSTEM
I-DE-INERT GAS SEAWATER SYSTEM	INERT GAS SEAWATER SYSTEM
I-DE-INERT GAS SYSTEM	INERT GAS SYSTEM
I-DE- HYDROCARBON AND INERT GAS DISTRIBUTION SYSTEM	HYDROCARBON AND INERT GAS DISTRIBUTION SYSTEM
I-DE- N2 PURGING AND STRIPPING SYSTEM FOR HULL	N2 PURGING AND STRIPPING SYSTEM FOR HULL
I-DE-TANKS CLEANING AND RECIRCULATION SYSTEM	TANKS CLEANING AND RECIRCULATION SYSTEM
I-DE-SLOP DISCHARGE SYSTEM	SLOP DISCHARGE SYSTEM
I-DE-HULL SERVICE AND INSTRUMENT AIR DISTRIBUTION SYSTEM	HULL SERVICE AND INSTRUMENT AIR DISTRIBUTION SYSTEM
I-ET- HULL PIPING PRACTICE	HULL PIPING PRACTICE

I-FD-DIESEL OIL DAILY TANK FOR INERT GAS GENERATOR (TQ-GG-5241501A/B-04)	DIESEL OIL DAILY TANK FOR INERT GAS GENERATOR (TQ-GG-5241501A/B-04)
I-FD-INERT GAS GENERATOR SEA WATER PUMP (B-5241502A/B)	INERT GAS GENERATOR SEA WATER PUMP (B-5241502A/B)
I-FD-INERT GAS GENERATOR (GG-5241501A/B)	INERT GAS GENERATOR (GG-5241501A/B)
I-FD-INERT GAS SEAL PUMP (B-5241501A/B)	INERT GAS SEAL PUMP (B-5241501A/B)
OUTFITTING	
I-DE- HULL GENERAL NOTES AND TYPICAL DETAILS	HULL GENERAL NOTES AND TYPICAL DETAILS
GENERAL	
I-DE-GENERAL ARRANGEMENT	GENERAL ARRANGEMENT
I-DE- AREA CLASSIFICATION – GENERAL	AREA CLASSIFICATION – GENERAL
I-ET-AUTOMATION INTERFACE OF PACKAGE UNITS	AUTOMATION INTERFACE OF PACKAGE UNITS
I-ET-FIELD INSTRUMENTATION	FIELD INSTRUMENTATION
I-ET-METOCEAN DATA	METOCEAN DATA
I-RL-GENERAL SPECIFICATION FOR AVAILABLE UTILITIES	GENERAL SPECIFICATION FOR AVAILABLE UTILITIES
I-RL-MOTION ANALYSIS	MOTION ANALYSIS

Table 1 – Hull Systems Reference Documents

(*) Note: the above documents code number is intentionally omitted since this technical specification is issued for different basic design projects. The actual document code shall be checked across the contractual basic design document list. Title naturally may vary slightly from one project to another.

3.2. TYPICAL DOCUMENTS

TYPICAL DOCUMENTS	
GENERAL	
I-ET-3000.00-0000-940-P4X-002	SYMBOLS FOR PRODUCTION UNITS DESIGN
I-ET-3010.00-1200-940-P4X-002	GENERAL TECHNICAL TERMS
I-ET-3000.00-1200-940-P4X-001	TAGGING PROCEDURE FOR PRODUCTION UNITS DESIGN
CONSTRUCTION	
I-ET-3010.00-1200-200-P4X-115	REQUIREMENTS FOR PIPING FABRICATION AND COMMISSIONING
I-ET-3010.00-1200-200-P4X-116	REQUIREMENTS FOR BOLTED JOINTS ASSEMBLY AND MANAGEMENT
I-ET-3010.00-1200-955-P4X-001	WELDING
I-ET-3010.00-1200-970-P4X-003	REQUIREMENTS FOR PERSONNEL QUALIFICATION AND CERTIFICATION

I-ET-3010.00-1200-970-P4X-004	NON-DESTRUCTIVE TESTING REQUIREMENTS FOR METALLIC AND NON-METALLIC MATERIALS
MECHANICAL	
I-ET-3010.00-1352-130-P4X-001	FLOOR GRATINGS, TRAY SYSTEMS AND GUARDRAILS MADE OF COMPOSITE MATERIALS.
I-ET-3010.00-1200-300-P4X-001	NOISE AND VIBRATION CONTROL REQUIREMENTS
NAVAL	
I-ET-3010.00-1350-960-P4X-001	DESIGN REQUIREMENTS – NAVAL ARCHITECTURE
PAINTING	
I-ET-3010.00-1200-956-P4X-002	GENERAL PAINTING
DR-ENGP-I-1.15	COLOR CODING
SAFETY	
I-ET-3010.00-5400-947-P4X-002	SAFETY SIGNALLING
DR-ENGP-M-I-1.3	SAFETY ENGINEERING
PIPING	
I-ET-3010.00-1200-251-P4X-001	REQUIREMENTS FOR BOLTING MATERIALS
ELECTRICAL	
I-DE-3010.00-5140-700-P4X-003	GROUNDING INSTALLATION TYPICAL DETAILS
I-ET-3010.00-5140-700-P4X-001	SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS
I-ET-3010.00-5140-700-P4X-002	SPECIFICATION FOR ELECTRICAL MATERIAL FOR OFFSHORE UNITS
I-ET-3010.00-5140-700-P4X-003	ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS
I-ET-3010.00-5140-700-P4X-007	SPECIFICATION FOR GENERIC ELECTRICAL EQUIPMENT FOR OFFSHORE UNITS
I-ET-3010.00-5140-700-P4X-009	GENERAL REQUIREMENTS FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS
I-ET-3010.00-5140-712-P4X-001	LOW-VOLTAGE INDUCTION MOTORS FOR OFFSHORE UNITS
I-ET-3010.00-5140-741-P4X-004	SPECIFICATION FOR LOW-VOLTAGE GENERIC ELECTRICAL PANELS FOR OFFSHORE UNITS
I-ET-3010.00-5140-772-P4X-002	SPECIFICATION FOR LOW-VOLTAGE FREQUENCY CONVERTERS, SOFT-STARTERS AND INVERTERS FOR OFFSHORE UNITS
INSTRUMENTATION AND AUTOMATION	

I-ET-3010.00-1200-800-P4X-002	AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS
I-ET-3010.00-1200-800-P4X-013	GENERAL CRITERIA FOR INSTRUMENTATION PROJECTS
I-ET-3010.00-1200-800-P4X-015	REQUIREMENTS FOR TUBING AND FITTING (ALIGNED TO IOGP-JIP33 S-716)
I-ET-3010.00-5500-854-P4X-001	MACHINERY MONITORING SYSTEM
I-ET-3010.00-5520-888-P4X-001	AUTOMATION PANELS

Table 2 – Typical Documents.

4. DESIGN REQUIREMENTS

4.1. DESIGN CONDITIONS

4.1.1. PACKAGE Equipment shall be designed for a design life defined on I-MD-DESCRIPTIVE MEMORANDUM – HULL SYSTEMS in a corrosive offshore environment without the need for replacement of any major component due to wear, corrosion, fatigue, or material failure.

4.1.2. PACKAGER shall design the equipment for the full range of operational conditions as specified in this technical specification.

4.1.3. PACKAGE Equipment shall be designed with the compliance of the normative and design requirements as stated in this specification and complying with the technical parameters stated on the above item 3 with the FPSO basic design reference documents.

4.1.4. All elements of the PACKAGE shall be of proven design and well within the manufacturer's actual experience.

4.2. SAFETY REQUIREMENTS

4.2.1. Personnel safety protection shall be provided according to Brazilian Regulatory Norms (NR) issued by Brazilian Government.

4.2.2. Warning signs in Brazilian Portuguese language shall be provided where risk of personnel injury exist.

4.2.3. Rotating equipment outer parts, such as pulleys, couplings, belts and flywheels, shall have rigid protection, manufactured with aluminum ASTM B211 and shall be capable of being easily removed.

4.2.4. In accordance with the requirements of SOLAS II-1, Regulation 3-5, and MSC.1/Circ. 1379, all equipment and material to be supplied by PACKAGER must be "asbestos free".

4.2.5. Safety signalling shall be in full compliance with I-ET-3010.00-5400-947-P4X-002 – SAFETY SIGNALLING.

4.2.6. All electric and electronic equipment shall be adequate for the area classification

where the equipment is placed.

4.2.7. For additional safety requirements refer to DR-ENGP-M-I-1.3 – SAFETY ENGINEERING GUIDELINE

4.3. NOISE AND VIBRATIONS

4.3.1. Noise and vibrations limits shall be in conformance with I-ET-3010.00-1200-300-P4X-001 – NOISE AND VIBRATION CONTROL REQUIREMENTS.

4.4. MOTIONS AND ACCELERATION

4.4.1. All equipment shall be able to withstand with the UNIT subjected to 100-year return period environmental conditions.

4.4.2. All equipment shall be able to operate with the UNIT subjected to 1-year return period environmental conditions.

4.4.3. All environmental conditions are defined in I-ET-METOCEAN DATA.

4.4.4. For the Hull loading conditions details and the maximum designed operational trim and heel inclinations refer to I-ET-3010.00-1350-960-P4X-001 – DESIGN REQUIREMENTS – NAVAL ARCHITECTURE.

4.4.5. For the FPSO displacement and accelerations refer to I-RL–MOTION ANALYSIS.

4.4.6. PACKAGE shall withstand inertial forces during transportation from construction site to the final offshore location.

5. SCOPE OF SUPPLY

5.1. PACKAGE EQUIPMENT

5.1.1. PACKAGER shall supply the below following items:

Equipment	Qty
INERT GAS GENERATOR	2 X 100%
INERT GAS GENERATOR UNIT LOCAL CONTROL PANEL	2 X 100%
INERT GAS GENERATOR UNIT REMOTE CONTROL PANEL	1 X 100%
DIESEL OIL PUMP UNIT FOR INERT GAS	2 X 100%
EXHAUST FANS FOR FUEL GAS PIPE CASING	4 X100%
INERT GAS GENERATOR BLOWER	2 X 100%
VENTILATED FUEL GAS SUPPLY CABINET	2 X 100%
DECK WATER SEAL (MAIN)	1 X 100%
DECK WATER SEAL (AUXILIARY)	1 X 100%
PRESSURE / VACUUM BREAKER (MAIN)	1 X 100%
PRESSURE / VACUUM BREAKER (AUXILIARY)	1 X 100%
PRESSURE / VACUUM BREAKER (SETTLING) (if applicable)	1 X 100%

Table 2 – PACKAGE Scope of Supply.

5.1.2. In addition to the Table 2, PACKAGER shall supply components, parts, accessories, valves, instruments, protection devices as detailed on item 5.2.

5.2. PACKAGE COMPONENTS, PARTS AND ACCESSORIES

5.2.1. PACKAGER shall supply the following Inert Gas system components, parts and accessories as below detailed.

a. A set of the Inert Gas system control valves to be defined by PACKAGER, see item 6.6.

b. Devices for the Inert Gas system control, protection and interlocking to keep the IGGs discharge pressure, flow, gas return, O_2 gas content and temperature under the safe and allowable operational limits of the Inert Gas system as detailed on item 6.11.4.

c. Non return valves and shut down valves (Deck Isolation Valves) to ensure gas flow non-return from Main Deck to the Forecastle.

d. Two (2) Deck Pressure Monitoring System to be installed close to the Deck Water Seal Main and Auxiliary.

e. One (01) portable O_2 analyzer.

i. Note 1: the above items are detailed on I-DE–INERT GAS SEAWATER SYSTEM, I-DE–INERT GAS SYSTEM and/or I-DE–HYDROCARBON AND INERT GAS DISTRIBUTION SYSTEM.

5.3. EQUIPMENT LOCATION

5.3.1. For equipment location refer to I-DE-GENERAL ARRANGEMENT and I-DE-INERT GAS SYSTEM.

5.3.2. For Areas Classification refer to I-DE- AREA CLASSIFICATION – GENERAL

6. PACKAGE TECHNICAL SPECIFICATION

6.1. INERT GAS GENERATOR

6.1.1. The inert gas system shall comply with SOLAS chapter II-2 and shall be designed for 1.25x Cargo Pumps maximum flow rate, which is 9,000 m^3/h (1.25 x 6 Cargo pumps x 1200 m^3/h pumps flow).

6.1.2. The inert gas shall be produced by two (2x100%) Inert Gas Generators (GG-5241501 A/B).

6.1.3. Inert gas system has the purpose to supply the inert gas for cargo, slop, produced water, settling and off-spec oil tanks in two main services:

- Offloading operation.
- Cargo, slop, produced water, settling and off-spec oil tanks purging operation.
  - Note: for simultaneous operations, inert gas generator A shall be set for the Offloading operation and Inert Gas Generator B for the tanks purging operation.

6.1.4. The Inert Gas Generator shall be automatic dual fuel type, burning fuel gas as the main fuel and diesel oil as the secondary fuel.

6.1.5. HULL SUPPLIER shall ensure PACKAGER requirements for sea water pressure and flow are being following for all operational drafts.

6.1.6. Each Inert Gas Generator scrubber shall have an independent sea water overboard line as indicated on I-DE-INERT GAS SYSTEM for the IGGs draining with the discharge to the sea through the Hull structural shell side.

- Note 1: PACKAGER shall issue all the recommendations for the draining lines design parameters as diameter, position, inclination, and for the required parameters for the sea water quality standard (acid pH, etc.).

- Note 2: all parts in contact with sea water shall have the material selected to work with this fluid even in high temperature.

- Note 3: The maximum discharge temperature of the Inert Gas Generator sea water cooling (for scrubbers) shall be limited to 40ºC, considering the most critical operational case and also considering highest expected sea water temperature as defined in I-ET-METOCEAN DATA.

6.1.7. Inert Gas Generator shall be equipped with fresh water connection for flushing the cooling jacket, scrubber and other components exposed to seawater.

- For fresh water refer to I-DE-FRESH, HOT AND POTABLE WATER SYSTEM DISTRIBUTION.

6.1.8. Essential instrument air shall be provided for the pneumatic valves, control valves and all other required PACKAGE instruments / devices.

6.1.9. Inert Gas Generator shall be designed in such way that no diesel oil is discharged to the sea in case of misfire and / or flame out from the combustion chambers.

- Note: All diesel spilled shall be contained within the combustion chamber and be burned in next start. PACKAGER shall include additional protections / interlocks, as well as valves, sensors, non-drip nozzles etc., to ensure the dripped diesel volume is as small as possible. The solution shall be submitted to OWNER appraisal during Technical Bid Evaluation.

6.1.10. The Inert Gas System shall comply with the following design parameters:

a. Maximum delivery pressure at Inert Gas Generator assembly outlet: 1200 mmWC.

b. O_2 content: 2 – 4%.

c. maximum temperature of inert gas at scrubber outlet: 10ºC above sea water temperature.

d. For sea water maximum inlet temperature requirements refer to I-ET-METOCEAN DATA.

e. For other remaining design parameters refer to I-DE-INERT GAS SYSTEM.

6.1.11. The Inert Gas System shall be able to perform the inertization of the tank with the smallest volume without exceeding the maximum design velocity of 40 m/s inside the inert gas piping.

6.1.12. For contingency operations, the inert gas system shall be able to provide inert gas from a range of 500 Nm^3/h to 9,000 Nm^3/h at the specified oxygen levels to

allow a slow inertization of ballast, cofferdam, and void tanks.

- Note: the speed control for the IGGs may be performed by a variable speed blower (Variable Speed Drive) or by actuation of a FV (flow valve) / PV (pressure valve) or a combination of both solutions. Other arrangements shall be submitted for OWNER approval.

6.1.13. It shall be possible to use the Inert Gas Generator Blowers to perform cargo, slop, produced water, settling and off-spec oil tanks (if applicable) Gas Freeing operation. The maximum Gas Freeing capacity shall be 9,000 Nm^3/h, with possibility to adjust the flow between 500 Nm^3/h to 9,000 Nm^3/h for this operation.

6.1.14. PACKAGE/equipment Maximum Allowable Working Pressure (MAWP) shall be higher than the maximum pressure that may occur at PACKAGE/equipment inlet tie-in point.

6.1.14.1. In particular cases where it is not possible to comply with above requirement, it shall be included on PACKAGE scope of supply devices for pressure control together with devices for protection against over pressure, for example, a combination of a self-operated pressure reducing valve and a pressure relief valve.

- Note: This requirement (item 6.1.14) is also applicable for PACKAGE required utilities, such as, but not limited to, seawater/fresh water cooling, compressed air, diesel, nitrogen.

6.2. INERT GAS GENERATOR BLOWERS

6.2.1. Inert Gas Generator Blowers (2 x 100%) shall be electrical driven centrifugal type and have the purpose to supply safe ambient air to the Inert Gas Generator burners.

6.2.2. Inert Gas Generator Blowers shall be designed for the total production of one (1) generator running at full load (9,000 m^3/h).

6.2.3. Inert Gas Generator Blowers shall be supplied with a soft-starter or a variable speed drive to comply with voltage drop requirements states in I-ET-3010.00-5140-700-P4X-003 – ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS.

6.3. DIESEL OIL PUMP UNIT FOR INERT GAS

6.3.1. Diesel Oil Pump Unit for Inert Gas, 2x100%, electrical driven type shall be designed each one to supply diesel oil to both Inert Gas Generators.

6.3.2. Diesel Oil Pump Unit for Inert Gas shall suction diesel oil from one (1) dedicated structural diesel oil daily tank which is not under PACKAGER scope of supply.

- Note: For diesel oil daily tank data sheet refer to I-FD-DIESEL OIL DAILY TANK FOR INTER GAS GENERATORS.

6.3.3. Diesel Oil Pump Unit for Inert Gas type (centrifugal or positive displacement) shall be defined by PACKAGER.

6.3.4. Diesel Oil Pump Unit for Inert Gas shall be controlled by remote and local control panels supplied by PACKAGER.

6.4. VENTILATED FUEL GAS SUPPLY CABINET

6.4.1. Ventilated Fuel Gas Supply Cabinets (2 x 100%) are totally enclosed spaces with the purpose to provide a safe connection between the Topside fuel gas lines and the IGGs. Cabinets shall be placed close to the Inert Gas Generators at the same room but shall be considered itself as a Hazardous Area. Cabinets shall be supplied with gas detectors (H_2S and CH_4).

- Note: In case CH4 or H2S is confirmed, fuel gas admission valves to the PACKAGE shall be closed and IGGs shall be stopped/tripped (as per PACKAGER design). Details of this interlock shall be confirmed by PACKAGER and submitted to OWNER for appraisal.

6.4.2. Ventilated Fuel Gas Supply Cabinet shall be interconnected with both Topside fuel gas line (upstream) and Inert Gas Generators (downstream) through a pipe-in-pipe type line (fuel gas piping case) for all non-classified route with the main requirements as below:

i. the annular of fuel gas piping case shall be continuously exhausted through the ventilation cabinet dedicated exhausters (EXHAUST FANS FOR FUEL GAS PIPE CASING item 6.4.3).

ii. The air admitted to the fuel gas piping cases shall continuously pass through the gas detectors (CH4 or H2S) installed in Ventilated Fuel Gas Supply Cabinet

iii. the fuel gas piping inside non classified areas as IGG room shall be all fully welded, fabricated in stainless steel AISI 316L or similar and with length as short as possible. The maximum pipe length shall be defined by PACKAGER.

6.4.3. Each Ventilated Fuel Gas Supply Cabinet and connected fuel gas pipe casings shall be continuously exhausted by two (2 x 100%) exhausting fans (EXHAUST FANS FOR FUEL GAS PIPE CASING).

6.4.4. In case the main Exhaust Fan for Fuel Gas Pipe Casing stops the stand-by fan shall start automatically. In case both fans stop, the fuel gas supply to the Inert Gas Generator shall be stopped.

6.4.5. Exhaust Fans for Fuel Gas Pipe Casing (4 x 100%) shall be axial type and driven by electric motors.

- Note: Expansion joints at the exhaust fans suction and discharge shall be supplied by PACKAGER to account for vibration issues.

6.4.6. Fuel Gas vent lines and Exhaust Fans for Fuel Gas Pipe Casing shall have the discharge directed to a safe location outside the Inert Gas Generator room, according to Class Society requirements.

- Note: The final discharge position shall be confirmed by the I-RL-GAS DISPERSION ANALYSIS issued by HULL SUPPLIER and to be approved by the Inert Gas System PACKAGER, as indicated on I-DE-INERT GAS SYSTEM.

6.4.7. Fuel gas lines outside the Ventilated Fuel Gas Supply Cabinets shall have double blocking manual valves (not PACKAGER scope of supply) to isolate the fuel gas supply cabinet.

6.5. INERT GAS SYSTEM LOCAL AND REMOTE CONTROL PANELS

6.5.1. PACKAGER shall supply three (3) control panels. Two (2) local control panels and one remote control panel.

6.5.2. Local control panels shall be installed on the Inert Gas Generators compartment.

6.5.3. Remote control panel shall be installed on central control room (CCR) in a location close to the Hull Systems operators.

6.5.4. The selection key of the remote/local control panels shall be installed on CCR close to the inert gas remote control panel.

- Note: the selection key status shall be indicated on both remote and local control panels.

6.5.5. The remote control panel shall be independent from SOS-HMI which will be solely dedicated to the system register and alarms. The remote control panel shall execute all functions of control, start, stop and alarms of this system.

6.5.6. Local control panels shall execute all monitoring, operation (start / stop), control and alarms of Inert Gas System: this panel shall act as a back-up of the remote control panel.

6.5.7. Local control panels and remote control panel shall indicate the Inert Gas Generator Seawater Pumps and the Inert Gas Seal Pumps status conditions.

6.6. INERT GAS SYSTEM CONTROL VALVES

6.6.1. Inert Gas System Control Valves have the purpose to ensure the design and operational parameters of Inert Gas system are under the design allowable limits.

6.6.2. Control valves, logic and actuation system design shall be defined by PACKAGER.

6.6.3. PACKAGER shall indicate the failure position of all valves in the event of instrument air or electrical power failure. Fail Closed (FC), Fail Open (FO), or Fail in the last position (FL) inert gas Non-return Valves

6.6.4. The Inert Gas System shall have the generated gas volume controlled in accordance with the instantaneous demand, not allowing the gas to return to the system during the tanks filling operations.

6.6.5. Non-return retention valves shall be the primary barriers of the gas return to the Inert Gas Generators compartment and shall be fitted downstream both Deck Water Seals (Main and Auxiliary) at the inert gas distribution header and the purging header, respectively.

- Note 2: non-return retention valves shall be designed for 9,000 m^3/h.

6.7. INERT GAS SEALING AND DECK WATER SEALS

6.7.1. Deck Water Seals (Main and Auxiliary) have the purpose to ensure the inert gas non-return to the IGGs compartment through the inert gas distribution lines:

6.7.2. PACKAGER shall supply as a secondary barrier of gas return, two (02) identical Deck Water Seal: one (1) Deck Water Seal (Main) for the HC / Inert Gas distribution header and other one (1) Deck Water Seal (Auxiliary) for the purging header.

6.7.3. Deck Water Seals (Main and Auxiliary) shall be designed according to the SOLAS requirement Chapter II – 2.

6.7.4. Deck Water Seals (Main and Auxiliary) shall be designed for 9,000 m^3/h which is (1.25 x 6 cargo pumps x 1,200 m^3/h maximum cargo pumps flow rate).

6.7.5. Two (02) dedicated electric driven centrifugal pumps (Inert Gas Seal Pumps, 2 x 100%) with continuous operation shall be provided to keep the sea water sealing on Deck Water Seals Main and Auxiliary. Those pumps shall be installed in the Engine Room lowest level for sea water suction through the sea water sea chest crossover.

- Note: Inert Gas Seal Pumps are NOT PACKAGER scope of supply, but their automation, instrumentation and control devices shall be designed and supplied by HULL SUPPLIER following PACKAGER recommendations.

6.7.6. Deck Water Seals (Main and Auxiliary) shall have the following sea water sealing system minimum requirements:

i. Sea water level inside the Deck Water Seal Main and Auxiliary shall be compatible with the maximum pressure on the tanks.

ii. To follow the requirements defined by PACKAGER.

iii. To be provided with means to ensure the water sealing operation under sea water freezing temperature.

- Note: this requirement may be disregarded if approved by CS.

6.7.7. Deck Water Seals (Main and Auxiliary) shall be internally coated with polyethylene or similar material subject for OWNER appraisal.

- Note 1: Internal painting scheme or lining shall be defined with the purpose to resist to sea water effects with high pH levels.
- Note 2: Painting scheme shall be defined by PACKAGER and shall be submitted to OWNER for appraisal.

6.7.8. Deck Water Seals (Main and Auxiliary) shall have each one an independent overboard / draining line to the sea (not PACKAGER scope of supply). These lines shall follow the PACKAGER requirements (diameter, slope and relative position to minimum water level).

- Note: draining piping lines / valves and accessories material shall be compatible with the sea water fed by Engine Room sea chests that are equipped with Marine Grow Prevention System.

6.7.9. Deck Water Seals (Main and Auxiliary) water level shall be monitored by SOS-HMI, with high and low level alarms on CCR.

6.8. DECK ISOLATING VALVES AND SHUTDOWNVALVES

6.8.1. Deck isolating valves shall be manual valve type with position remotely indicated on SOS-HMI.

6.8.2. Those valves shall be installed downstream the Deck Water Seals (Main and Auxiliary) and upstream the non-return valves with the purpose to isolate the inert gas distribution header and the purging header from the Inert Gas Generators.

6.8.3. Minimum straight pipe length downstream and upstream the valves shall be informed by PACKAGER.

6.8.4. For Deck isolating valves specification refer to I-DE-INERT GAS SEAWATER SYSTEM.

6.8.5. It shall be provided a Shutdown Valve (SDV) upstream each deck water seals.

6.8.6. The Shutdown Valve (SDV) shall be closed in case high or low level in correspondent deck water seal.

6.9. PRESSURE / VACUUM BREAKERS (P/V BREAKERS)

6.9.1. P/V Breakers Main and Auxiliary are Inert Gas system safety devices, and the last barrier of the cargo area tanks against overpressure.

6.9.2. P/V Breakers Main and Auxiliary shall be sealed with fresh water supplied by Hull fresh water system.

- Note: for Hull Fresh Water System refer to I-DE-P&ID FRESH, HOT AND POTABLE WATER SYSTEM DISTRIBUTION.

6.9.3. P/V Breakers Main and Auxiliary shall be internally coated with the same painting scheme as the fresh water storage tanks of the UNIT. Refer to item 7.3.

6.9.4. P/V Breakers Main and Auxiliary discharges shall be routed to a safe location. PACKAGER shall confirm diameters and piping routing to guarantee P/V Breakers performance.

6.9.5. P/V Breakers Main and Auxiliary water level shall be monitored locally by a magnetic level gauge and remotely by the SOS-HMI with high and low level alarms.

6.9.6. For P/V Breakers Main and Auxiliary set points and additional requirements refer to I-DE-HYDROCARBON AND INERT GAS DISTRIBUTION SYSTEM.

6.9.7. If applicable, P/V Breakers for Settling Tanks shall be supplied. To check applicability, refer to I-DE-HYDROCARBON AND INERT GAS DISTRIBUTION SYSTEM.

6.10. INERT GAS VENT SYSTEM

6.10.1. PACKAGER shall provide inert gas vent system with vent pipes to be installed on the Inert Gas Generators inert gas system distribution lines and on the fuel gas system cabinet.

6.10.2. Flame arrester on IGGs vent pipes shall be avoided. In case of duly necessary usage of flame arrester, the design of the IGGs vent lines with the flame arrester shall be supplied by PACKAGER and be formally approved by OWNER.

6.10.3. All pressure and vacuum vent / relief openings shall be fitted with flame screens with easy access for cleaning and maintenance.

6.10.4. Flame screens shall be installed on inlets and outlets of any relief / venting device and shall be of robust construction, sufficient to withstand the gas pressure at the system maximum capacity, creating a minimum resistance to the gas flow.

6.10.5. Relief systems vent pipes shall be directed to a safe location approved by CS.

6.10.6. For fuel gas pipe-in-pipe vent systems refer to item 6.4.2.

6.10.7. PACKAGER shall supply the inert gas relief / vent system design automation and instrumentation.

6.10.8. For piping and automation logic preliminary / basic information refer to I-DE-INERT GAS SYSTEM.

6.11. INERT GAS PROTECTION AND CONTROL DEVICES

6.11.1. PACKAGER shall provide all protection, control, and interlocking devices to control the PACKAGE against high / low pressure, temperature, flow, and any other necessary parameter to ensure the safe operation of the Inert Gas

System.

6.11.2. For pressure control, a Deck Pressure Monitoring system shall be installed downstream the Deck Water Seals Main and Auxiliary with at least two pressure transmitters interlocked with a pressure regulating valve installed downstream the IGGs as indicated on I-DE-INERT GAS SYSTEM.

6.11.3. Pressure deviation and combustible (fuel gas or diesel) misfire or flame out shall be alarmed on CCR.

6.11.4. PACKAGER shall provide devices for control, protection and interlocking for the minimum hazardous scenarios as below detailed:

a. High flow and high pressure in fuel gas lines

b. Low flow and low pressure in fuel gas lines

c. Low flow and low pressure of diesel oil to burners

d. Very low pressure upstream the diesel oil pump unit stopping the diesel pumps.

e. Reverse flow on diesel oil pump unit

f. Low flow and low pressure of combustion air

g. Inert Gas Generator burners flame out.

h. High pressure at Inert Gas Generators discharge stopping the inert gas delivery to tanks and directed the inert gas to atmosphere.

i. High O_2 content at Inert Gas Generators discharge stopping the inert gas delivery to tanks and directed the inert gas to atmosphere.

j. Low flow of sea water sealing

k. No or Low flow of sea water to the Inert Gas Generators.

l. High sea water pressure at scrubber.

m. High sea water level at scrubber stopping the sea water pumps.

n. Stop Inert Gas Generator closing fuel gas valves (double block) at Ventilated Fuel Gas Supply Cabinets.

o. Devices for the system control, protection and / or interlocking as mentioned on item of this technical specification.

6.11.5. PACKAGER shall provide devices for the system control, protection and / or interlocking as mentioned on item 6.4.1, 6.4.4, 6.7.9, 6.8.1, 6.8.6 and 6.9.5 of this technical specification.

6.11.6. PACKAGER shall provide at least four (4) O_2 AIT (Analyzer Indicator and Transmitter), being at least two (2) fitted for each Inert Gas Generator.

- Note: one (1) AIT shall be used for control, both AIT used for safety interlocks (either one would stop delivery to tanks based on a determined setpoint). Deviation of O2 content between both AIT (setpoint 10%) shall generate an alarm. Other configurations shall be submitted to OWNER for appraisal.

6.11.7. Maximum O_2 content in inert gas shall be 2% when the inert gas is generated in fuel gas mode and 4% in diesel oil mode.

- Note: PACKAGER shall inform the IGGs performance with 1% of O_2 content on fuel gas mode.

6.11.8. PACKAGER shall provide flow measuring devices such as a flow venturi pipe downstream the Inert Gas Generators. The pipeline upstream and downstream the flow venturi shall have a minimum straight length defined by PACKAGER.

6.11.9. PACKAGER shall provide any other remaining Hull Inert Gas Generators PACKAGE protection, interlocking and control according to applicable Classification Society and the statutory rules (trip in ignition failure, lack of supply air, and other typical IGG interlock as per PACKAGER design).

6.11.10. Inert Gas Generator automation and instrumentation shall follow the PACKAGER recommendation.

6.11.11. For inert gas piping and automation logic refer to I-DE-INERT GAS SYSTEM.

6.12. INERT GAS SYSTEM GENERAL REQUIREMENTS

6.12.1. The manufacturing and installation of the inert gas generator shall comply with the rules of the CS, with the SOLAS Regulations Chapter II – 2 and with the IMO revised guidelines for inert gas system (MSC/circ. 353, as amended by MSC/circ. 387).

6.12.2. PACKAGER shall be responsible for the approval of the diagrams and installation drawings associated to the PACKAGE installation. Basically, the following documents shall be submitted, but not limited to:

i. Inert Gas System piping and instrument diagram.

ii. PACKAGE arrangement on exposed deck with the restriction's indications and recommendations for the Deck Water Seals Main and Auxiliary installation distance from the IGGs, same for P/V Breakers and other devices with particular installation requirements.

iii. Machinery Space pipelines diagram and arrangement.

iv. Scrubber cooling discharge pipeline arrangement and accessories.

6.12.3. The level gauges shall be installed in such position that the level indicated in receiver will be easily seen. All level gauges shall have flanged connections, which can be isolated, and be complete with vent and drain, valves and connection.

6.12.4. All valves shall be positioned with the stem pointing upwards. They shall be located in such a way that the handwheel or actuator will not obstruct walkways and be easily accessible for operation and maintenance. Where hand operated valves are not easily operable, gear operated valves shall be used.

6.12.5. Valves, instruments, etc. elevated above 1.75 m above the floor, shall have access ladders or platform provided.

6.12.6. Sampling point / facilities shall be provided complete with necessary fittings and valves, and the design shall reflect nature of the fluids being sampled.

6.12.7. Studs, bolts, tightening bolts and nuts shall be according to I-ET-3010.00-1200-251- P4X-001 – REQUIREMENTS FOR BOLTING MATERIALS.

6.13. DIESEL OIL AND FUEL GAS SPECIFICATION

6.13.1. For the Diesel Oil and Fuel Gas specification refer to I-RL-GENERAL SPECIFICATION FOR AVAILABLE UTILITIES.

7. GENERAL REQUIREMENTS

7.1. ELECTRICAL REQUIREMENTS

7.1.1. Electrical equipment installed in hazardous areas shall have the safety execution specified in accordance with standards IEC 60079, IEC 61892 series and, for FPSO/FSO units, IEC 60092. Electrical equipment installed in external safe areas, that shall be kept operating during emergency shutdown (ESD-3P and ESD-3T) shall be certified for installation in hazardous areas Zone 2 (EPL Gc) Group IIA temperature T3, unless they are automatically disconnected if there is gas in the equipment area, according to IEC 61892-1. For more details, refer to I-ET-3010.00-5140-700-P4X-009 – GENERAL REQUIREMENTS FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.

7.1.2. Electrical equipment and material shall comply with requirements of the references mentioned on Table 2.

7.2. INSTRUMENTATION AND AUTOMATION REQUIREMENTS

7.2.1. PACKAGE instrumentation and control design shall fulfill the requirements of the technical specifications mentioned on Table 2:

7.2.2. PACKAGE shall replicate main variables via network in SOS-HMI (at CCR).

7.3. PAINTING REQUIREMENTS

7.3.1. Painting and coating in accordance with I-ET-3010.00-1200-956-P4X-002 – GENERAL PAINTING and DR-ENGP-I-1.15 COLOR CODING.

7.3.2. All components shall be delivered fully painted/coated, unless otherwise indicated on this specification.

7.3.3. The performed pre-treatment and complete coating shall be in accordance with the paint manufacturer's data sheets.

7.4. SKIDS LAYOUT AND FOUNDATION REQUIREMENTS

7.4.1. PACKAGE components detailed on item 6 which are supplied assembled on skids shall follow the below minimum requirements.

7.4.2. PACKAGE skid structure shall be designed to withstand the design conditions mentioned on item 4.4 and to ensure the lifting conditions on manufacturing site and shipyard. Lifting lugs shall be provided according to PACKAGER lifting procedure.

7.4.3. The skid main frame shall be all welded construction. Structural skid welds, including lifting facilities shall be continuous and shall comply with AWS D1.1 (structural welding code) and CS Rules.

7.4.4. Skid structure shall be designed to be welded to the supporting structure unless otherwise specified.

7.4.5. PACKAGE skid layout and arrangement shall be designed to provide sufficient access to pumps, instruments, equipment, and control panels so as to ease the operability and maintenance with safe conditions.

7.4.6. Instruments and valves shall be installed on a suitable height to allow safe access for monitoring, operation, and maintenance.

7.4.7. All necessary maintenance davits, monorails, padeyes or trolleys shall be provided to ensure the safe and easy maintenance conditions.

7.4.8. Access ladders, platforms, gratings and any other access device shall comply with I-ET-3010.00-1352-130-P4X-001 - FLOOR GRATINGS, TRAY SYSTEMS AND GUARDRAILS MADE OF COMPOSITE MATERIALS. Metallic material is also acceptable and I-DE-HULL GENERAL NOTES AND TYPICAL DETAILS, item 3.23, shall be followed for metallic grating requirements.

7.5. NAMEPLATES AND TAG NUMBERING

7.5.1. PACKAGER / MANUFACTURER Equipment shall have nameplates in Brazilian Portuguese language, made of stainless steel AISI 316L, with 3 mm minimum thickness and fixed by stainless steel (AISI 316L) bolts or fasteners on visible and accessible location.

7.5.2. Tagging of all instruments, electrical, mechanical and piping items, including valves, shall be carried out as detailed on I-ET-3000.00-1200-940-P4X-001 –

TAGGING PROCEDURE FOR PRODUCTION UNITS DESIGN.

8. PACKAGE MANUFACTURING AND DELIVERY REQUIREMENTS

8.1. GENERAL

8.1.1. All materials and equipment supplied by PACKAGER / MANUFACTURER shall be brand new (not overhauled), field proven, free from defects and accepted by Owner and the Classification Society.

8.1.2. Materials and equipment shall be manufactured according to internationally recognized standards for the offshore oil drilling and production industries and shall be in conformance with the Basic Design and Agreement specifications and requirements.

8.1.3. Field proven definition: Systems and equipment shall demonstrate satisfactory operation at least in 3 floating offshore installation units, operating under process conditions (pressure, flow, capacity and similar fluids) for a minimum of 24,000 hours. For rotating equipment, they must demonstrate operation with fluid, flow and discharge pressure similar to the design. Unproven designs or prototypes (including components) without offshore service will not be accepted.

8.2. MANUFACTURING

8.2.1. PACKAGE equipment, structures and piping welding, welding inspection, non-destructive testing (NDT), bolted joints assembly and piping fabrication and commissioning activities shall be performed in compliance with the technical specifications mentioned on Table 1 and Table 2.

8.3. DOCUMENTATION

8.3.1. For the PACKAGE documentation and data-book requirements refer to EXHIBIT III – DIRECTIVES FOR ENGINEERING.

8.3.2. Additionally, for the PACKAGE documentation, data-book requirements refer to EXHIBIT V – DIRECTIVES FOR PROCUREMENT.

8.4. SPARE PARTS

8.4.1. For the PACKAGE, spare parts, special tools, CS required spare parts and spare parts list recommended for two (2) years of operation refer to EXHIBIT V – DIRECTIVES FOR PROCUREMENT.

8.5. INSPECTION AND TESTS

8.5.1. For PACKAGE Inspection and Test Plan (ITP), Factory Acceptance Test (FAT), Inspection Release Certificate (IRC) and Site Acceptance Test (SAT), refer to EXHIBIT V - DIRECTIVES FOR PROCUREMENT, EXHIBIT VII - DIRECTIVES FOR QUALITY ASSURANCE SYSTEM and EXHIBIT VIII - DIRECTIVES FOR COMMISSIONING.

8.6. PRESERVATION, PACKING AND TRANSPORTATION

8.6.1. For PACKAGE preservation, packing and transportation requirements refer to EXHIBIT V – DIRECTIVES FOR PROCUREMENT.