

	TECHNICAL SPECIFICATION	Nº: I-ET-3010.2D-1350-320-P4X-001	
	CLIENT:	AGUP	SHEET: 1 of 17
	JOB:	HIGH CAPACITY FPSO - GAS EXPORTATION ALL ELECTRIC	
	AREA:	ATAPU 2 AND SÉPIA 2	
SRGE	TITLE:	STRUCTURAL TANKS GAS RECOVERY COMPRESSION UNIT (UC-1350001)	INTERNAL ESUP

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TECHNICAL SPECIFICATION

Nº I-ET-3010.2D-1350-320-P4X-001

REV. B

AREA: ATAPU 2 AND SÉPIA 2

SHEET 2 of 17

TITLE: **STRUCTURAL TANKS GAS RECOVERY
COMPRESSION UNIT (UC-1350001)**

INTERNAL
ESUP

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1. DEFINITIONS AND ABBREVIATIONS

1.1 DEFINITIONS:

PETROBRAS	FPSO contracting and operating company.
PACKAGER	Company responsible for project, assembly, construction, fabrication, test of compressor and project, assembly, tests, integration and furnishing of all other main equipment in the skid, including the auxiliaries systems.
PURCHASER	EPC company responsible for project, assembly, erection, construction, fabrication, test and furnishing, lift, hook up, installation and integration of all Modules of FPSO, with complete and fully operative systems in accordance with the requirements of this specification, codes and standards referenced therein.
VENDOR	Company hired by the PURCHASER or PACKAGER to supply of equipment, components of equipment, instruments, control systems, etc. that will be part of the main system to be supplied.

1.2 ABBREVIATIONS:

AEPR	Automation & Electrical Panels Room
AMS	Asset Management System
API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
ASV	Anti-surge Valve
AVM	Anti-Vibration Mounting
BDV	Blow Down Valve
CCR	Central Control Room (located in the Hull Accommodation)
CCR-ATR	Central Control Room – Automation and Turbomachinery Room
CSS	Control and Safety System
Cv	Coefficient flow valve
DGS	Dry Gas Seal
DIO	Optical Internal Distributor
ESD	Emergency shutdown
FAT	Factory Acceptance Test
FGS	Fire and Gas System
FIT	Factory Integrated Test
FPSO	Floating Production Storage and Off-loading
FPU	Floating Production Unit
HMI	Human Machine Interface
IGCR	Inert Gas Compressor Running
I/O	Input/Output
LAN	Local Area Network
MCC	Motor Control Center



MMS	Machinery Monitoring System
MPA	Automatized Procedures Module (Portuguese: Módulo de Procedimentos Automatizados)
MPS	Machinery Protection System
MRT	Mechanical Running Test
OPC UA	Open Platform Communications Unified Architecture
PAS	Package Automation System
PCS	Process Control System
PLC	Programmable Logic Controller
PMS	Power Management System
PSD	Process Shutdown System
PSV	Pressure Safety Valves
PCV	Pressure Control Valves
PDCV	Pressure Differential Control Valve
P&ID	Piping and Instrument Diagram
RESD	Emergency Shutdown Relay
RFI	Radio Frequency Interference
RIO	Remote I/O Panel
SAT	Site Acceptance Test
SDV	Shut Down Valve
SGCS	Seal Gas Conditioning System
SGP	Seal Gas Panel
SLT	Sound Level Test
SIT	Site Integration Test
SOS	Supervision and Operation System
SYAT	Shipyard Acceptance Test
TAP	Performance Acceptance Test
TCP/IP	Transmission Control Protocol/Internet Protocol
UCP	Unit Control Panel
UCP_HMI	Human Machine Interface for Unit Control Panel

2. GENERAL

- 2.1 Structural Tanks Gas recovery compressor shall be in accordance with API std 681, last edition.
- 2.2 The complete Structural Tanks Gas Recovery Compression Unit shall be designed for minimum 30 years of operation installed on the FPSO.
- 2.3 All documents listed in Material Requisition are mandatory, as well as the electrical, automation and safety requirements for STRUCTURAL TANKS GAS RECOVERY COMPRESSION UNIT package are described in these documents.



- 2.4 All components of the system shall be suitable for offshore environment, throughout the whole platform service life, under all operational conditions and submitted to Unit motions and accelerations described in PETROBRAS specifications.
- 2.5 PURCHASER and PACKAGER shall be entirely responsible for material selection on items not specified by PETROBRAS and shall inform material of all main parts according to ASTM code. All bolts and nuts shall be supplied with PURCHASER and PACKAGER certificates and fully marked according to applicable ASTM standard.
- 2.6 All shop punch lists shall be cleared before shipment.
- 2.7 Equipment shall be prepared for outdoor storage according to PURCHASER specifications.
- 2.8 PURCHASER and PACKAGER shall specify the products to be used for preservation of the equipment components and spare parts, their removal and reapplication methods and the application date. Such data shall be summarized on two tags to be securely fastened on all equipment and outside of each crate. If rust preventives are required, volatile products shall not be applied.
- 2.9 Hazardous and toxic materials with associated adverse health effects shall be avoided or minimized. PURCHASER, PACKAGER and VENDORS are encouraged to promote their replacement. Asbestos, hazardous and toxic components shall not be used in the materials and equipment supplied for this project or for this plant or facility. As the use of such materials will not be tolerated, PETROBRAS strongly recommends PACKAGER, PURCHASER and VENDOR to take all necessary measures to ensure their use is fully avoided throughout this project. Material safety data-sheets may be required by PETROBRAS any time, to demonstrate that any particular material has not been used and will not be used throughout all stages of this project.
- 2.10 All equipment, components and panels shall have a nameplate easy to access, to view and read. Nameplate shall be made in AISI 316 steel and bolted (with stainless steel elements) to the equipment. Layout drawings shall be submitted to PETROBRAS approval. Nameplates shall contain the following information, in Brazilian Portuguese language:
- Client name;
 - Client job;
 - Client area;
 - Supplier name;
 - Series number and model;
 - Year of manufacturing;
 - Main design and test data: pressure, temperature, voltage, rotation, etc;
 - Specific data;
 - Tag number;
 - Purchaser's requisition number (RM);
 - Purchaser's request for quotation number (RFQ);
 - Purchaser's order number (PO);
 - Empty weight;
 - Design code.
- 2.11 All safety signals shall be in Portuguese language.



3. CONSTRUCTION FEATURES

- 3.1 The Structural Tanks Gas Recovery Compression Unit will be designed to recover volatile gases from crude oil tanks. It will be connected to HYDROCARBON HEADER /INERT GAS DISTRIBUTION HEADER and to V-1350001.
- 3.2 The Structural Tanks Gas Recovery Compression Unit shall operate over wide ranges, usually within narrow suction pressure bands. The Structural Tanks Gas Recovery Compressor shall be equipped with compressor recycle valve. Suction pressure is maintained by pressure control of a recycle valve, with additional loading and unloading of the compressors when limits of valve opening/closing or suction pressure are reached. Usually, the controls are set up to sequentially load and unload the compressor.
- 3.3 PURCHASER and PACKAGER shall deliver his standard production line equipment. This specification contains the standards normally applied by the PETROBRAS and the information required from MANUFACTURER/PACKAGER to assess the use of the equipment. The PETROBRAS may therefore accept equipment to other recognized standards than those defined. Prototypes and equipment not field proven will not be accepted.
- 3.4 The complete package shall be designed, manufactured, tested, inspected and certified to conform to the requirements of this specification and be designed to meet the duty as stipulated on the project data sheets.
- 3.5 PURCHASER and PACKAGER shall assume full unit responsibility for the complete package, including the driver and all ancillaries.
- 3.6 The package, including all ancillary equipment, shall be assembled to the maximum extent possible, aligned and pre-checked in MANUFACTURER/PACKAGER'S shop, allowing shipment to the conversion yard with minimal fieldwork.
- 3.7 Connections between pipe flanges and suction and discharge nozzle flanges of compressor shall be provided with removable spools to facilitate compressor remove and disassembly. Removable spools shall not have any process instruments. The removable spool shall have two borescope accesses (suction and discharge), closer to the compressor flanges. These access with blind flange connections shall be quick and easy to open and close.
- 3.8 Clamp connections are not acceptable.
- 3.9 PACKAGER and PURCHASER shall consider the presence of free water and corrosive agent (H₂S and CO₂) even when not specified of all compressor operating cases, and its corrosive contents. PACKAGER and PURCHASER shall also consider, in addition to steady state operation, the transient conditions during: compression system starts and stops; plant pressurization; stopping compressor and depressurizing plant; compressor stopping and plant depressurizing, compressor stopped and plant pressurized.
- 3.10 All materials that are exposed to hydrocarbons containing hydrogen sulphide shall follow the requirements of ISO 15156 for sour service.
- 3.11 Equipment and piping served by cooling water shall also be design with protections/detections against scenario of lack of supply and/or overpressure and/or high cooling water temperature.

4. ACCESSORIES AND AUXILIARIES

4.1 Piping

- 4.1.1 Except where indicated, all piping and accessories within equipment package limit shall be in accordance with PACKAGER piping specification and international standards.
- 4.1.2 All auxiliary piping requiring field connections shall be brought to the skid edge and shall be flanged.
- 4.1.3 Manual block valves and spectacle / blind flanges shall be provided at all battery limits such as inlet and outlet nozzles, drain lines, etc. PURCHASER and PACKAGER considering piping standards as in I-ET-3010.2D-1200-200-P4X-001 – PIPING SPECIFICATION FOR TOPSIDE.
- 4.1.4 All equipment shall have sufficient flexibility in all pipe and duct connections.
- 4.1.5 The interconnecting pipework between auxiliary skid and the main baseplate shall be provided by PURCHASER. The pipes arrangement shall avoid the accumulation of liquid (siphon). Drainage shall occur in all lower parts of the piping.
- 4.1.6 A temporary basket particulate filter for machine starting, removable without disassembly of the piping, shall be installed in the suction line, close to each stage of compression.

4.2 Couplings and coupling guards

- 4.2.1 PACKAGER is responsible for all couplings within the package, including those for auxiliary equipment.
- 4.2.2 Coupling for main equipment shall be a stainless steel flexible-element, non-lubricated type.
- 4.2.3 PACKAGER and PURCHASER shall submit to PETROBRAS main equipment coupling data sheet according to API 671.
- 4.2.4 All coupling guards (including those for auxiliary equipment) shall be rigid, fully enclosed, in non-sparking material and solely fitted to equipment baseplates, not fastened. Safety coupling guards (without feet) are also acceptable. In case of failure, guards shall be able to retain broken parts, for personnel protection. Coupling guards shall be designed to allow removal without disassembling the coupling and shall be constructed so that routine inspections are performed by means of strobe light, with the equipment running.
- 4.2.5 Coupling guard drains shall have sight glasses in horizontal drain lines. The coupling guard shall not be used as a normal operating lube oil drain path.

4.3 Baseplate



- 4.3.1 Main baseplate shall be capable of supporting the stresses arising from platform motions and should be provided with three (3) point supports and Anti-Vibration Mounting (AVM). In order to reduce package weight, different baseplate supporting is acceptable under PETROBRAS evaluation and approval.
- 4.3.2 Baseplate shall be rigid enough to avoid permanent distortion during lifting, shipment and operation. When the baseplate is lifted, with all equipment mounted, beam deflection shall not exceed $L/400$ (L is the total baseplate length).
- 4.3.3 Driver, driven machine, transmission, seal panel and local panel shall be mounted on a single baseplate. Other auxiliaries shall be mounted on the same baseplate (preferable) or provided with their own skid. PACKAGER and PURCHASER shall submit layout to PETROBRAS comments and approval.
- 4.3.4 The baseplate shall have a removable solid checkered plate or open grating top floor where required for maintenance.
- 4.3.5 All furnished skids shall be sufficiently stiff to withstand all vibration loads induced by the equipment and transfer them to the deck beams.
- 4.3.6 Skid mounted assemblies shall be constructed in order to not allowed equipment or parts be dismounted during lifting.
- 4.3.7 No equipment / component shall protrude beyond the skid limits. In cases where it cannot be avoided, required protection against mechanical damage shall be provided.
- 4.3.8 Each skid shall be provided with facilities (pad-eyes, lugs, bollards) for lifting, having suitable access for rigging. The estimated lifting load and safety factor for each point shall be informed in PURCHASER proposal. Main lifting points shall not be welded to the beam flange, unless the strength level is low enough or if the beam flange has a suitable thickness.
- 4.3.9 All equipment to be mounted on skids shall allow on-field leveling and alignment using jacking screws (in both plane directions) and precision type shims. Total shim thickness shall not exceed 6.35mm and the number of shims shall be kept to a minimum. Any additional height shall be made up of solid stainless steel plate.
- 4.3.10 All skid mounted equipment containing liquids that shall be drained onto the skid area, shall be fitted with drip pan underneath the equipment and provided with flanged nozzle with sufficient slope. Drip pans draining system shall be designed considering the total deluge flow over the skid. A single drain nozzle shall be located at the skid edge with appropriate piping, blocking valve, strainer and water seal.
- 4.3.11 Fasteners (including washers) and shims shall be constructed in AISI 316L steel.

4.4 Support system

- 4.4.1 All required supporting system (including spring supports, structure, etc.) shall be supplied (for on-skid elements) or specified with all design requirements (such as loads, position, forces, etc.) by PACKAGER and PURCHASER.

4.5 Insulation

- 4.5.1 All required insulation for personnel protection or machine thermal efficiency shall be applied and provided by PACKAGER and PURCHASER.
- 4.5.2 Insulating shall ensure a temperature below 60°C over the external surface for personnel protection.
- 4.5.3 To prevent corrosion under insulation, only non hygroscopic insulation material shall be used.
- 4.5.4 In order to avoid damages during transportation and erection insulation shall be carried out after final installation in place.

4.6 Seal system

- 4.6.1 Compressor shall be fitted with double mechanical cartridge type seals.
- 4.6.2 The seal system shall be a pressurized seal barrier system according to API standard 682, Plan 53-B. Seal flushing connection shall not be used unless approved by PETROBRAS. Seal API 682 plans combination is acceptable in order to reduce water make-up consumption to be submitted and approved by PETROBRAS.
- 4.6.3 Each of the mechanical seal packages shall consist of the following main components:
 - Pressure control valve to maintain correct pressure in the seal system;
 - Bladder-type accumulator, with barrier fluid;
 - Pressure transmitter with high, low and low-low alarms;
 - Temperature indicator;
 - Air Finned Cooler;
 - Manual valves and check valve.

5. AUTOMATION

5.1 General requirements

- 5.1.1 All instruments and controls shall be fit for purpose, suitable for marine environmental for which they are intended, according to the same standards and requirements applicable for this project. PACKAGER and PURCHASER shall ensure that the equipment is properly certified for the specified classification.
- 5.1.2 Package equipment shall be provided with PACKAGER'S control system and the safeguarding incorporated. PACKAGER and PURCHASER shall assume total responsibility for the instrumentation, design, engineering, operational philosophy, and the PLC based control and safeguarding systems. These are part of PURCHASER'S scope, unless specified otherwise.

- 5.1.3 The Package Automation System (PAS) shall be designed according to the requirements described in specifications I-ET-3010.2D-1200-800-P4X-014 – AUTOMATION INTERFACE OF PACKAGED UNITS, I-ET-3010.00-1200-800-P4X-002 - AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS and I-MD-3010.2D-5520-800-P4X-003 - AUTOMATION NETWORK DESCRIPTION.
- 5.1.4 The control system PN-UC-1350001 (Structural Tanks Gas Recovery System Compressor Unit Panel) shall have its package classification according to I-ET-3010.2D-1200-800-P4X-014 - AUTOMATION INTERFACE OF PACKAGED UNITS, I-ET-3010.00-1200-800-P4X-002 - AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS and I-MD-3010.2D-5520-800-P4X-001 - AUTOMATION AND CONTROL SYSTEM FUNCTIONS. These panels shall be installed at the Automation and Electrical Panels Room (AEPR).
- 5.1.5 Capacity control shall be based on recycle flow and steps (whenever multiples compressors are available). Set point shall be based on compressor suction pressure. Compressor start-up/shutdown shall be fully automated

5.2 Panel PN-UC-1350001 Structural Tanks Gas Compression Unit Panel)– External Interfaces

- 5.2.1 This panel shall have all the external interfaces simulated and tested during commissioning and leave the logic completely ready for the integration with the FLARE SYSTEM. Shutdown of PN-UC-1350001 generates a LP Flare event and its occurrence must be taken into account by flare panel and turndown panel.
- 5.2.2 The external interfaces are described in I-DE-3010.2D-1350-944-P4X-001 – STRUCTURAL TANKS GAS RECOVERY SYSTEM, I-ET-3010.2D-1200-800-P4X-014 - AUTOMATION INTERFACE OF PACKAGE UNITS and I-ET-3010.00-1200-800-P4X-002 – AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS.
- a. The Structural Tanks Gas Compression Unit Panel sends independent signals:
- to open Quick Open Valves associated to HC Blanket Flaring Header;
 - to close Shut Down Valve to HC Blanket Collecting Header (Inlet of the Compression Unit).
- Obs: When Quick Open Valves are requested to open, the Compression Unit shall shut down;
- b. The main objective of this compressor is to control pressure of the HC Distribution header, when the tanks are being loaded with oil.
- c. A signal informing if the compressor should be recovering gas or not is sent by CSS to UC-1350001 package:
- This signal does not replace the need for the internal pressure transmitters (i.e., pressure transmitters for control and interlocking based in internal pressure of the UC-1350001 are still required);

- In case this external signal indicates that the compressor should not be recovering gas, the compressor shall remain turned on, but in full recirculation;
- In case this external signal indicates that the compressor should be turned on, the internal PIT of the package shall be operating normally, and controlling pressure upstream of the compressor.

- d. UAS (Compression unit shutdown status) shall deliver signal to CSS – PSD;
- e. Compression unit shutdown status shall deliver signal to PN-5412001;
- f. ESD-2 (Process Plant shut down status), several conditions shall lead to Compression Unit shut down according to I-DE-3010.2D-1350-944-P4X-001- STRUCTURAL TANKS GAS RECOVERY SYSTEM;
- g. All the parameters monitored by the Compression Unit Panel need to be made available at Central Control Room;
- h. The confirmed fire signal at the Compression Unit Area is made available to Compression Unit Panel. This signal shall be considered to applied to the Compression Unit shutdown and blowdown;
- i. The Structural Tanks Gas Compression Unit Panel shall give permission to close HC Blanket QOVs by solenoid valves connected to PN- UC-1350001 in case of compression unit start;
- j. The signals that shall be sent to CSS through network shall be defined during Detail Engineering Design, in strict agreement between PETROBRAS, PURCHASER and PACKAGER.

5.3 Minimum Safety Requirements

- 5.3.1 Safeguarding functions may be implemented according to API RP14C. All Structural Tanks Gas Recovery Unit shall be fail-safe.

5.4 Instrumentation Minimum Requirements

- 5.4.1 All instrumentation and alarms mentioned are the minimum required by PETROBRAS. PURCHASER and PACKAGER shall indicate other instrumentation and alarms for general protection and monitoring according to their experience and for compliance with Classification Society's requirements and submit in technical proposal to PETROBRAS for approval.

5.5 Human Machine Interface (HMI) of UCP

- 5.5.1 UCP_HMI shall allow the operator to view and acknowledge alarms and trips, protections reset, status of each I/O and intermediate variables, software monitoring/modification, system configuring, first-out of alarms and shutdowns, list of set points and parameters, analog variables, variables performance and trend, recording of all relevant data and periodic reports, events, number of starts and operation hours, by-pass of inputs and override of outputs.
- 5.5.2 UCP_HMI shall comply, at least, with the following requirements:
 - Industrial microcomputer installed inside the panel housing;



- Read and write access to removable data storage devices shall be disabled. Enabling this access shall be possible with password protection;
 - HMI screen shall be on front door of the panel. Minimum 20 inch widescreen LCD color touch screen display. The CPU of HMI shall be independent from the display screen of HMI;
 - Recording and storing of all digital and analog variables, alarms and events of PAS system with trend capable of playback any variable and capable to export logs in the CSV standard;
 - Listing in chronological order of all alarms, trips, events, and user-defined actions with PLC timestamps with milliseconds time resolution. The message of first trip of SD sequence shall be emphasized;
 - Display of process plant and auxiliaries PI&Ds with all variables and variables from Compressor Control, including Machinery Protection System;
- 5.5.3 PACKAGER and PURCHASER shall provide UCP_HMI supervisory software (runtime and development tool) running on Windows environment, compatible with the size of the application and in its latest version (preferably at 64 bits). Software shall be supplied, installed, configured in the UCP_HMI and provided with complete manuals/electronic media. Software licenses shall also be provided.
- 5.5.4 If, for any reason, HMI have some malfunction, the control system shall continue with all its function normally. PACKAGER and PURCHASER shall provide a hardware interface (such as a laptop computer connection) in order to establish an external communication with PLC.
- 5.5.5 English and Brazilian Portuguese languages shall be used on all UCP_HMI screens installed on UCP.
- 5.5.6 All PLCs, HMIs, MPS shall be synchronized. Time synchronism shall be sent from Time Servers, see I-MD-3010.2D-5520-800-P4X-003 - AUTOMATION NETWORK DESCRIPTION.
- 5.5.7 UCP_HMI software shall be compatible with OSI "Plant Information-PI" software.
- 5.6 Machinery Protection System (MPS) and Machinery Monitoring System (MMS)**
- 5.6.1 Machinery Protection System (MPS) shall be according to the API 670 latest revision.
- 5.6.2 All vibration and temperature protection systems shall be according to Original Equipment Manufacturer (OEM) standards and API 670 compliant.
- 5.6.3 All signals form MPS monitoring cards shall be available to send data to MMS.
- 5.6.4 The MMS (provided by PURCHASER) shall be designed in according to the requirements described in the items below and in the specification I-ET-3010.00-5500-854-P4X-001 – MACHINERY MONITORING SYSTEM.



- 5.6.5 Besides the control and supervisory UCP system, Machinery Protection System shall be integrated in the Machinery Monitoring System (MMS) of the FPSO, provided by PURCHASER, for maintenance purposes. PACKAGER shall provide interface cards installed in the Machinery Protection System to allow the interconnection with the MMS (software and hardware).
- 5.6.6 All vibration signals (including displacement and accelerometers) shall be available with buffer signal output. PACKAGER shall provide all documentation of vibration signals and configuration files of the Machinery Protection System to be implemented by the MMS Supplier for Monitoring System configuration.

6. ELECTRICAL

- 6.1 Electrical equipment and materials shall comply with requirements of I-ET-3010.00-5140-700-P4X-002 - SPECIFICATION FOR ELECTRICAL MATERIAL FOR OFFSHORE UNITS, I-ET-3010.00-5140-700-P4X-007 - SPECIFICATION FOR GENERIC ELECTRICAL EQUIPMENT FOR OFFSHORE UNITS, I-ET-3010.00-5140-700-P4X-009 - GENERAL REQUIREMENTS FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS and I-ET-3010.00-5140-741-P4X-004 - SPECIFICATION FOR LOW-VOLTAGE GENERIC ELECTRICAL PANELS FOR OFFSHORE UNITS. All electrical panel shall comply with I-ET-3010.00-5140-700-P4X-005 - REQUIREMENTS FOR HUMAN ENGINEERING DESIGN FOR ELECTRICAL SYSTEMS OF OFFSHORE UNITS.
- 6.2 Electrical installations inside the package and the voltages to be supplied for electrical loads (motors, heaters, control panels, etc.) shall comply with requirements of I-ET-3010.00-5140-700-P4X-003 - ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS.
- 6.3 Electrical motors shall comply with requirements of I-ET-3010.00-5140-712-P4X-001 - LOW-VOLTAGE INDUCTION MOTORS FOR OFFSHORE UNITS and I-ET-3010.00-5140-712-P4X-002 - MEDIUM-VOLTAGE INDUCTION MOTORS FOR OFFSHORE UNITS. The electrical motors shall be fed from platform normal panels.
- 6.4 The electrical interfaces of the package shall comply with requirements of I-DE-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION ARCHITECTURE DIAGRAM, I-ET-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION ARCHITECTURE and I-LI-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION INTERFACE SIGNALS LIST and I-DE-3010.00-5140-797-P4X-002 - ELECTRICAL SYSTEM AUTOMATION TYPICAL ACTUATION DIAGRAMS.
- 6.5 Equipment, accessories, piping and structures shall be grounded according to requirements of 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, IEC 61892-6 and IEC-60092-502. Besides these standards, for installations in hazardous area, the grounding requirements of IEC 61892-7 shall be complied.



- 6.6 Motocompressor auxiliary loads shall be fed by auxiliary MCCs (Motor Control Center), provided by PURCHASER (out of scope of PACKAGER). However, PACKAGER shall provide all necessary information about auxiliary loads for Integrator, in order to allow complete and suitable fabrication of auxiliary MCCs. Auxiliary MCCs (Motor Control Center) shall comply with I-ET-3010.00-5140-741-P4X-001 - LOW-VOLTAGE MOTOR CONTROL CENTER AND SWITCHGEAR FOR OFFSHORE UNITS.

7. OPERATION AND MAINTENANCE REQUIREMENTS

- 7.1 PACKAGER and PURCHASER shall make the applicable recommendations to optimize operation and maintenance, taking into account the remote location and platform general conditions. Any changes to equipment design, materials or specific spares that may improve the equipment operability, availability or reliability shall be submitted to PETROBRAS for review and approval. But PACKAGER and PURCHASER shall always comply with PETROBRAS requirements before suggest any modification.
- 7.2 The packages shall be designed so that all maintenance can be carried out with standard tools as much as possible.
- 7.3 Equipment layout shall enable easy and safe access for maintenance to all components and parts. PACKAGER and PURCHASER shall provide suitable walkways, ladders and handrails for all packages, including auxiliaries. All equipment and peripherals, especially oil reservoirs, shall have full access and inspection doors / hatches.
- 7.4 Equipment layout attached documents shall be used as a reference, but any solution adopted shall be within the footprint limits indicated.
- 7.5 Instruments and piping accessories shall be arranged in proper location in order to allow easy access by maintenance and operation personnel. Installation of piping and cable supports next to couplings, bearings and seals shall be avoided, for instance.
- 7.6 PACKAGER and PURCHASER shall provide electrically driven lifting / handling devices and external structure components enabling assembly, disassembly and removal all components inside the package (compressor, electric motor, rotor, etc.), including internal parts such as compressor rotor and electric motor rotor with adequate and certified capacity to handle maximum maintenance weight and / or dimensions. Lifting and handling devices shall be according to I-ET-3010.2D-5266-630-P4X-001 – TOPSIDE'S MECHANICAL HANDLING PROCEDURES.
- 7.7 PACKAGER and PURCHASER shall provide special tools for all maintenance activities including tools for compressor, compressor rotor, driver and driver rotor, to assembly, disassembly and removal.
- 7.8 PACKAGER and PURCHASER shall include in proposal a schedule stating the expected time between major overhauls.
- 7.9 Noise control requirements
- 7.9.1 Noise control analysis is a mandatory item to be carried-out. PACKAGER and PURCHASER shall present noise data regarding items included in scope of supply.



- 7.9.2 The maximum allowable sound level shall be 90 dB(A) at one (1) meter around the unit and up to two (2) meters from the floor.
- 7.9.3 The noise control system for the package shall consider the noise radiated by inlet / outlet piping, equipment enclosure and equipment casings.
- 7.9.4 Whenever electric motor drivers are used, it shall be verified if motor fan design can be modified (e.g., use of unidirectional blades, etc.) before any apparatus are applied for noise attenuation.
- 7.9.5 In case of expected noise are higher than allowable limits, the equipment shall be furnished with some noise control reduction measure and the maximum noise allowable value will be 85 dB(A). PACKAGER and PURCHASER may consider the best solution, which may include acoustic blanket or acoustic walls (open roof) and safety system requirements. The use of device to comply with noise requirement shall be proved to be efficient and submit to PETROBRAS approval.
- 7.9.6 For all equipment installed without acoustical enclosure, if any, the following data will be required during proposal phase:
- Sound power level of the equipment;
 - Sound pressure level, in each of the four main directions and in one point of the top.
- 7.9.7 For all equipment installed inside acoustic enclosure, if any, the following data will be required during proposal phase:
- Sound power level of the equipment without enclosure;
 - Sound pressure level, in each of the four main directions and in one point of the top, for the equipment plus enclosure;
 - Acoustical data of enclosure and silencers (when applicable).

8. INSPECTION AND TESTS

8.1 General requirements

- 8.1.1 PETROBRAS is entitled to inspect the package anytime during fabrication to ensure that material and workmanship are in accordance with the specifications.
- 8.1.2 Inspection of materials and / or equipment will be made by PETROBRAS or its authorized representatives.
- 8.1.3 Unless otherwise specified, all witnessed tests shall be informed, at least, 90 days before the scheduled dates.
- 8.1.4 PETROBRAS inspector shall have the right to request inspections to ensure that the equipment complies with the relevant classification society requirements.
- 8.1.5 In case any defects and/or shortcomings are found, PACKAGER and PURCHASER shall bear the full cost of such inspection and replacement as necessary. Any repair shall previously be approved by PETROBRAS. The subsequent inspection necessary to confirm the satisfactory results will be at PACKAGER and PURCHASER cost.

- 8.1.6 All process gas system welds shall be 100 % radiographically inspected and submitted to magnetic particle examination.
- 8.1.7 Prior to execution, PACKAGER and PURCHASER shall submit for PETROBRAS approval the planning and test procedures.
- 8.1.8 Testing, performance validation, verification and commissioning activities shall demonstrate that the Safety Requirement Specification designed for the Structural Tanks Gas Recovery Compression Unit has been reached.
- 8.1.9 PACKAGER and PURCHASER shall be responsible for providing personnel, material, necessary equipment and instruments for all the tests, independent of the place where they are carried out, until the final commissioning and acceptance of the unit by PETROBRAS.
- 8.1.10 Any component of hardware or software failed during a test shall be re-tested as necessary to prove rectification has been completed satisfactorily.
- 8.1.11 The devices shall have self-diagnosis features to detect on-line failures. Input signals line monitoring and partial stroke test routine shall be available.

8.2 Hydrostatic test (HT)

- 8.2.1 For all trains, parts being tested shall be externally coated with a layer of white lead carbonate or any other suitable powder to help leakage detection.
- 8.2.2 No vises or clamping devices shall be used for pressing of nozzle flanges.
- 8.2.3 PTFE tape or thread compounds shall not be used to prevent leakage of threaded plugs and connections.

8.3 Performance Test (PT)

- 8.3.1 PT shall be performed on each unit according to API STD 681.
- 8.3.2 The performance test procedure shall be agreed with PETROBRAS.

8.4 Mechanical Running Test (MRT)

- 8.4.1 MRT shall be performed on each unit according to API STD 681.
- 8.4.2 The MRT procedure shall be agreed with PETROBRAS.

8.5 Site Acceptance Test (SAT)

- 8.5.1 Site Acceptance Test (SAT) is an offshore acceptance test to be performed when the motocompressor is able to operate after all commissioning is complete and not pending.
- 8.5.2 SAT shall be performed according to "Annex A" (Rotating Equipment Reliability Test).
- 8.5.3 PURCHASER and PACKAGER shall provide all facilities, support and technical assistance for SAT. PURCHASER is responsible for any repairs required during the SAT that are not caused by factors external to the motocompressor system.

8.5.4 The SAT procedure shall be agreed with PETROBRAS.

8.6 Shipyard Acceptance Test (SYAT)

8.6.1 Shipyard Acceptance Test (SYAT) is inert gas (N₂) functional test onshore, performed on each unit.

8.6.2 Shipyard Acceptance Test (SYAT) shall be performed in the shipyard facilities after compressor and process plant complete commissioning (including N₂He leakage test of piping system been executed) and complete integration with all systems of FPSO that support the operation of compression system.

8.6.3 PURCHASER shall provide all facilities, support and technical procedures to execute a SYAT, according to Annex B - Inert Gas Compressor Running Test. PACKAGER shall provide technical assistance for all SYAT.

8.6.4 The SYAT procedure shall be agreed with PETROBRAS including acceptance criteria.

9. ANNEX

9.1 Annex A: Rotating Equipment Reliability Test.



9.2 Annex B: Inert Gas Compressor Running Test.

