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	CLIENT: SRGE		SHEET: 1 of 27
	JOB: REFERENCE HULL 01		
	AREA: -		
SRGE	TITLE: HULL INERT GAS GENERATOR		INTERNAL
			ESUP

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A	REVISED ACCORDING TO THE CONSISTENCY ANALYSIS

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PROJECT	ESUP	ESUP							
EXECUTION	CXZ0	CXZ0							
CHECK	U3Y0	T3P7							
APPROVAL	BYA6	BYA6							


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THIS FORM IS PART OF PETROBRAS N-381 REV.M 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 FPSO design documentation.

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.

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.

- ASME B31.3 – Process Piping
- ASME B16.5 – Pipe Flanges & Flanged Fittings

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- AWS D1.1 – Structural Welding Code
- 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)
- IEC International Electric Codes
- Classification Society defined for the Hull scope.

2.2. BRAZILIAN CODES AND STANDARDS


- NRs – Brazilian Federal Government Regulatory Norms (Normas Regulamentadoras).
- 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. REFERENCE DOCUMENTS
3.1. REFERENCE HULL 01 FPSO DESIGN

REF DOC NUMBER	REF DOC NAME
HULL SYSTEMS	
I-DE-3010.2E-1350-944-P4X-001	CLOSED VENTING SYSTEM
I-DE-3010.2E-1350-944-P4X-002	LOADING SYSTEM
I-DE-3010.2E-1350-944-P4X-003	CARGO SYSTEM
I-DE-3010.2E-5241-944-P4X-002	INERT GAS SEAWATER SYSTEM
I-DE-3010.2E-5241-944-P4X-003	INERT GAS SYSTEM
I-DE-3010.2E-5241-944-P4X-004	INERT GAS DISTRIBUTION SYSTEM
I-DE-3010.2E-5241-944-P4X-005	PURGING AND STRIPPING SYSTEM FOR SUBMERGED PUMPS PIPE STACKS

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I-DE-3010.2E-5271-944-P4X-001	TANKS CLEANING AND RECIRCULATION SYSTEM		
I-DE-3010.2E-5336-944-P4X-005	SLOP DISCHARGE SYSTEM		
I-DE-3010.2E-6124-944-P4X-001	HULL SERVICE AND INSTRUMENT AIR DISTRIBUTION SYSTEM		
I-ET-3010.2E-1350-200-P4X-001	HULL PIPING PRACTICE		
I-FD-3010.2E-5133-510-P4X-002	DIESEL OIL DAILY TANK FOR INERT GAS GENERATOR (TQ-GG-5241501A/B-04)		
I-FD-3010.2E-5241-311-P4X-001	INERT GAS GENERATOR SEA WATER PUMP (B-5241502A/B)		
I-FD-3010.2E-5241-424-P4X-001	INERT GAS GENERATOR (GG-5241501A/B)		
I-FD-3010.2E-5241-424-P4X-002	INERT GAS SEAL PUMP (B-5241501A/B)		
OUTFITTING			
I-DE-3010.2E-1351-140-P4X-001	HULL GENERAL NOTES AND TYPICAL DETAILS		
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-3010.00-1200-955-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		

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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		
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		
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 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		

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I-ET-3010.00-1200-800-P4X-013	GENERAL CRITERIA FOR INSTRUMENTATION PROJECTS
I-ET-3010.00-5500-854-P4X-001	MACHINERY MONITORING SYSTEM
I-ET-3010.00-5520-888-P4X-001	AUTOMATION PANELS
I-ET-3010.00-1200-800-P4X-015	REQUIREMENTS FOR TUBING AND FITTING (ALIGNED TO IOGP-JIP33 S-716)
SPECIFIC PROJECT DOCUMENTS (*)	
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 – Reference Documents

(*): specific project documents title and number may vary slightly from one project to another. Project's document list shall be consulted in order to verify the correct document number and title design requirements


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

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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 signaling shall be in full compliance with I-ET-3010.00-5400-947-P4X-002 – SAFETY SIGNALING.

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-003 – DESIGN PREMISSES - 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:

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%
SP-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, see item 6.6.
- 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 as detailed on item 6.12.4.
- 5.2.3. Non return valves and shut down valves (Deck Isolation Valves) to ensure gas flow non-return.
- 5.2.4. Two (2) Deck Pressure Monitoring System to be installed close to the Deck Water Seal Main and Auxiliar.
- 5.2.5. 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.
- 5.2.6. One (01) portable O₂ analyzer.

5.3. EQUIPMENT LOCATION

- 5.3.1. PACKAGE components are to be installed according to the below Table 3:

TAG	Equipment	Qty
Forecastle (specific room)		
GG-5241501A/B	Inert gas generator	2
B-GG-5241501A/B	Diesel oil pump unit for inert gas	2
EXT-GG-5241501A/B-A/B	Exhaust fans for fuel gas pipe casing	4
SP-GG-5241501A/B	Inert gas generator blower	2
Z-GG-5241501A/B	Ventilated fuel gas supply cabinet	2
Main Deck		
TQ-GG-5241501A/B-01	Deck water seal (main)	1
TQ-GG-5241501A/B-02	Pressure / vacuum breaker (main)	1
TQ-GG-5241501A/B-03	Pressure / vacuum breaker (auxiliar)	1
TQ-GG-5241501A/B-05	Deck water seal (auxiliar)	1
Inside cargo area tanks		
---	INERT GAS INJECTION NOZZLES	23


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Table 3 – PACKAGE equipment location

- 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- AREA CLASSIFICATION – GENERAL
- 5.3.6. I-DE-GENERAL ARRANGEMENT and I-DE-3010.2E-5241-944-P4X-003 – INERT GAS SYSTEM 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 Cargo 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.
- 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-5241501A/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.

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○ PACKAGER shall provide control and protection for high water level in GG-5241501A/B scrubber.

6.1.6. Each Inert Gas Generator (GG-5241501A/B) shall have an independent sea water overboard line as indicated on I-DE-3010.2E-5241-944-P4X-003 – 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 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 (GG-5241501 A/B) sea water cooling (for scrubbers) shall be limited to 40°C, considering most critical operational case and also considering highest expected sea water temperature defined in I-ET-METOCEAN DATA.

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-3010.2E-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 devices.

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.

- Note: If PACKAGE design consists of an Inert Gas Generator that may result in diesel oil discharge to the sea due to a misfire or flame out, regardless of the unlikeliness of such scenario, PACKAGER / HULL SUPPLIER shall include additional protections / interlocks, as well as piping, tanks, sensors, non-drip nozzles etc., to ensure diesel will not be discharged overboard in any situation. This design shall be approved by OWNER.

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

- maximum delivery pressure at Inert Gas Generator (GG-5241501 A/B) assembly outlet: 1200 mmWC.
- maximum temperature of inert gas at scrubber outlet: 10°C above sea water temperature.

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- O₂ content: 2 – 4%.
 - NOTE 1: Oxygen content for Inert Gas shall be adjustable on the PACKAGE HMIs.
 - NOTE 2: for lower content as 1% refer to item 6.12.6.
- For sea water maximum inlet temperature requirements refer to I-ET-METOCEAN DATA.
- For other remaining design parameters refer to I-DE-3010.2E-5241-944-P4X-003 – 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 Nm³/h to 9,000 Nm³/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 (VSD driven) or by actuation of FV / PV valves 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 (SP-GG-5241501 A/B) to perform cargo, slop, produced water and off-spec oil tanks Gas Freeing operation. The maximum Gas Freeing capacity shall be 9,000 Nm³/h, with possibility to adjust the flow between 500 Nm³/h to 9,000 Nm³/h.


6.2. INERT GAS GENERATOR BLOWERS (SP-GG-5241501 A/B)

6.2.1. Inert Gas Generator Blowers (SP-GG-5241501 A/B) (2 x 100%) shall be electrical driven centrifugal type and have the purpose to supply safe ambient air to the Inert Gas Generator (GG-5241501 A/B) burners.

6.2.2. Inert Gas Generator Blowers (SP-GG-5241501 A/B) shall be designed for the total production of one (1) generator running at full load (9,000 m³/h).

6.2.3. Inert Gas Generator Blowers (SP-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.

6.2.4. PACKAGER shall provide protection for low flow and low pressure of combustion air and for the Inert Gas Generators (GG-5241501 A/B) burners flame out.


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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 each one to supply diesel oil to both Inert Gas Generators (GG-5241501A/B).
- 6.3.2. Diesel Oil Pump Unit for Inert Gas (B-5241501A/B) shall suction diesel oil from one (1) dedicated structural diesel oil daily tank (TQ-GG-5241501A/B-04) which is not under PACKAGER scope of supply.
- o Note: For diesel oil daily tank data sheet refer I-FD-3010.2E-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. Diesel Oil Pump Unit for Inert Gas (B-5241501A/B) shall be controlled by two (02) panels: one (1) remote control panel in the CCR and one local panel installed on IGG compartment, both to be supplied by PACKAGER.
- 6.3.6. 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.
- 6.3.7. 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. Ventilated Fuel Gas Supply Cabinets (Z-GG-5241501A/B) (2 x 100%) have the purpose to provide a safe connection between the Topside fuel gas lines and the IGGs. Cabinets shall be considered as a Hazardous Area and be supplied with the minimum gas detectors (H₂S and CH₄).
- NOTE: In case CH₄ or H₂S is confirmed by mentioned gas detectors, Fuel Gas admission valves to the IGG PACKAGE shall be closed and IGGs shall be stopped/tripped (as per PACKAGER design). Details of this interlock shall be confirmed per PACKAGER and approved by Buyer.
- 6.4.2. 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.

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<p>ii. the presence of gas in the exhausted gas discharge shall start the safety procedures required by CS.</p> <p>iii. the fuel gas piping inside non classified areas shall be all 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.</p> <p>6.4.3. Fuel gas lines outside the Ventilated Fuel Gas Supply Cabinets (Z-GG-5241501A/B) 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.</p> <p>6.4.4. Ventilated Fuel Gas Supply Cabinet (Z-GG-5241501A/B), 2 x 100%, shall be each one permanently ventilated by two (2 x 100%) exhausting fans EXT-GG-5241501A/B-A/B.</p> <ul style="list-style-type: none"> ▪ Note 1: Exhaust Fans for Fuel Gas Pipe Casing (EXT-GG-5241501A-A/B), shall have automatic start of the stand-by fan for continuous exhausting of the Ventilated Fuel Gas Supply Cabinet (Z-GG-5241501A) and the fuel gas pipe casing as detailed on I-DE-3010.2E-5241-944-P4X-003 – INERT GAS SYSTEM ▪ Note 2: Exhaust Fans for Fuel Gas Pipe Casing (EXT-GG-5241501B-A/B), shall have automatic start of the stand-by fan for continuous exhausting of the Ventilated Fuel Gas Supply Cabinet (Z-GG-5241501B) and the fuel gas pipe casing as detailed on I-DE-3010.2E-5241-944-P4X-003 – INERT GAS SYSTEM. <p>6.4.5. Ventilated Fuel Gas Supply Cabinet (Z-GG-5241501B) and Exhaust fans (EXT-GG-5241501A/B-A/B) shall have the discharge directed to a safe area outside the Inert Gas Generator room to be positioned at external area safe location, according to class society requirements. The final position shall be confirmed by a gas dispersion analysis and approved by the inert gas system PACKAGER. as indicated on I-DE-3010.2E-5241-944-P4X-003 – INERT GAS SYSTEM.</p> <p>6.4.6. Exhaust fans for fuel gas pipe casing (EXT-GG-5241501A/B-A/B) shall be axial type driven by electric motors.</p> <ul style="list-style-type: none"> ▪ Note: Expansion joints at the exhaust fans suction and discharge shall be provided to account for vibration issues and shall be supplied by PACKAGER. <p>6.4.7. For Fuel Gas parameters refer to item 6.15.</p> <p>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.</p>			

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. Local control panels 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.
- Note: the selection key status shall be indicated on both inert gas remote and local control panels.
- 6.5.5. The inert gas 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 panels shall indicate the Inert Gas Generator Seawater Pumps (B-5241502A/B) and the Inert Gas Seal Pumps (B-5241502A/B) working conditions.
- 6.5.8. 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.
- 6.5.9. 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. Control valves specification and actuation system design shall be defined by the PACKAGER.
- 6.6.3. 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. 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 and purging header.

- Note 1: non-return retention valves are considered safety devices and shall be designed according to the SOLAS requirement Chapter II – 2.
- Note 2: non-return retention valves shall be designed for 9,000 m³/h.

6.7.3. 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.

6.8. 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 the Engine Room.
 - Note: those two (2) sea water pumps, called Inert Gas Seal Pumps (B-5241501A/B), are NOT under PACKAGER scope of supply, but their automation, instrumentation and control devices shall be designed and supplied following 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.
 - 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.

- 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 approval.

6.8.8. Deck Water Seals monitoring and control system shall have an automatic control to ensure the seal safe operational water sealing level which shall be monitored by SOS-HMI, with the high and low alarms levels monitored on CCR:

6.8.9. Deck Water Seals shall have each one an independent overboard / draining line to the sea (not PACKAGER scope of supply) with the minimum design requirements:

- Note 1: The positioning of the draining lines discharge to the sea shall follow the PACKAGER requirements.
- Note 2: Draining piping lines / valves and accessories material shall be compatible with the sea water standard with acid pH levels. Sea water quality standard shall be defined by PACKAGER.


6.8.10. 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 header and the purging header from the Inert Gas Generators (GG-5241501A/B).

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

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6.9.4. For Deck isolating valves specification refer to I-DE-3010.2E-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 and the last barrier of the cargo area tanks, to keep the pressure under the allowable limits.

6.10.2. 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-3010.2E-5115-944-P4X-003 – P&ID FRESH, HOT AND POTABLE WATER SYSTEM DISTRIBUTION.

6.10.3. 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.

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

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

6.10.6. 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.

6.10.7. For P/V Breakers Vacuum / Pressure set points and additional requirements refer to I-DE-3010.2E-5241-944-P4X-004 – HYDROCARBON AND INERT GAS DISTRIBUTION SYSTEM.


6.11. INERT GAS VENT SYSTEM

6.11.1. PACKAGER shall provide inert gas vent system with vent pipes 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 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.

6.11.3. 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.


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- 6.11.5. Relief systems vent pipes shall be directed to a safe location approved by CS.
- 6.11.6. For fuel gas pipe-in-pipe vent systems refer to item 6.4.2.
- 6.11.7. PACKAGER shall supply the inert gas relief / vent system design automation and instrumentation.
- 6.11.8. For piping and automation logic preliminary / basic information refer to I-DE-3010.2E-5241-944-P4X-003 – INERT GAS SYSTEM.

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 pressure regulating valve installed downstream the IGGs as indicated on I-DE-3010.2E-5241-944-P4X-003 – INERT GAS SYSTEM.
- 6.12.3. Pressure deviation and combustible (fuel gas or diesel) misfire or flame out shall be alarmed on CCR.
- 6.12.4. PACKAGER shall provide devices for control, protection and interlocking for the minimum hazardous 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 delivery to cargo area tanks.
 - 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 and protection for scrubber seawater high pressure to the Inert Gas Generators (GG-5241501A/B).
 - g. Devices for control, protection and interlocking for IGG scrubbers' high level (LSH) to stop the sea water pumps (B-5241501A/B).

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<p>h. 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.</p> <p>i. Devices for the system control, protection and / or interlocking as mentioned on item 6.2.4, 6.3.7, 6.4.8, 6.8.6 of this technical specification.</p> <p>6.12.5. PACKAGER shall provide at least four (4) O₂ analyzers (AIT), being at least two (2) fitted for each IGG.</p> <ul style="list-style-type: none"> ▪ NOTE: Typically, one (1) AIT for each IGG shall be used for safety interlocks and one (1) AIT for process control. Other configurations may be accepted by Buyer depending on PACKAGER design. <p>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.</p> <ul style="list-style-type: none"> ▪ Note: PACKAGER shall inform the IGGs performance with 1% of O₂ content on fuel gas mode. <p>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 lines.</p> <p>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.</p> <p>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).</p> <p>6.12.10. Inert Gas Generator (GG-5241501 A/B) automation and instrumentation shall follow the PACKAGER recommendation.</p> <p>6.12.11. For inert gas piping and automation logic refer to I-DE-3010.2E-5241-944-P4X-003 – INERT GAS SYSTEM.</p> <p>6.13. INERT GAS INJECTION NOZZLES</p> <p>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.</p> <p>6.13.2. Nozzle's diameter shall produce a sufficient jet depth to reach the cargo area tanks bottom.</p> <p>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.</p>			

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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-3010.2E-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).

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, 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 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.

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6.15. DIESEL OIL AND FUEL GAS SPECIFICATION

6.15.1. 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. All electrical equipment installed in hazardous areas (see Area Classification documentation) or installed outdoors and kept on during emergency condition (ESD-3P or ESD-3T) shall be certified according to IEC 61892 and INMETRO Resolution 115.

7.1.2. Electrical equipment and material shall comply with requirements of the following references:


- a) I-ET-3010.00-5140-700-P4X-001 – SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS
- b) I-ET-3010.00-5140-700-P4X-002 – SPECIFICATION FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.
- c) I-ET-3010.00-5140-700-P4X-003 – ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS.
- d) I-ET-3010.00-5140-712-P4X-001 – LOW-VOLTAGE INDUCTION MOTORS FOR OFFSHORE UNITS.
- e) I-DE-3010.00-5140-700-P4X-003 – GROUNDING INSTALLATION TYPICAL DETAILS.

7.2. INSTRUMENTATION AND AUTOMATION REQUIREMENTS

7.2.1. PACKAGE instrumentation and control design shall fulfill the requirements of the following technical specifications:

- a) I-ET-3010.00-1200-800-P4X-002 – AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS.
- b) I-ET-3010.00-1200-800-P4X-013 – GENERAL CRITERIA FOR INSTRUMENTATION PROJECTS.
- c) I-ET-FIELD INSTRUMENTATION.
- d) I-ET-AUTOMATION INTERFACE OF PACKAGE UNITS.
- e) I-ET-3010.00-5520-888-P4X-001 – AUTOMATION PANELS.

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

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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-3010.2E-1351-140-P4X-001 – 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

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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. WELDING

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 following technical specifications:

- a) I-ET-3010.00-1000-970-P4X-002 – Requirements for NDT.
- b) I-ET-3010.00-1000-955-P4X-002 – Requirements for Welding Inspection.
- c) I-ET-3010.00-1000-955-P4X-001 – Welding.
- d) I-ET-3010.00-1200-200-P4X-001 – Requirements for Bolted Joints Assembly and Management.
- e) I-ET-3010.00-1200-200-P4X-115 – Requirements for Piping Fabrication and Commissioning.

8.3. DOCUMENTATION

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

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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, tests, factory acceptance test (FAT), Site Acceptancy test (SAT), Site Integration Test (SIT) and inspection release certificate (IRC), refer to EXHIBIT V – DIRECTIVES FOR PROCUREMENT.

8.5.2. For PACKAGE inspection and test plan (ITP) requirements refer to EXHIBIT VII – DIRECTIVES FOR QUALITY ASSURANCE SYSTEM.

8.6. PRESERVATION, PACKING AND TRANSPORTATION

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