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	CLIENT:	BÚZIOS	SHEET: 1 of 34
	JOB:	HIGH CAPACITY FPSO	
	AREA:	BÚZIOS	
SRGE	TITLE:	HULL INERT GAS GENERATOR	INTERNAL
			ESUP

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INDEX OF REVISIONS

REV.	DESCRIPTION AND/OR REVISED SHEETS
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THIS FORM IS PART OF PETROBRAS N-381 REV.J ANNEX A – FIGURE A.1.



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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 High Capacity FPSO design documentation.

HULL INERT GAS GENERATOR Package shall be composed by the following components which shall be supplied by the same PACKAGER:


- GG-5241501A/B – Inert Gas Generator
- PN-GG-5241501A/B-02 – Inert gas generator unit local control panel
- B-GG-5241501A/B – Diesel oil pump unit for inert gas
- EXT-GG-5241501A/B-A/B – Exhaust fans for fuel gas pipe casing
- VT-GG-5241501A/B – Inert gas generator blower
- Z-GG-5241501A/B – Ventilated fuel gas supply cabinet
- TQ-GG-5241501A/B-01 – Deck water seal (main)
- TQ-GG-5241501A/B-02 – Pressure / vacuum breaker (main)
- TQ-GG-5241501A/B-03 – Pressure / vacuum breaker (auxiliar)
- TQ-GG-5241501A/B-05 – Deck water seal (auxiliar)
- Retention valves for inert gas distribution header and purge header
- Deck Isolation and control valves
- Remote and local control panels
- Selection Keys for the remote and local control panels
- Inert gas injection nozzles

1.2. DEFINITIONS

PACKAGE: An assembly of equipment supplied interconnected, tested and operating, requiring only the available utilities from the FPSO for full operation.

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

OWNER: PETROBRAS.

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HULL INERT GAS GENERATOR the PACKAGE name.

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

1.3. ABBREVIATIONS

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.

- ANSI American National Standards Institute
- API American Petroleum Institute
- ASME American Society Of Mechanical Engineers
- BGV German Safety Regulations
- DIN German National Standard Code
- EN European Standards
- ISO International Standard Organization
- IMO International Maritime Organization
- IMO MODU CODE 2009
- SOLAS Regulations Chapter II – 2 and with the IMO revised guidelines for inert gas system (MSC/circ. 353, as amended by MSC/circ. 387)

- VDE / IEC German National Electric Standard Codes / International Electric Codes
- Classification Society defined for the Hull scope.

2.2. BRAZILIAN CODES AND STANDARDS

- NRs – Brazilian Federal Government Regulatory Norms (Norma Regulamentadora);
- NORMAM-01 – 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. HIGH CAPACITY FPSO REFERENCE DOCUMENTS

REF DOC NUMBER	REF DOC NAME
GENERAL	
I-DE-3010.1Y-1200-942-P4X-001	GENERAL ARRANGEMENT
I-DE-3010.1Y-5400-94A-P4X-001	AREA CLASSIFICATION – GENERAL
I-ET-3000.00-0000-940-P4X-002	SYMBOLS FOR PRODUCTION UNITS DESIGN
I-ET-3000.00-1200-940-P4X-001	TAGGING PROCEDURE FOR PRODUCTION UNITS DESIGN
I-RL-3010.1Y-1200-940-P4X-001	GENERAL SPECIFICATION FOR AVAILABLE UTILITIES
I-ET-3010.00-1200-940-P4X-002	GENERAL TECHNICAL TERMS
I-ET-3A36.00-1000-941-PPC-001	METOCEAN DATA
CONSTRUCTION	
I-ET-3010.00-1200-955-P4X-001	WELDING
I-ET-3010.00-1000-970-P4X-002	REQUIREMENTS FOR NDT

I-ET-3010.00-1200-955-P4X-002	REQUIREMENTS FOR WELDING INSPECTION
I-ET-3010.00-0000-970-P4X-001	REQUIREMENTS FOR PROCEDURES AND PERSONNEL QUALIFICATION AND CERTIFICATION
HULL SYSTEMS	
I-DE-3010.1Y-1350-944-P4X-001	CLOSED VENTING SYSTEM
I-DE-3010.1Y-1350-944-P4X-002	LOADING SYSTEM
I-DE-3010.1Y-1350-944-P4X-003	CARGO SYSTEM
I-DE-3010.1Y-5241-944-P4X-002	INERT GAS SEAWATER SYSTEM
I-DE-3010.1Y-5241-944-P4X-003	INERT GAS SYSTEM
I-DE-3010.1Y-5241-944-P4X-004	INERT GAS DISTRIBUTION SYSTEM
I-DE-3010.1Y-5241-944-P4X-005	PURGING AND STRIPPING SYSTEM FOR SUBMERGED PUMPS PIPE STACKS
I-DE-3010.1Y-5271-944-P4X-001	TANKS CLEANING AND RECIRCULATION SYSTEM
I-DE-3010.1Y-5336-944-P4X-005	SLOP DISCHARGE SYSTEM
I-DE-3010.1Y-6124-944-P4X-001	HULL SERVICE AND INSTRUMENT AIR DISTRIBUTION SYSTEM
I-ET-3010.1Y-1350-200-P4X-001	HULL PIPING PRACTICE
I-FD-3010.1Y-5133-510-P4X-002	DIESEL OIL DAILY TANK FOR INERT GAS GENERATOR (TQ-GG-5241501A/B-04)
I-FD-3010.1Y-5241-311-P4X-001	INERT GAS GENERATOR SEA WATER PUMP (B-5241502A/B)
I-FD-3010.1Y-5241-424-P4X-001	INERT GAS GENERATOR (GG-5241501A/B)
I-FD-3010.1Y-5241-424-P4X-002	INERT GAS SEAL PUMP



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(B-5241501A/B)

NAVAL

I-DE-3010.1Y-1350-960-P4X-002

CAPACITIES PLAN

I-ET-3010.1Y-1350-960-P4X-002

DESIGN REQUIREMENTS - NAVAL ARCHITECTURE

I-RL-3010.1Y-1350-960-P4X-009

MOTION ANALYSIS

MECHANICAL

I-ET-3010.00-1200-300-P4X-001

NOISE AND VIBRATION CONTROL REQUIREMENTS

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 SIGNALING

DR-ENGP-M-I-1.3

SAFETY ENGINEERING GUIDELINE

PIPING

I-ET-3010.1Y-1200-200-P4X-002

PIPING SPECIFICATION FOR HULL

I-ET-3010.00-1200-200-P4X-004

REQUIREMENTS FOR PIPING SUPPORTS

I-ET-3010.00-1200-251-P4X-001

REQUIREMENTS FOR BOLTING MATERIALS

I-ET-3010.00-1200-200-P4X-115

REQUIREMENTS FOR PIPING FABRICATION AND COMMISSIONING

I-ET-3010.00-1200-200-P4X-001

MINIMUM REQUIREMENTS FOR PIPING MECHANICAL DESIGN AND LAYOUT.

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 AND EQUIPMENT FOR OFFSHORE UNITS
I-ET-3010.00-5140-700-P4X-003	ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS
I-ET-3010.00-5140-712-P4X-001	LOW-VOLTAGE INDUCTION MOTORS FOR OFFSHORE UNITS
INSTRUMENTATION AND AUTOMATION	
I-ET-3010.00-1200-800-P4X-002	AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS
I-ET-3010.1Y-1200-800-P4X-014	AUTOMATION INTERFACE OF PACKAGE UNITS
I-ET-3010.00-1200-800-P4X-013	GENERAL CRITERIA FOR INSTRUMENTATION PROJECTS
I-ET-3010.00-5520-888-P4X-001	AUTOMATION PANELS

Table 1 – Reference Documents

Note: Reference Documents latest revision shall be considered.

4. DESIGN REQUIREMENTS


4.1. DESIGN CONDITIONS

4.1.1. PACKAGE Equipment shall be designed for a 30-year life 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 High Capacity FPSO basic design reference documents.

4.1.4. All elements of the PACKAGE shall be of proven design and well within the

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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 signaling shall be in full compliance with I-ET-3010.00-5400-947-P4X-002 – SAFETY SIGNALING.
- 4.2.6. Double block & bleed arrangements are required for isolation of equipment in piping classes of 300# and above.

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-3A36.00-1000-941-PPC-001 – METEOCEAN DATA, at any draft from fully loaded to the minimum loaded / ballasted condition.
- 4.4.4. For the Hull loading conditions details and the maximum designed operational trim and heel inclinations refer to I-ET-3010.1Y-1350-960-P4X-002 – DESIGN REQUIREMENTS - NAVAL ARCHITECTURE.
- 4.4.5. For the design data and information regarding motion requirements refer to I-RL-3010.1Y-1350-960-P4X-009 – MOTION ANALYSIS.
- 4.4.6. PACKAGE is also to 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 main shall supply the below following items:

TAG	Equipment	Qty
GG-5241501A/B	INERT GAS GENERATOR	2 X 100%
PN-GG-5241501A-02	INERT GAS GENERATOR UNIT LOCAL CONTROL PANEL	1 X 100%
PN-GG-5241501B-02	INERT GAS GENERATOR UNIT LOCAL CONTROL PANEL	1 X 100%
B-GG-5241501A/B	DIESEL OIL PUMP UNIT FOR INERT GAS	2 X 100%
EXT-GG-5241501A-A/B	EXHAUST FANS FOR FUEL GAS PIPE CASING	2 X100%
EXT-GG-5241501B-A/B	EXHAUST FANS FOR FUEL GAS PIPE CASING	2 X100%
VT-GG-5241501A/B	INERT GAS GENERATOR BLOWER	2 X 100%
Z-GG-5241501A/B	VENTILATED FUEL GAS SUPPLY CABINET	2 X 100%
TQ-GG-5241501A/B-01	DECK WATER SEAL (MAIN)	1 X 100%
TQ-GG-5241501A/B-02	PRESSURE / VACUUM BREAKER (MAIN)	1 X 100%
TQ-GG-5241501A/B-03	PRESSURE / VACUUM BREAKER (AUXILIAR)	1 X 100%
TQ-GG-5241501A/B-05	DECK WATER SEAL (AUXILIAR)	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. A set of control valves to be defined by PACKAGER.

5.2.2. PACKAGER shall provide devices for control, protection and interlocking to keep the IGGs discharge pressure, flow, gas return, O₂ gas content and temperature under the safe and allowable operational limits of the inert gas system.

5.2.3. Devices for control, protection and interlocking requirements are detailed on item 6.12.4.

5.2.4. Non return valves and shut down valves (Deck Isolation Valves) to ensure gas flow non-return.

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

5.2.6. Inert Gas nozzles inside each cargo area tank (cargo oil, slop, produced water and off-spec oil tanks) at the tank inert gas piping inlet end.

5.2.7. A portable O₂ analyzer.

5.3. EQUIPMENT LOCATION

PACKAGE components are to be installed according to the below table 2:

TAG	Equipment	Location	Qty
GG-5241501A/B	INERT GAS GENERATOR	Forecastle (specific room)	2
B-GG-5241501A/B	DIESEL OIL PUMP UNIT FOR INERT GAS	Forecastle (specific room)	2
EXT-GG-5241501A/B- A/B	EXHAUST FANS FOR FUEL GAS PIPE CASING	Forecastle (specific room)	4
VT-GG-5241501A/B	INERT GAS GENERATOR BLOWER	Forecastle (specific room)	2
Z-GG-5241501A/B	VENTILATED FUEL GAS SUPPLY CABINET	Forecastle (specific room)	2
TQ-GG-5241501A/B-01	DECK WATER SEAL (MAIN)	Main Deck	1
TQ-GG-5241501A/B-02	PRESSURE / VACUUM BREAKER (MAIN)	Main Deck	1
TQ-GG-5241501A/B-03	PRESSURE / VACUUM BREAKER (AUXILIAR)	Main Deck	1
TQ-GG-5241501A/B-05	DECK WATER SEAL (AUXILIAR)	Main Deck	1
---	INERT GAS INJECTION NOZZLES	Inside cargo, slop, produced water and off- spec oil tanks	23

Table 3 – PACKAGE equipment location

- 5.3.1. P/V Breakers, Deck Water Seals, non-return valves and shut-down valves shall be installed on Main Deck and outside the Inert Gas Generator Room (Forecastle).
- 5.3.2. TQ-GG-5241501A/B-02 – Pressure / Vacuum Breaker (Main) and TQ-GG-5241501A/B-03 Pressure / Vacuum Breaker (Auxiliar) shall be installed on cargo area as close as possible of UNIT midship.
- 5.3.3. Deck Water Seal (Main) – TQ-GG-5241501A/B-01 and Deck Water Seal (Auxiliar) – TQ-GG-5241501A/B-05 shall be installed as close as possible of the Inert Gas Generators compartment which is at the Forecastle.
- 5.3.4. Forecastle is a closed and non-classified compartment and Main Deck is a classified area.
- 5.3.5. For Areas Classification refer to I-DE-3010.1Y-5400-94A-P4X-001 – AREA CLASSIFICATION - GENERAL.
- 5.3.6. I-DE-3010.1Y-1200-942-P4X-001 – GENERAL ARRANGEMENT shall be used as reference for equipment location.

6. PACKAGE TECHNICAL SPECIFICATION

6.1. INERT GAS GENERATOR (GG-5241501 A/B)

- 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 m³/h (1,25 x 6 pumps x 1200 m³/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 and off-spec oil tanks in two main services:
- Offloading operation.
 - Cargo, slop, produced water and off-spec oil tanks purging operation.
 - Note 1: for simultaneous operations, inert gas generator A (GG-5241501 A) shall be set for the Offloading operation and Inert Gas Generator B (GG-5241501 B) for the cargo, slop, produced water and off-spec oil tanks purging.
 - Note 2: for non-simultaneous operations (only offloading or purging) any Inert Gas Generator (GG-5241501A/B) may be set for use.
- 6.1.4. The Inert Gas Generator (GG-5241501A/B) shall be of automatic dual fuel type,

burning fuel gas as the main fuel and diesel oil as the secondary one.

6.1.5. Inert Gas Generator (GG-5241501 A/B) shall ensure that pressure and flow parameters are following the PACKAGER requirements according the FPSO Hull draft variation.

- PACKAGER shall provide control and protection for no flow or low sea water flow to feed GG-5241501A/B.
- PACKAGER shall provide control and protection for high water level in GG-5241501A/B scrubber.

6.1.6. Each Inert Gas Generator (GG-5241501 A/B) shall have an independent sea water draining line with the discharge to the sea through the Hull structural shell side.

- Inert Gas Generator (GG-5241501 A/B) sea water drain design parameters as piping lines diameter, inclination and position shall be designed following the PACKAGER recommendations.
- Inert Gas Generator (GG-5241501 A/B) sea water drain shall be compatible with the sea water with acid pH. Sea water quality requirement shall be defined by PACKAGER.
- all parts in contact with the sea water shall have proper material to work with this fluid even in high temperature.
- The Inert Gas Generator (GG-5241501 A/B) sea water draining lines design shall be approved by PACKAGER.

6.1.7. Inert Gas Generator shall be supplied with fresh water flushing for the cooling jacket, scrubber and other components exposed to seawater, to be defined by PACKAGER design.


- For fresh water refer to I-DE-3010.1Y-5115-944-P4X-003 – 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 or device.

6.1.9. Inert Gas Generator (GG-5241501 A/B) 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.

6.1.10. The following design parameters shall be confirmed and revised according to the PACKAGER recommendations during the design detail phase:

- maximum delivery pressure at Inert Gas Generator (GG-5241501 A/B) assembly outlet: 1200 mmWC.

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<ul style="list-style-type: none"> ○ maximum temperature of inert gas at scrubber outlet: 10°C above sea water temperature. ○ O₂ content: 2 – 4%. ○ For sea water maximum inlet temperature requirements refer to I-ET-3A36.00-1000-941-PPC-001 METOCEAN DATA. ○ For other remaining design parameters refer to I-DE-3010.1Y-5241-944-P4X-003 – INERT GAS SYSTEM. <p>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.</p> <p>6.1.12. For contingency operations, the inert gas system shall be able to provide inert gas from a range of 500 Nm³/h to 9,000 Nm³/h at the specified oxygen levels to allow a slow inertization of ballast, cofferdam, and void tanks.</p> <ul style="list-style-type: none"> ○ Note: the speed control for the IGGs may be performed by a variable speed blower (VSD driven) or by actuation of FV / PV valves or a combination of both solutions. Other arrangements may be submitted for OWNER approval. <p>6.2. INERT GAS GENERATOR BLOWERS (VT-GG-5241501 A/B)</p> <p>6.2.1. Two (2) Inert Gas Generator Blowers (VT-GG-5241501 A/B) (2x100%) shall be designed to supply safe ambient air to the Inert Gas Generator (GG-5241501 A/B).</p> <p>6.2.2. Inert Gas Generator Blowers (VT-GG-5241501 A/B) shall be centrifugal type electrical driven 2 x 100% redundancy and dimensioned for the total production of one (1) generator running at full load.</p> <p>6.2.3. Inert Gas Generator Blowers (VT-GG-5241501 A/B) shall be designed for 9,000 m³/h which is 1,25 of the maximum cargo pumps flow rate (1,25 x 6 cargo pumps x 1,200 m³/h maximum cargo pumps flow rate).</p> <p>6.2.4. Inert Gas Generator Blowers (VT-GG-5241501 A/B) shall have drip tray and drain connection to the Hull draining systems.</p> <p>6.2.5. Inert Gas Generator Blowers (VT-GG-5241501 A/B) electrical motors shall have soft-starters as required in I-ET-3010.00-5140-700-P4X-003 – ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS.</p> <p>6.2.6. PACKAGER shall provide protection for low flow and low pressure of combustion air and for the Inert Gas Generators (GG-5241501A/B) burners flame out.</p>			

6.3. DIESEL OIL PUMP UNIT FOR INERT GAS (B-5241501A/B)

6.3.1. Diesel Oil Pump Unit for Inert Gas (B-5241501A/B) 2x100% configuration electrical driven type shall be designed to attend the diesel oil supply for both the Inert Gas Generator (GG-5241501A/B).

6.3.2. Diesel Oil Pump Unit for Inert Gas (B-5241501A/B) receive the diesel oil from one (1) dedicated structural Diesel oil daily tank (TQ-GG-5241501A/B-04) which are not under PACKAGE scope of supply.

- Note: For diesel oil daily tank data sheet refer I-FD-3010.1Y-5133-510-P4X-002 – DIESEL OIL DAILY TANK FOR INTER GAS GENERATORS (TQ-GG-5241501A/B-04).

6.3.3. Diesel Oil Pump Unit for Inert Gas (B-5241501A/B) type (centrifugal or positive displacement) shall be defined by PACKAGER according to the PACKAGE design parameters and requirements.

6.3.4. Diesel Oil fluid parameters are detailed on item 6.15.

6.3.5. One (1) drip tray shall be installed at the bottom of each pump skid with proper connection flange ASME B16.5 for Hull bilge system lines to be disposed at Bilge Well located at the Forecastle bottom.

6.3.6. Diesel Oil Pump Unit for Inert Gas (B-5241501A/B) shall be controlled only by two panels: one (1) remote control panel in the CCR and one local panel installed on IGG compartment, both to be supplied by PACKAGER.

6.3.7. PACKAGER shall provide protection for low flow / low pressure of diesel oil to the Inert Gas Generators (GG-5241501A/B) burners. PACKAGER shall also provide protection for the Inert Gas Generators (GG-5241501A/B) burners flame out.

6.3.8. PACKAGER shall provide protections for eventual reverse flow on pumps B-GG-5241501A/B.

6.4. VENTILATED FUEL GAS SUPPLY CABINET (Z-GG-5241501A/B)

6.4.1. Each Ventilated Fuel Gas Supply Cabinet (Z-GG-5241501A/B) shall be permanently ventilated by two (2) extracting fans.

- i. Exhaust fans for fuel gas pipe casing (EXT-GG-5241501A-A/B) 2 x 100% shall have automatic stand-by for continuous supply to Z-GG-5241501A.
- ii. Exhaust fans for fuel gas pipe casing (EXT-GG-5241501B-A/B) 2 x 100% shall have automatic stand-by for continuous supply to Z-GG-5241501B.
- iii. Exhaust fans shall have the discharge directed to a safe area outside the Inert Gas Generator room as indicated on I-DE-3010.1Y-5241-944-P4X-003 - INERT GAS SYSTEM.

- iv. Exhaust fans discharge location shall be approved by CS (min 2.4 m above the vent penetration deck).
- v. Ventilated Fuel Gas Supply Cabinet shall be supplied with gas detectors (H₂S and CH₄).
- vi. Exhaust fans for fuel gas pipe casing (EXT-GG-5241501A/B-A/B) shall be axial type driven by electric motors.
- vii. Expansion joints at the exhaust fans suction and discharge shall be provided to account for vibration issues and shall be supplied by PACKAGER.

6.4.2. Ventilated Fuel Gas Supply Cabinets (Z-GG-5241501A/B) shall be considered as a Hazardous Area.

6.4.3. Fuel gas system shall have a double blocking system provided by valves (not PACKAGER scope of supply) to avoid the fuel gas to be continuously supplied in case of fuel gas cabinet ventilation fail.

6.4.4. Ventilation cabinet vent shall be directed to a safe location to be defined by CS.

6.4.5. Ventilated Fuel Gas Supply Cabinet (Z-GG-5241501A/B) shall be connected with both Topside fuel gas line and Inert Gas Generators (GG-5241501A/B) through a pipe-in-pipe type line with the main requirements as below:

- i. the annular of this piping shall be continuously exhausted through the ventilation cabinet exhausters.
- ii. the presence of gas in the exhausted gas discharge shall start the safety procedures required by CS.
- iii. the fuel gas piping inside non classified areas shall be all welded and with length as short as possible. Maximum length to be defined by PACKAGER.
- iv. to be fabricated in stainless steel AISI 316L or similar (at least the pipe-in-pipe inside the gas cabinet).

6.4.6. Fuel gas hoses shall have the following minimum requirements:

- i. fuel gas hoses shall be double walled type flexible hoses.
- ii. double walled flexible hoses are not under PACKAGER scope of supply, but all design recommendations and requirements as within this topic are PACKAGER responsibility.
- iii. double walled flexible hose design shall be submitted to the PACKAGER for approval.

iv. double walled flexible hose length shall follow PACKAGER requirements.

6.4.7. Fuel Gas parameters are detailed on item 6.15.

6.4.8. PACKAGER shall provide protection for low flow / low pressure of fuel gas to the Inert Gas Generators (GG-5241501A/B) burners. PACKAGER shall also provide protection for Inert Gas Generators (GG-5241501A/B) burners flame out.

6.5. INERT GAS SYSTEM LOCAL AND REMOTE CONTROL PANELS

6.5.1. The local control panels for the inert gas system are composed by two (2) panels called Inert Gas Generator Unit Local Control Panel (PN-GG-5241501A/B-02), being one (1) dedicated for each IGG.

6.5.2. Inert Gas Generator Unit Local Control Panel (PN-GG-5241501A/B-02) shall be installed on the inert gas compartment.

6.5.3. The inert gas system 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.

6.5.5. The selection key status shall be indicated on both inert gas remote and local control panels.

6.5.6. The inert gas remote control panel shall be independent from SOS-HMI which will be solely dedicated to the system register and alarms.

6.5.7. The remote control panel shall execute all functions of control, start, stop and alarms of this system;

6.5.8. Inert Gas Generator Unit Local Control Panel (PN-GG-5241501A/B-02) 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.

6.5.9. Inert Gas Generator Unit Local Control Panel (PN-GG-5241501A/B-02) and remote control panels shall indicate the Inert Gas Generator Seawater Pumps (B-5241502A/B) and the Inert Gas Seal Pumps (B-5241502A/B) working conditions.

6.5.10. Except otherwise indicated, all system components, such as valves and fans, shall be remotely controlled from the CCR by means of an adequate instrumentation, to allow a complete control and monitoring of the system.

6.5.11. Both inert gas system local / remote control panels and the corresponding selection keys are PACKAGER scope of supply.

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 all system components under the allowable limits.

6.6.2. Automation and instrumentation of the control valves systems shall follow the PACKAGER recommendations.

6.6.3. Control valves specification and actuation system design shall be defined by the PACKAGER.

6.6.4. Pneumatic control valves shall have actuators FO/FC/FL (position of Valve in shutdown/standby position). The definition of the failure modes for those actuators shall be according to CS and Statutory rules.

6.7. INERT GAS NON-RETURN VALVES

6.7.1. 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.

6.7.2. Adequate barriers shall be provided on inert gas distribution header and purge header to avoid the gas return from the cargo area tanks back to the Inert Gas Generator compartment.

6.7.3. Retention Non-return Valves minimum requirements:

- i. As a primary barrier of the gas return, a retention (non-return) valve shall be fitted on Main Deck downstream of both Deck Water Seals (Main and Auxiliary) at the inert gas distribution and purging header.
- ii. Retention valves shall be provided with positive means of closure.
- iii. Retention valves are considered safety devices and shall be designed according to the SOLAS requirement Chapter II – 2.
- iv. Retention valves shall be installed downstream the Deck Water Seals (Main and Auxiliary) and upstream the Inert Gas Distribution and Purging Headers.
 - o Note: a spectacle flange (not PACKAGER scope) shall be installed within Deck Water Seals (Main and Auxiliary) and the corresponding Retention Valves.
- v. A separate deck isolating valve shall be fitted upstream the non-return valve, in order to keep the inert gas main components isolated from the non-return devices.

6.7.4. The non-return retention valves shall be designed for 9,000 m³/h which is 1,25 of the maximum cargo pumps flow rate (1,25 x 6 cargo pumps x 1,200 m³/h maximum cargo pumps flow rate).

6.8. INERT GAS SEALING AND DECK WATER SEALS

- 6.8.1. Deck Water seals have the purpose to ensure the inert gas non-return to the IGGs compartment through the inert gas distribution lines:
- 6.8.2. as a secondary barrier of gas return, two identical Deck water Seals shall be supplied: one (1) Deck Water Seal (Main) for the inert gas distribution header water sealing and other one (1) Deck Water Seal (Auxiliary) for the purging header water sealing.
- 6.8.3. Deck water seals shall be designed according to the SOLAS requirement Chapter II – 2.
- 6.8.4. Deck Water Seals Main and Auxiliar shall be designed for 9,000 m³/h which is (1,25 x 6 cargo pumps x 1,200 m³/h maximum cargo pumps flow rate).
- 6.8.5. Deck Water Seal shall have the following sea water sealing system minimum requirements:
- i. Deck Water Seals exclusively dedicated sea water sealing system shall be composed by two (2) electric driven sea water centrifugal pumps (2 x 100%) to be installed in Engine Room.
 - o Note: those two (2) sea water pumps, called Inert Gas Seal Pumps (B-5241501A/B), are NOT under PACKAGE scope of supply, but all their automation, instruments and control devices shall be designed and supplied following the PACKAGER recommendations.
 - ii. Sea water inside the Deck Water Seals shall be kept at a minimum water level compatible with the maximum pressure on the tanks.
 - iii. All materials used in equipment circulated by sea water (i.e., Scrubber, Deck Seal) shall be suitable for circulating sea water.
 - iv. Sea water sealing minimum requirements shall be defined by PACKAGER.
 - v. Deck Water Seals shall be provided with means to ensure the water sealing operation under sea water freezing temperature.
 - o Note: this requirement may be disregarded if approved by CS.
- 6.8.6. PACKAGER shall provide protection for sea water sealing low flow rating.
- 6.8.7. Deck Water Seals shall be internally coated with polyethylene or similar material subject for OWNER approval.
- 6.8.8. Internal painting scheme or lining shall be defined with the purpose to resist to sea water effects with high pH levels. Painting scheme shall be defined by PACKAGER and shall be submitted to OWNER for approval.
- 6.8.9. Deck Water Seals monitoring and control system shall have the following minimum requirements:

- i. an automatic control to ensure a safe operational level.
- ii. water sealing level shall be monitored by SOS-HMI.
- iii. the high and low alarms levels shall be monitored on CCR.

6.8.10. Deck Water Seals draining system are not PACKAGER scope of supply, but PACKAGER recommendations shall be applied:

- i. Draining from the equipment itself to the overboard shall have the design approved by PACKAGER.
- ii. Draining piping lines / valves position and material shall have the design be approved by PACKAGER.
- iii. Draining piping material shall be compatible with the sea water standard by considering the pH levels.

6.8.11. The automation and instrumentation of the sealing systems shall follow the PACKAGER recommendations.

6.9. DECK ISOLATING VALVES

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

6.9.2. Those valves shall be installed downstream the Deck Water Seals and upstream the non-return valves with the purpose to isolate the inert gas distribution and purging headers from the Inert Gas Generator (GG-5241501A/B).

6.9.3. Deck isolating valves shall be of bi-eccentric butterfly flanged type and as PACKAGER scope of supply.

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

6.9.5. For Deck isolating valves specification refer to I-DE-3010.1Y-5241-944-P4X-003 – INERT GAS SYSTEM.

6.10. PRESSURE / VACUUM BREAKERS

6.10.1. Pressure / Vacuum breakers (P/V Breakers) TQ-GG-5241501A/B-02 (Main) and TQ-GG-5241501A/B-03 (Auxiliar) are safety devices responsible to keep the inert gas system pressure under the allowable limits.

6.10.2. P/V Breakers are the last pressure barrier and shall follow the minimum technical requirements as below detailed on the next items.

6.10.3. P/V Breakers connection with the respective headers shall be done by a single manual shut-down valve locked opened set with the open / close position monitored by the SOS-HMI.

- Note: the above P/V Breaker piping connection with header, the header itself and the shut-down valve are not PACKAGER scope of supply.

6.10.4.P/V Breaker shall be sealed with fresh water supplied by Hull fresh water system.

- Note: for Hull Fresh Water System refer to I-DE-3010.1Y-5115-944-P4X-003 – P&ID FRESH, HOT AND POTABLE WATER SYSTEM DISTRIBUTION.

6.10.5.P/V Breaker shall be internally coated with the same painting scheme as the fresh water storage tanks of the UNIT. Refer to item 7.3.

6.10.6.P/V Breakers discharge to the atmosphere shall be installed in a safe position to avoid vented gas presence in surrounded non classified areas.

6.10.7.P/V Breakers water level shall be monitored by the SOS-HMI and with high and low level alarms.

6.10.8.P/V Breakers shall have level sight glass.

6.10.9.P/V Breakers automation and instrumentation design shall follow the PACKAGER recommendations. For instrumentation and automation requirements refer to item 7.2 of this specification.

6.10.10. For P/V Breakers Vacuum / Pressure set points and additional requirements refer to I-DE-3010.1Y-5241-944-P4X-004 – INERT GAS DITRIBUTION SYSTEM and I-DE-3010.1Y-5271-944-P4X-001 – TANK CLEANING AND RECIRCULATION SYSTEM.

6.11. INERT GAS VENT SYSTEM

6.11.1. PACKAGER shall provide inert gas vent system with vent posts to be installed on the inert Gas Generators (GG-5241501), inert gas system distribution lines and on the fuel gas system cabinet (Z-GG-5241501A/B).

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

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

6.11.4. 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.

6.11.5. Relief systems vent posts shall be directed to a safe location approved by CS.

6.11.6. For fuel gas pipe-in-pipe vent systems refer to item 6.4.5.

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

6.11.8. For piping and automation logic refer to I-DE-3010.1Y-5241-944-P4X-003 – INERT GAS SYSTEM PIPING AND INSTRUMENT DIAGRAM.

6.12. INERT GAS PROTECTION AND CONTROL DEVICES

6.12.1. 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.

6.12.2. For pressure control, a Deck Pressure Monitoring system shall be installed downstream the Deck Water Seals with at least two pressure transmitters interlocked with a pneumatic pressure valve installed downstream the IGGs.

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

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

- a. Devices for control, protection and interlocking for high fuel gas flow and high pressure of fuel gas lines.
- b. Devices for control, protection and interlocking for overpressure on the GG-5241501A/B inert gas discharge.
- c. Devices for interlocking with very low pressure (PSLL) upstream the inert gas diesel oil pump, B-GG-5241501A/B, to stop this pump.
- d. Devices for interlocking with O₂ high content at the AITs installed at the discharge of Inert Gas Generators (GG-5241501A/B) to stop the Inert Gas Generators (GG-5241501A/B).
- e. Devices for control and protection for the event of Inert Gas Generators (GG-5241501A/B) sea water feeding low flow to the Inert Gas Generators (GG-5241501A/B).
- f. Devices for control, protection and interlocking for IGG scrubbers' high level (LSH) to stop the sea water pumps (B-5241501A/B).
- g. Inert Gas Generators (GG-5241501A/B) fuel feeding system shall have double blocking valves to avoid fuel gas feeding in case of IGGs ventilation interruption as mentioned on item 6.4.3 of this technical specification.
- h. Devices for the system control, protection and / or interlocking as mentioned on item 6.2.6, 6.3.8, 6.4.8, 6.8.6 of this technical specification.


- 6.12.5. PACKAGER shall provide at least two (2) O₂ analyzers (AIT), being at least one (1) fitted for each IGG.
- 6.12.6. O₂ presence in inert gas shall have the maximum content 2% when the inert gas is generated in fuel gas mode and 4% in diesel oil mode.
- 6.12.7. In case of system overpressure or high O₂ content at the IGGs discharge the inert gas flow shall be directed to the IGGs vent posts.
- 6.12.8. PACKAGER shall provide proper flow devices such as a flow Venturi pipe downstream the IGGs. The pipeline upstream and downstream the flow Venturi shall have minimum straight length defined by PACKAGER.
- 6.12.9. In addition to 6.12.4 PACKAGER shall provide any other remaining Hull Inert Gas Generators PACKAGE protection, interlocking and control according to applicable CS and statutory rules (trip in ignition failure, lack of supply air, and other typical IGG interlock as per PACKAGER design).
- 6.12.10. Inert Gas Generator (GG-5241501 A/B) automation and instrumentation shall follow the PACKAGER recommendation.
- 6.12.11. For inert gas piping and automation logic refer to I-DE-3010.1Y-5241-944-P4X-003 – INERT GAS SYSTEM PIPING AND INSTRUMENT DIAGRAM.

6.13. INERT GAS INJECTION NOZZLES

- 6.13.1. One (1) injection nozzle shall be installed internally on tank top of each cargo, slop, produced water and off-spec oil tank at the inert gas tank inlet piping end.
- 6.13.2. Nozzle's diameter shall produce a sufficient jet depth to reach the cargo area tanks bottom.
- 6.13.3. The inert gas velocity shall not exceed 40 m/s in any section of the gas distribution piping, thus avoiding excessive pressure drop in the system when operating at maximum capacity.
- 6.13.4. Injection nozzles material shall be defined by PACKAGER but with minimum requirement standard of a stainless steel AISI 316.
- 6.13.5. For injection nozzles installation on tanks refer to I-ET-3010.1Y-1350-200-P4X-001 – HULL PIPING PRACTICE.

6.14. INERT GAS SYSTEM GENERAL REQUIREMENTS

- 6.14.1. 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).

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6.14.2. 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:

- i. Inert Gas System pipelines diagram.
- ii. PACKAGE arrangement on exposed deck with the restriction's indications and recommendations for the Deck Water Seals 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.

6.14.3. 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.

6.14.4. 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.

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

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

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

6.15. DIESEL OIL AND FUEL GAS SPECIFICATION

6.15.1. For the Diesel Oil and Fuel Gas specification refer to I-RL-3010.1Y-1200-940-P4X-001 – GENERAL SPECIFICATION FOR AVAILABLE UTILITIES.

7. GENERAL REQUIREMENTS

7.1. ELECTRICAL REQUIREMENTS

7.1.1. All electrical equipment installed in hazardous areas (see Area Classification documentation) or installed outdoors and kept on during emergency condition (ESD) shall be certified according to IEC 61892, INMETRO Resolution 179, May 18th 2010 and INMETRO resolution 89, February 23rd 2012.

7.1.2. All electrical signal connections for external interconnection with the panel shall be clustered in junction boxes with at least IP-56 level of protection, located inside

the panel and grouped according to the different types of signals involved.

7.1.3. Electrical equipment and material shall comply with requirements of I-ET-3010.00-5140-700-P4X-002 – SPECIFICATION FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.

7.1.4. Electrical induction motors shall comply with requirements of I-ET-3010.00-5140-712-P4X-001 – LOW-VOLTAGE INDUCTION MOTORS FOR OFFSHORE UNITS.

7.1.5. Concerning electrical system voltages and quantity of feeders for motors, panels and auxiliaries, centrifugal pumps shall be fed according to definitions of I-ET-3010.00-5140-700-P4X-003 – ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS.

7.1.6. Power lighting and grounding installations inside the package shall comply with requirements of I-ET-3010.00-5140-700-P4X-003 – ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS.

7.1.7. Grounding installations shall comply with I-ET-3010.00-5140-700-P4X-001 – SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS and I-DE-3010.00-5140-700-P4X-003 – GROUNDING INSTALLATION TYPICAL DETAILS.

7.2. INSTRUMENTATION AND AUTOMATION REQUIREMENTS

7.2.1. PACKAGE shall be protected with all necessary instruments to operate safely, adequately and without interruption in a tropical marine environment.

7.2.2. The instrumentation and control design shall fulfill the requirements of

- i. I-ET-3010.00-1200-800-P4X-002 – AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS and of
- ii. I-ET-3010.00-1200-800-P4X-013 – GENERAL CRITERIA FOR INSTRUMENTATION PROJECTS.

7.2.3. The minimum requirements for the adequate interfacing of the PACKAGE Automation and Instrumentation System with the UNIT are described on I-ET-3010.1Y-1200-800-P4X-014 – AUTOMATION INTERFACE OF PACKAGE UNITS.

7.2.4. For the control and automation panels design requirements I-ET-3010.00-5520-888-P4X-001 – AUTOMATION PANELS shall be considered.

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 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 also to ensure the lifting conditions on manufacturing site and shipyard. Lifting lugs shall be provided according to PACKAGER lifting procedure.

7.4.3. Skid foundation structural steel components shall be designed and fabricated in accordance with AISC ASD.

7.4.4. 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.

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

7.4.6. 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. Instruments and alves 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 be metallic type and designed according to PACKAGER / MANUFACTURER standard and to the industrial recognized international codes.

7.4.9. PACKAGE skid shall have a drip tray to collect drained water from the equipment with drain flanges for the connection with the Hull draining system.

7.4.10. PACKAGE Equipment and components shall be located entirely within the skids / equipment base perimeter, including all equipment, piping, valves, electrical, instrumentation and controls.

7.5. AVAILABLE ON BOARD

7.5.1. For utilities available onboard refer to I-RL-3010.1Y-1200-940-P4X-001 – GENERAL SPECIFICATION FOR AVAILABLE UTILITIES.

7.6. NAMEPLATES AND TAG NUMBERING

- 7.6.1. 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.
- 7.6.2. Tagging of all instruments, electrical, mechanical and piping items, including valves, shall be carried out.
- 7.6.3. Tags shall be supplied with the number and description in the Brazilian Portuguese Language, unless otherwise stated in the technical data sheets.
- 7.6.4. For TAG numbering refer to I-ET-3000.00-1200-940-P4X-001 – TAGGING PROCEDURE FOR PRODUCTION UNITS DESIGN
- 7.6.5. For Instrumentation tagging the ISA –5.1 and N-1710 shall be followed.

8. MANUFACTURING

- 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. QUALITY ASSURANCE AND CONTROL SYSTEM

- 8.2.1. Engineering, fabrication and manufacturing shall conform to good manufacturing practices. Quality system according to ISO 9001 in relevant extent shall be in place and implemented.

8.3. WELDING AND NDT

- 8.3.1. All equipment, structures and piping welds shall be performed according to the requirements described in the latest revision of I-ET-3010.00-1200-955-P4X-001 – WELDING.
- 8.3.2. Welding shall be carried out with procedures and welders qualified in accordance with ASME Section IX. Welding shall not be performed before qualified welding

procedures have been approved.

8.3.3. Intermittent fillet welds are not acceptable.

8.3.4. Welding inspection and NDTs shall be performed according to the requirements described in the latest revision of

- I-ET-3010.00-1000-970-P4X-002 – REQUIREMENTS FOR NDT and
- I-ET-3010.00-1200-955-P4X-002 – REQUIREMENTS FOR WELDING INSPECTION.

8.3.5. Qualification and Certification for procedures and personnel shall be in accordance with I-ET-3010.00-0000-970-P4X-001 – REQUIREMENTS FOR PROCEDURES AND PERSONNEL QUALIFICATION AND CERTIFICATION.

8.3.6. Final NDTs, for acceptance purposes shall be carried out after completion of any post weld heat treatment (when applicable) and before the applications of painting, hydrostatic testing, etc.

8.4. INSPECTION AND TESTS

8.4.1. PACKAGER / MANUFACTURER shall develop and implement an Inspection and Test Plan (ITP) containing hold points, review and witness points following the schedule of the PACKAGE inspections, tests and events accordingly.

8.4.2. PACKAGE inspection, tests and events shall be attended by the MANUFACTURER, PACKAGER, HULL SUPPLIER, CS and OWNER inspection team whenever necessary.

8.4.3. PACKAGE shall be tested according to the design codes, applicable industry standards, CS Rules and any other one requirement stated on this technical specification.

8.4.4. Unless waive by OWNER, the following PACKAGE inspections and checks shall be witnessed by OWNER inspector:

- i. verification of equipment construction materials (vessels, heat exchangers, pumps, etc.) for conformity with the specification requirements.
- ii. verification of piping, fittings and valves conform to specification of materials and fabrication.
- iii. reports for all NDT performed on the pressure retaining parts (radiographic, dye penetrant, magnetic particles and ultrasonic inspection);
- iv. approval of the relief valve settings and witness of their testing after setting.

- v. review of Inspection and Test Records.
- vi. visual check.
- vii. Electrical tests as:
 - a MEGGER test for cables and electric motors.
 - all tests stated in the respective motors and power / control panel respective specifications.

8.5. FACTORY ACCEPTANCE TEST (FAT)

8.5.1. FAT is a set of functional and performance tests to be executed in any equipment, electrical, instrumentation and telecom panels or any other commissionable item carried out on the PACKAGER / MANUFACTURER factory or in specialized test facilities, in order to demonstrate its compliance with the project specifications and allow its release to shipyard.

8.5.2. For Factory Acceptance Test (FAT) minimum scope requirements:

- i. Pressure test (usually hydrostatic) test of all vessels, heat exchangers, tanks, pumps, pipes and valves.
 - o Note: All piping systems and equipment shall be drained and dried after hydrostatic testing.
- ii. Performance test, NPSH test and Mechanical running test of all pumps.
- iii. Electrical continuity checks on all wiring and earthing.
- iv. Functional checks on all instruments and valves.
- v. Alarms and Equipment Protection Tests.
- vi. All other equipment tests and factory checking to be carried out according to the FAT procedure approved by parts.

8.5.3. For Factory Acceptance Test (FAT) event invitation e reports:

- i. OWNER, CS and HULL SUPPLIER shall be communicated about the FAT event following ITP and the fabrication schedule. FAT invitation schedule shall be negotiated during PACKAGE kick-off meeting on the detail design phase.
- ii. PACKAGER shall issue the FAT procedure for all parts involved as OWNER, HULL SUPPLIER and CS, where applicable, and submit to them for approval.



- iii. PACKAGER shall issue the FAT report with all test results and duly signed or stamped by all parts that witnessed the FAT and with the necessary test documentation attached.
- iv. Acceptance of FAT will not be considered as the final acceptance test of the PACKAGE.

8.6. PRE-COMMISSIONING AND COMMISSIONING

- 8.6.1. PACKAGER / MANUFACTURER shall be required to provide any necessary support for installation, assembly, pre-commissioning and commissioning of the PACKAGE either at a shore based fabrication yard or onboard the FPSO.
- 8.6.2. PACKAGER / MANUFACTURER is responsible for assembly supervision of the PACKAGE equipment, including the assembly of components to be delivered loose (for example, some components of the pumps, like stuffing box, etc.).
- 8.6.3. Final acceptance will be on satisfactory completion of commissioning tests as specified by OWNER.

9. PACKAGE DELIVERY REQUIREMENTS

9.1. PRESERVATION, PACKING AND TRANSPORTATION

- 9.1.1. PACKAGER / MANUFACTURER shall ensure all the conditions and practices of preservation, packing and transportation are fulfilled and following the PACKAGE / Equipment specific and technical characteristics recommendations.
- 9.1.2. PACKAGER / MANUFACTURER shall submit to HULL SUPPLIER the PACKAGE preservation requirements and recommendations with all necessary considerations for the PACKAGE Equipment preservation during the UNIT whole design life.
- 9.1.3. Preservation and packing shall be proper for transportation and storage in a marine environment and protected against moisture and damage during transport, handling and lifting.
- 9.1.4. In any case, suitable preservation and protective measures shall be provided to prevent equipment deterioration prior to entering into service.
- 9.1.5. All packings shall be clearly marked for shipping, including lifting points, gross weight, dimensions and center of gravity.
- 9.1.6. All sea fastening and temporary supports used on the equipment for shipment shall be clearly identified.
- 9.1.7. PACKAGER / MANUFACTURER shall ensure that all loose valves, tubes and instruments are supplied with plastic caps.
- 9.1.8. PACKAGER / MANUFACTURER shall also ensure that all electric panels and

motors will be supplied with Volatile Corrosion Inhibitor (VCI) impregnated plastic protection or similar, and external plug for space heater connection.

9.1.9. PACKAGER / MANUFACTURER shall provide clear and comprehensive instructions on the exterior of all packages advising the necessary warning notices for unpacking, handling and installing the equipment on arrival at destination.

9.1.10. The equipment shall be thoroughly cleaned internally and be free of all loose foreign materials.

- i. The preparation shall make the equipment suitable for outdoor storage in a coastal tropical climate from the time of Shipment.
- ii. If there is a risk of damage to valves and other appurtenances during transportation, they shall be disconnected and tagged. All components shall then be securely packed as above.
- iii. Spare parts and tools to be packed separately and clearly marked "Spare Parts" and "Tools" respectively.

9.2. SPARE PARTS, CONSUMABLES AND TOOLS

9.2.1. Spare parts, consumables, and tools shall be provided by PACKAGER / MANUFACTURER as the following minimum requirements:

- i. All equipment / material consumable and spare parts recommended by PACKAGER / MANUFACTURER for the construction, testing, commissioning, pre-operation and start-up phases.
- ii. All spare parts recommended or required by the CS, such spare parts will be delivered together with the relevant equipment;
- iii. All special tools required for construction, pre-commissioning, commissioning and all levels of maintenance and operation
- iv. Spare parts list recommended by PACKAGER / MANUFACTURER for two years of operation.

9.3. DOCUMENTATION

9.3.1. Drawings and Weight Control

For Engineering Documentation minimum requirements:

- i. PACKAGER / MANUFACTURER design drawings shall show all necessary dimensions and details required for interface information and installation.
- ii. Clearances for maintenance shall be shown on the drawings.

- iii. Drawings and documents shall be clear and completely legible with all text in the English language.
- iv. Instruction manuals for operation and maintenance of the PACKAGE equipment shall be provided in Portuguese language.
- v. Drawings are only accepted when signed by PACKAGER as checked and approved. All revised editions of drawings or documents shall show the revisions clearly marked up, the issue date and PACKAGER's checked and approved signatures.
- vi. PACKAGER / MANUFACTURER shall produce a weight / center of gravity data sheet considering each PACKAGE component with the respective assembly dry and operational weight and CoG.
 - o Note: Operational weight means the component dry weight added to the respective component fluid weight on operational condition.
- vii. PACKAGER shall send in advance all recommendations for PACKAGE installation, maintenance and commissioning.

9.3.2. Data Book

PACKAGER shall issue a PACKAGE / Equipment Data Book to be delivered to HULL SUPPLIER for approval. Data Book minimum content shall be as the following:

- i. Certified drawings, data sheets, technical specifications, performance curves and calculation memorandum.
- ii. Construction, maintenance and operating manuals, instructions for preservation and commissioning, and all catalogs, including of the sub-suppliers.
- iii. All certificates of materials and equipment, certificates of electrical cables and equipment to hazardous areas, all tests, destructive and non-destructive examinations, test reports (including FAT), certificates and reports of classification society, procedures for welding qualifications and welding processes.
- iv. The documentation requested by Brazilian law NR-13, subdivided for equipment (if applicable).
- v. The documentation requested by Brazilian law NR-10, subdivided for equipment (if applicable).

Data Book delivery standard and conditions including number of parts and sections, number of printed and electronic copies will be further defined by OWNER on detail design phase.

9.4. TRAINING



TECHNICAL SPECIFICATION

Nr: I-ET-3010.1Y-5241-424-P4X-001

REV. A

BÚZIOS

SHEET: 34 of 34

TITLE:

HULL INERT GAS GENERATOR

INTERNAL

ESUP

9.4.1. PACKAGER shall provide training to qualify OWNER technicians for operation and maintenance (install, dismantle, replace parts, make adjustments, etc.) of each equipment.