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	CLIENT: SRGE		SHEET 1 of 17						
	JOB: REFERENCE BASIC DESIGN		1001056398 0010						
	AREA: BÚZIOS								
DP&T-SRGE	TITLE: <b>CO2 REMOVAL UNIT</b>		NP-1						
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## 1 INTRODUCTION

This Technical Specification covers the minimum requirements for design, engineering, materials, fabrication, inspection, and testing of CO<sub>2</sub> REMOVAL UNIT (PACKAGE) of the Reference Basic Design, which shall be installed to adjust the CO<sub>2</sub> content in the produced natural gas. The Table 1 includes the scope of supply in the package.

Table 1 -Package scope

TAG	DESCRIPTION	QUANTITY	CAPACITY
UT-1235001	CO <sub>2</sub> Removal Unity (Membrane Separation)	1 x 100%	6,000,000 m <sup>3</sup> /d (@15.6°C and 101.3 kPa)

The CO<sub>2</sub> Removal Unit (UT-1235001) shall be able to handle 6,000,000 m<sup>3</sup>/d of produced natural gas and it will be installed downstream the gas pretreatment systems, supplied by others.

The PACKAGE shall be designed to process a range of inlet gas flow rates and CO<sub>2</sub> inlet compositions according to all process data of each oilfield listed in the Data sheet.

## 2 NORMATIVE REFERENCES AND DESIGN SPECIFICATIONS

All equipment shall comply with the requirements of this technical specification and references stated below. All equipment parts and details not complying with any of these requirements shall be informed on a "Deviation List". Otherwise they will be considered as "Agreed", and so required.

As a general guideline, in case of conflicting requirements between this technical specification and other cited references, the most stringent shall prevail. If necessary the PACKAGER may revert to PETROBRAS for clarification.

### 2.1 CODES AND STANDARDS

The latest issue of the references shall be used unless otherwise agreed. Other recognized standards may be used, provided they meet or exceed the requirements of the standards referenced below. PACKAGER shall be responsible for ascertaining the applicability of any standard or code. The PACKAGER shall, in case of conflict between codes, standards, other project specifications and this specification revert to PURCHASER for clarification.

API RP 520 Part I & II	Sizing, selection and installation of pressure relieving devices in refineries
API RP 14C	Analysis, Design, Installation and Testing of Safety Systems for Offshore Production Facilities.
API RP 14E	Design and Installation of Offshore Production Platform Piping Systems
API RP 2A-WSD	Planning, Designing and Constructing Fixed Offshore Platforms-Working Stress Design
ASME/BPVC SEC VIII	Rules for construction of pressure vessels
ASME/BPVC SEC IX	Qualification Standard for Welding, Brazing and Fusing Procedures



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ASME/BPVC SEC X	Fiber-Reinforced Plastic Pressure Vessels
ASME B31.3	Process Piping
ASME B16.5	Pipe Flanges and Flanged Fittings
AISC	Steel Construction Manual
IEC 60092-502	Electrical Installation in Ships - Tankers Special Features
IEC 61892 – All parts	Mobile and Fixed Offshore Units - Electrical Installations

**2.2 GOVERNAMENTAL REGULATION**

- CONAMA - Brazilian Environment Ministry (Resolution 393/2007)
- IBAMA - Brazilian environmental regulations concerning the discharge of all types of effluents
- INMETRO - Resolution nº 179, May 18<sup>th</sup>2010 and its annexes and resolution 270 June 21<sup>st</sup> 2011
- NR 10 - Brazilian Ministry of Labor (Ministério do Trabalho e Emprego – Norma Regulamentadora Nº 10, Segurança em Instalações e Serviços em Eletricidade)
- NR 12 - Brazilian Ministry of Labor (Ministério do Trabalho e Emprego – Norma Regulamentadora Nº 12, Segurança no Trabalho em Máquinas e Equipamentos)
- NR 13 - Brazilian Ministry of Labor (Ministério do Trabalho e Emprego – Norma Regulamentadora Nº 13, Pressure Vessels and Boiler Regulations)
- NR 26 - Brazilian Ministry of Labor (Ministério do Trabalho e Emprego – Norma Regulamentadora Nº 26, Sinalização de Segurança)
- NR 30 - Brazilian Ministry of Labor (Ministério do Trabalho e Emprego – Norma Regulamentadora Nº 30, Segurança e Saúde no Trabalho Aquaviário – Anexo 2)
- NR 37 - Brazilian Ministry of Labor (Ministério do Trabalho e Emprego – Norma Regulamentadora Nº 37, Segurança e Saúde em Plataformas de Petróleo)

Brazilian Government regulations are mandatory and shall prevail, if more stringent, over the requirements of this specification and other references herein.

**2.3 DESIGN SPECIFICATIONS**

DR-ENGP-M-I-1.3	SAFETY ENGINEERING
DR-ENGP-I-1.15	COLOR CODING
I-DE-3010.1M-1200-942-P4X-002	GENERAL ARRANGEMENT
I-DE-3010.1M-1414-942-P4X-001	M-04 - CO2 REMOVAL - EQUIPMENT LAYOUT PLAN
I-DE-3010.1M-1235-943-P4X-001	PROCESS FLOW DIAGRAM - CO <sub>2</sub> REMOVAL UNIT (UT-1235001)
I-DE-3010.1M-1235-944-P4X-001	PIPING AND INSTRUMENT DIAGRAM - CO <sub>2</sub> REMOVAL UNIT (UT-1235001)
I-DE-3010.1M-5400-94A-P4X-001	AREA CLASSIFICATION - GENERAL
I-ET-3010.1M-1200-300-P4X-001	NOISE CONTROL REQUIREMENTS FOR TOPSIDE

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I-ET-3010.1M-1200-200-P4X-001	PIPING SPECIFICATION FOR TOPSIDE
I-ET-3010.00-1200-431-P4X-001	THERMAL INSULATION FOR MARITIME INSTALLATIONS
I-ET-3010.00-1200-540-P4X-001	REQUIREMENTS FOR PRESSURE VESSELS DESIGN
I-ET-3010.00-1200-540-P4X-002	REQUIREMENTS FOR PRESSURE VESSELS FABRICATION
I-ET-3010.00-1200-251-P4X-001	BOLT MATERIALS
I-ET-3010.00-1200-800-P4X-002	AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGED UNITS
I-ET-3010.1M-1200-800-P4X-014	AUTOMATION INTERFACE OF PACKAGED UNITS
I-ET-3010.00-5520-888-P4X-001	CSS / SOS PANELS
I-ET-3010.1M-1200-940-P4X-002	CORROSION MONITORING SYSTEM
I-ET-3010.00-1200-955-P4X-001	WELDING
I-ET-3010.00-1200-956-P4X-001	QUALIFICATION TESTS FOR PAINT SYSTEMS
I-ET-3010.00-1200-956-P4X-002	GENERAL PAINTING
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-3010.00-5140-700-P4X-005	REQUIREMENTS FOR HUMAN ENGINEERING DESIGN FOR ELECTRICAL SYSTEMS OF OFFSHORE UNITS
I-LI-3010.00-5140-700-P4X-001	ELECTRICAL EQUIPMENT DATA-SHEET MODELS
I-LI-3010.00-5140-797-P4X-001	ELECTRICAL SYSTEM AUTOMATION INTERFACE SIGNALS LIST
I-FD-3010.1M-1235-560-P4X-001	CO <sub>2</sub> REMOVAL UNIT (UT-1235001) – M-04
I-ET-3000.00-1200-940-P4X-001	TAGGING PROCEDURE FOR PRODUCTION UNITS DESIGN.
I-ET-3A26.00-1000-941-PPC-001_D	METOCEAN DATA
I-RL-3010.1M-1350-960-P4X-009	MOTION ANALYSIS

### 3 DEFINITIONS AND ABBREVIATIONS

#### 3.1 DEFINITIONS

*Packager.* Is defined as the responsible for project, assembly, construction, fabrication, test and furnishing of the Package.

*Manufacturer.* Is defined as the responsible by fabrication of equipment or components internal to the Package.

*Package or Package Units.* Is defined as an assembly of equipment supplied interconnected, test and operating, requiring only available utilities from the Unit for the Package operation.



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### 3.2 ABBREVIATIONS

FAT	Factory Acceptance Test
FPSO	Floating Production Storage and Offloading (vessel)
IBAMA	Environment Brazilian Institute
NDT	Non Destructive Testing
UCP	Unit Control Panel

## 4 GENERAL FUNCTIONAL REQUIREMENTS

The CO2 REMOVAL UNIT shall be provided with all necessary instruments to operate safely, adequately and without interruption in a tropical marine environment. PACKAGER shall be responsible for the complete design, fabrication, inspection, testing, and supply of the components and spares, in full compliance with the requirements of this specification, its attachments and all applicable codes, standards and regulations referenced and, where applicable, the requirements of the Classification Society.

### 4.1 OPERATION ENVIRONMENT

The equipment supplied shall be suitable for the environment and range of ambient condition, including atmospheric pressure, relative humidity, rainfall, air temperature (dry-bulb) (see Obs.1), characteristic monthly values and wind motions defined in the document I-ET-3A26.00-1000-941-PPC-001\_D - METOCEAN DATA.

Obs.1: For air temperature (dry bulb) of electrical equipment, use the most critical conditions, among those defined by Classification Society and specific documentation.

### 4.2 MOTION REQUIREMENTS

The necessary design data and information on motion requirements are given in I-RL-3010.1M-1350-960-P4X-009 – MOTION ANALYSIS.

### 4.3 DESIGN CONDITIONS

PACKAGER shall design the package's equipment for the full range of process conditions as specified in the Process Data Sheet I-FD-3010.0M-1235-560-P4X-001 - CO2 REMOVAL UNIT (UT-1235001) – M-04.

The CO2 Removal Unit will be installed on module M-04 (see I-DE-3010.1M-1414-942-P4X-001 - M-04 - CO2 REMOVAL - EQUIPMENT LAYOUT PLAN, and I-DE-3010.1M-1200-942-P4X-002 – GENERAL ARRANGEMENT). All package equipment shall be suitable for classified area.

All electrical equipment shall be certified, for installation in hazardous areas, complying with I-DE-3010.1M-5400-94A-P4X-001 - AREA CLASSIFICATION - GENERAL.

Safe and adequate ladders and/ or stairs and platforms shall meet the requirements of NR-12, and installed on all operation and maintenance areas (e.g. valves, instruments, etc.) elevated more than 1.75 m above the skid base plate.



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Valves shall preferably be positioned with their stem pointing upwards and located in such way that the hand wheel or stem will not obstruct walkways. Where hand operated valves are not easily operable, gear operated valves shall be used.

Adequate withdrawal spaces and clearances shall be provided for all removable vessel/ pipe internals (e.g. filters/ membranes). Adequate lifting facilities shall be in place to allow the temporary removal of the filter tops for maintenance and filter change out purposes.

PACKAGER shall ensure by means of a mechanical handling survey, that the maintenance envelopes required by the full movement of the loaded lifting beam hoists are kept clear, and are not impinged upon or traversed across by any pipes, cables or any other fixed items.

#### 4.4 DESIGN LOADS

In addition to Codes described loads and loads due to equipment motions defined on I-RL-3010.1M-1350-960-PPC-009 – MOTION ANALYSIS, the following loads shall be considered where relevant:

- Equipment transportation and erection loads;
- Nozzle loads;
- Thermal loads;
- Wind loads;
- Weight loads.

#### 4.5 DESIGN LIFETIME

PACKAGER shall design and fabricate the complete package's equipment for a minimum lifetime of 25 years.

#### 4.6 NOISE

Noise control analysis is a mandatory item to be carried-out, according to I-ET-3010.0M-1200-300-P4X-001 - NOISE CONTROL REQUIREMENTS FOR TOPSIDE.

#### 4.7 CORROSION MONITORING

PACKAGER shall design the PACKAGE equipment verifying the needs for corrosion monitoring and submit design to PETROBRAS for approval.

For reference the I-ET-3010.1M-1200-940-P4X-002 - CORROSION MONITORING SYSTEM shall be verified.

### 5 PACKAGE SPECIFICATION

#### 5.1 PACKAGER'S SCOPE OF SUPPLY AND DESIGN REQUIREMENTS

##### 5.1.1 GENERAL

A complete engineering package including design, fabrication, inspection, testing, certification and preparation for shipment of the CO<sub>2</sub> Removal Unit. The package shall



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include drawings showing dimensions, weights, instrumentation and any additional information.

For complete scope of requisition of equipment, materials and services, see I-RM-3010.1M-1235-560-P4X-001 - CO<sub>2</sub> REMOVAL UNIT.

All equipment, including sub-orders, shall be of proven design and well within the MANUFACTURER's actual experience.

For PETROBRAS "field proven" equipment is defined as having a Reference List with at least 3 (three) operating equipment (of similar capacity) installed in offshore production units.

Deviations from the items above, related to the "field proven design" may be accepted only for equipment which is part of research or development programs. In this case, their use shall be formally approved by PETROBRAS program coordinator.

PACKAGER shall collect all drains on a flanged connection.

#### 5.1.2 PROCESS DESIGN

The CO<sub>2</sub> Removal Unit (UT-1235001) shall be able to handle 6,000,000 m<sup>3</sup>/d (@ 15.6°C and 101.3 kPa) of treated natural gas and will be installed downstream of the gas pretreatment system supplied by others. For operating conditions, Gas Properties and Gas Composition of each oilfield see Process Data Sheet I-FD-3010.1M-1235-560-P4X-001 - CO<sub>2</sub> REMOVAL UNIT (UT-1235001) - M-04.

The CO<sub>2</sub> Removal Unit shall be suitable for operation at any point indicated in the Process Data Sheet I-FD-3010.1M-1235-560-P4X-001 - CO<sub>2</sub> REMOVAL UNIT (UT-1235001) - M-04.

#### 5.1.2.1 MEMBRANE PACKAGE

##### MEMBRANE BANKS

PACKAGER is free to offer what he deems to be the most economic arrangement of the membrane banks that can adequately handle the allocated module space and specified quality and quantity of gas. However, consideration should be given to providing a high availability for the unit.

Membrane elements shall be adequately selected for long life performance. The membrane banks shall be provided with sampling facilities to monitor the membranes performance during operation.

Membrane vessels shall be made of carbon steel, and comply with NR 13 requirements.

#### 5.1.3 MECHANICAL AND PIPING

The CO<sub>2</sub> Removal Unit, including all ancillary equipment shall be assembled to the maximum extent possible, aligned and pre-checked at the PACKAGER shop, allowing shipment to the installation site with minimal fieldwork.

Equipment and piping subject to temperature of 60°C and above shall be thermally insulated. Equipment and piping which require heat conservation shall also be thermally insulated. The insulation shall comply with I-ET-3010.00-1200-431-P4X-001 – THERMAL INSULATION FOR MARITIME INSTALLATIONS.





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All piping shall comply with I-ET-3010.1M-1200-200-P4X-001 – PIPING SPECIFICATION FOR TOPSIDE.

All interconnecting piping shall comply with the requirements of ASME B31.3. All skid piping within the limits of supply shall be fabricated and terminated at the baseplate edge by means of valves and/ or flanges and blind flanges according to ASME B16.5.

Flanges shall be flush with the transverse ends of the skid having a uniform B.O.P. (Bottom of Pipe) at as low as practical elevation. This shall be shown on PACKAGER's P&ID's and General Arrangement drawings. All tubing for the off-skid interfaces shall be terminated at the skid by means of compression fitting valves.

All piping shall be rigidly supported for service and shipment; supports on the module plates shall not be accepted without under deck stiffening. The supporting and installation shall enable piping removal without disturbing structural members.

All drain lines shall be routed through the deck to a common drain header, terminated in one flange at the skid edge.

There shall be a continuous fall, with no low point traps along the drain lines toward the end point. Drain line connections into the drain header shall be entering from the top.

All drain lines shall be hard-piped and provided with means to prevent vacuum conditions in the line.

Fabricated branch weld connections (fittings, couplings etc.) shall be directly joined to the header with full penetration welds, where applicable.

After completion of fabrication etc., all fabricated pipe spools shall be internally and externally cleaned to remove all loose scale, weld spatter, sand and other foreign materials.

PACKAGER shall check and approve all piping with respect to stresses, vibration and layout. Anchor points shall be provided at skid edge.

For bolt materials apply the requirements of I-ET-3010.00-1200-251-P4X-001 - BOLT MATERIALS.

#### 5.1.3.1 PRESSURE VESSELS DESIGN AND FABRICATION (MINIMUM REQUIREMENTS)

All pressure vessels shall comply with I-ET-3010.00-1200-540-P4X-002 - REQUIREMENTS FOR PRESSURE VESSELS FABRICATION, I-ET-3010.00-1200-540-P4X-001 - REQUIREMENTS FOR PRESSURE VESSELS DESIGN, ASME section VIII and NR 13.

#### 5.1.3.2 WELDING

During fabrication all the welding design shall comply with I-ET-3010.00-1200-955-P4X-001 - WELDING.

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#### 5.1.4 INSTRUMENTATION AND CONTROLS

The CO<sub>2</sub> Removal Unit shall be provided with all necessary instruments and controls to operate safely, adequately and without interruption in a tropical marine environment.

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.

The instrumentation and control design shall fulfill the requirements of I-ET-3010.00-1200-800-P4X-002 - AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGED UNITS and I-ET-3010.1M-1200-800-P4X-014 – AUTOMATION INTERFACE OF PACKAGED UNITS. The classification of the CO<sub>2</sub> Removal Unit is presented in I-ET-3010.1M-1200-800-P4X-014 – AUTOMATION INTERFACE OF PACKAGED UNITS. The CO<sub>2</sub> Removal Unit shall comply with all requirements of its applicable Package type.

Package shall include all local instruments (level, pressure, temperature etc.), control valves, control monitoring and safety protection instruments and devices for remote indication, control, alarms, protection and shutdown.

The UCP (PN-UT-1235001) shall be installed in the Automation and Electrical Module, which is a non-hazardous area. Panel and accessories shall be design for environmental protection IP-22 when installed in air conditioned room or ventilated room (Indoor panels). See details in I-ET-3010.00-5520-888-P4X-001 - CSS / SOS PANELS.

#### 5.1.5 ELECTRICAL REQUIREMENTS

Design of electrical equipment shall fulfill the requirements, including standards and documents referred to within these, in as well as referenced data sheets. Electrical installations and package electrical interfaces shall comply with requirements of:

- I-ET-3010.00-5140-700-P4X-001 - SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS
- I-ET-3010.00-5140-700-P4X-003 - ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS;
- I-ET-3010.00-5140-700-P4X-005 - REQUIREMENTS FOR HUMAN ENGINEERING DESIGN FOR ELECTRICAL SYSTEMS OF OFFSHORE UNITS;
- I-LI-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION INTERFACE SIGNALS LIST;
- I-LI-3010.00-5140-700-P4X-001 - ELECTRICAL EQUIPMENT DATA-SHEET MODELS.

Electrical material shall comply with:

- I-ET-3010.00-5140-700-P4X-002 - SPECIFICATION FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS;

Any deviations regarding these documents shall be identified in a Deviation List.



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Equipment, accessories, piping and structures shall be grounded according to requirements of IEC 61892-6 and IEC 60092-502. For installations in hazardous area, the grounding requirements of IEC 61892-7 shall also be complied with.

Electrical equipment installed in hazardous areas or installed in outdoors safe areas, but kept turned on during ESD situation shall be certified for installation in hazardous areas Zone 1, according to IEC 61892, INMETRO 179 of May 2010 and its annexes and INMETRO 270 June 21ST 2011.

#### 5.1.6 SKID DETAILS

This section is only applicable for equipment that is built on a skid. The skid shall be designed to accommodate the entire equipment within the scope of supply. The skid shall be of rigid construction, which will not distort during hoisting, operation and shipment, and shall withstand all moments and forces due to the vessel motion.

Lifting facilities shall enable lifting of the equipment with crane as a single point lift for transportation and installation. The design and manufacture of the lifting lugs shall be certified. The arrangement of equipment, piping and superstructure shall be such that the center of gravity coincides approximately with the geometrical center of the skid. When lifting the skids, complete with all equipment mounted, beam deflection shall not exceed 1/400 L.

The skid shall resist all sling forces, including both horizontal and vertical components of the applied sling angle (sling angles shall be between 50 and 90° with the horizontal plane).

Drip trays with drain connections shall be provided underneath equipment where significant spillage is likely to occur.

Lifting beams, spreader bars, slings, shackles etc. are within PACKAGER scope of supply. The skid shall be welded to the supporting structures. The floor shall be made of plate material with a raised on-slip tread. Welds underneath skid beams shall be ground flush. Skid shall have 2 diagonally opposed earthing bosses.

Welding shall be carried out with procedures and operators qualified in accordance with ASME section IX. Welding shall not be performed before qualified welding procedure is approved. Intermittent fillet welds are not permitted.

#### 5.1.7 MAINTENANCE LIFTING BEAMS

All required maintenance lifting beams, complete with the necessary hoisting and lifting gear, shall be provided to facilitate safe and easy maintenance.

All lifting beams shall overhang by at least 1.2 m into agreed lay-down areas. The deflection of the maintenance crane/ hoisting beams shall not exceed 1/500 of the span length. All beams and lifting gear shall be subject to load testing, witnessed by PETROBRAS representative and classification society.



### 5.1.8 PAINTING

#### 5.1.8.1 EXTERNAL

Paint system for external coating shall be according to I-ET-3010.00-1200-956-P4X-002 – GENERAL PAINTING.

PACKAGER shall provide information, during the BID process, about the painting system regarding:

- Material Safety Data Sheet,
- Data required by item 5.4 of ISO 20340: Paints And Varnishes - Performance Requirements for Protective Paint Systems for Offshore and Related Structures,
- Qualification tests reports according to I-ET-3010.00-1200-956-P4X-001 - QUALIFICATION TESTS FOR PAINT SYSTEMS.

#### 5.1.8.2 INTERNAL

Paint systems shall be according to MANUFACTURER's requirements, when not specified by PETROBRAS.

#### 5.1.8.3 COLOR

Color code adopted shall be in accordance with the latest revision of DR-ENGP-I-1.15 – COLOR CODING.

### 5.1.9 SAFETY

Maximum allowable pressure drop for pressure relief devices shall comply with API requirements.

Piping supports, instrument tappings, design pressures etc. shall be suitable for sustained operation under the pressure pulsations that occur if the bladders of pulsation dampeners fail.

For area classification see I-DE-3010.1M-5400-94A-P4X-001 – AREA CLASSIFICATION – GENERAL.

All safety signs shall be in Portuguese.

#### 5.1.9.1 LAYOUT

The use of connections in pipes with flammable liquids between decks of FPSO and the plant shall be minimized so as to reduce the risk of pool fire.

The use of connections in gas lines shall be minimized.

Any SDV (Shutdown valve) shall be installed in places where they are not affected by fire originating in other areas.

Instrumentation cables for emergency consumers shall have two different routings. The definition of the routes shall consider that a fire risk scenario shall not reach them simultaneously. The routing of such cables shall be as far as possible from fire risk



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areas. As an alternative to the use of two different routes, a fire resistant cable (according IEC 60331-1) may be used.

## 6 NAMEPLATES

MANUFACTURER shall attach corrosion resistant SS 316 nameplates on each item of equipment in an accessible location, fastened with corrosion resistant fastenings.

The nameplate shall include, as a minimum, the following information, in Portuguese:

- Petróleo Brasileiro S.A. - PETROBRAS
- Purchase order number;
- Manufacturer and year of build;
- Tag number;
- Service;
- Serial number;
- Main data for design, operation and testing (Power, Pressure, Volume, Temperature, Rotation, Flow rate), where applicable;
- Specific requirements;
- Installation
- Identification;
- Driver power rating and speed, where applicable;
- Design code;
- Empty, operation and test Weight.

## 7 TAG NUMBERING

The identification of all instrumentation, electrical, mechanical, and piping items, including valves, shall be in accordance to I-ET-3000.00-1200-940-P4X-001 – TAGGING PROCEDURE FOR PRODUCTION UNITS DESIGN.

Tags shall be supplied with the number and description in English, unless otherwise stated in the project data sheets. Valves and instruments shall be tagged with the applicable number only.

Tag numbers for remaining ancillary equipment shall be given after Purchase Order placement.

## 8 CERTIFICATION REQUIREMENTS

### 8.1 CLASSIFICATION SOCIETY CERTIFICATION

For each package's equipment, a class certificate suitable for the vessel to be classified shall be supplied.

PACKAGER shall perform the work in accordance with the requirements of Classification Society. PACKAGER is responsible for submitting to the Classification Society all documentation in compliance with stated Rules.

Equipment certification and approval as required by the above rules is PACKAGER's responsibility. PACKAGER shall communicate directly with Classification Society and



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provide all documentation necessary to obtain approvals. PURCHASER shall be copied on all correspondence between PACKAGER and Classification Society. PACKAGER shall obtain approval for all parts of their work as required by Classification Society before shipment of the equipment to the shipyard.

## 8.2 GENERAL CERTIFICATION

PACKAGER shall be responsible for obtaining all necessary certification of the equipment. PACKAGER through the independent certifying authority shall supply all certificates related to the materials, inspections, tests and qualification activities detailed in the approved Quality Plan.

For pressure containing parts of equipment and main components, PACKAGER shall specify material properties and chemical composition of the materials used in the Equipment by means of appropriated certificate.

## 9 INSPECTION, TESTING AND COMISSIONING

### 9.1 INSPECTIONS

PACKAGER shall submit an Inspection and Test Plan (ITP) with the bid.

PETROBRAS shall identify all the required witnessed inspections on a marked-up copy of the Inspection and Test Plan (ITP).

PETROBRAS shall reserve the right to inspect the package's equipment at any time throughout fabrication to ensure that material and workmanship are in accordance with this specification.

PACKAGER shall ensure that all the witnessed inspection requirements by the classification society are fully complied with and the due notice requirements are satisfied.

The notification period for such inspections shall be mutually agreed during the kick-off meeting.

### 9.2 PACKAGE INSPECTION

Unless waived by PETROBRAS, the following inspections and checks shall be witnessed by PETROBRAS inspector:

- Verification of the construction materials for skid, vessels etc. in conformity with the requirements of the specification;
- Verification that piping and fittings conform with specification of materials and fabrication;
- Inspection by radiographic, dye penetrant, magnetic particles, ultrasonic inspection of welds of the pressure pertaining parts of the vessels, pumps;
- Approval of relief valve settings and their tests after setting;
- Review of ITR's.
- A visual check noting that the thickness of pressure retaining parts meets or exceeds the quoted design thickness;
- Any repairs;

- Internal coating is complete with dry-film thickness quoted;
- The general appearance, materials, workmanship and standard of finish are acceptable;
- Dimensional check;
- Alignment check to be demonstrated;
- All instrumentation, control panels and ancillary equipment shall be built, checked, tested and function tested prior to installation as defined in the specification.

### 9.3 FACTORY ACCEPTANCE TEST

PACKAGER shall prepare a Factory Acceptance Test/ Procedure (FAT) for the CO<sub>2</sub> Removal Unit equipment, and submit it to the PURCHASER for approval.

A full function test of completed package shall be performed. The satisfactory operation of all indicators, selectors and controllers shall be demonstrated.

The correct operation of all controllers, alarm and fault protection equipment and indicators shall be demonstrated and, if necessary, fault simulations shall be performed.

The FAT will be witnessed by PETROBRAS representatives. PACKAGER shall advise the PURCHASER on the test schedule at least two (2) weeks for Brazilian PACKAGER/ MANUFACTURER/ Sub-Suppliers and 3 (three) weeks for foreign PACKAGER/ MANUFACTURER/ Sub-Suppliers in advance of the planned test dates. PACKAGER shall invite Classification Society surveyor for FAT.

Acceptance of the FAT will not be considered as the final acceptance test of the package unit. Final acceptance will be on satisfactory completion of commissioning tests as specified by PETROBRAS.

### 9.4 ASSEMBLY ASSISTANCE AND COMMISSIONING REQUIREMENTS

PACKAGER is responsible for assembly supervision of the equipment, including assembly of components to be delivered loose (for example, vessel internals etc).

PACKAGER shall be responsible for pre-commissioning and commissioning supervision of the equipment/ system supplied. Final acceptance will be on satisfactory completion of commissioning tests as specified by PETROBRAS.

## 10 PACKAGER RESPONSIBILITY

It is PACKAGER responsibility to submit to the Classification Society the documentation in compliance with Rules in force.

Any conflict between the requirements of this specification and related codes and standards, specification etc. shall be presented in writing for PURCHASER resolution prior to manufacturing.

PACKAGER shall assume sole contractual and total engineering responsibility for the equipment supplied.

PACKAGER responsibility shall include, but not be limited to:

- Resolving all engineering questions and/or problems relating to design and manufacture.
- Providing details as requested of any Sub-Suppliers relating to design and manufacturing.

- In all cases of conflict between this specification and applicable documents listed herein, the more stringent requirements shall prevail. In such cases, PACKAGER shall inform PURCHASER of the conflict and seek clarification.
- Commissioning & Training for operation.
- Installation at site shall be performed by others, however, presence of supervision by PACKAGER is required.

Compliance by PACKAGER with the provisions of this specification does not relieve the PACKAGER of his responsibility to furnish equipment and accessories of a proper mechanical design suited to meet the specified service conditions.

The technical proposal must, only and exclusively, have an explicit statement that it meets the requirements of all items of the respective Material Requisition (number and revision quoted) and its annexes, complemented by the Technical Clarification Circular Letters (number quoted), including the scope of supply, without any technical deviation. Any exclusion and/or alternative to what is specified in the Material Requisition and its annexes, including the use of the bidders standard and exclusive technology, shall be presented in a Deviation List, which only will be accepted by PURCHASER during the clarification phase, preceding the proposal presentation.

PURCHASER acceptance of each item of the Deviation List will be through Technical Clarification Circular Letters, issued to all bidders.

The Deviation List mentioned above shall contain, at least, for each requirement that the bidder intends to change:

- The document description, code and section that contain the requirement;
- The reason for deviation, always indicating the requirements that are different from bidder's standard, and the costs, schedule and technical benefits/ impacts of the change;
- The bidder proposal.

## **11 PREPARATION FOR SHIPMENT**

### **11.1 MARKING**

All items supplied according to this specification shall be adequately marked for identification against a certificate or relevant test documentation. Marking shall be such that it will not damage or impair the components.

Items that cannot be identified shall be rejected. Rejected items may be re-certified by carrying out all relevant testing, with prior approval of PETROBRAS.

As a minimum, the following identification shall be provided:

- Project Number;
- Manufacturer's name;
- Purchase Order Number;
- Minimum Breaking Load (MBL);
- Item Number;
- Classification Society surveyor's stamp.



## 11.2 SHIPMENT PACKING

The equipment shall be supplied tested, flushed and preserved.

The preparation shall make the equipment suitable for 12 months outdoor storage from the time of shipment. The packing shall be foreseen for the storage and commissioning period.

Unusual tools, spare parts, preservation materials, and accessories needed for this proposal inside shipment package if agreed.

The equipment shall be protected from corrosion.

PACKAGER shall submit the packing design to PETROBRAS for approval.

PACKAGER shall package the equipment in accordance with the packaging requirements of the country to which the equipment is being shipped.

PACKAGER shall provide the procedures for unpacking, handling and installation, as well as repacking and long-term storage and preservation requirements.

PACKAGER shall specify any limitations applicable to the transport and installation phase.

## 12 MATERIALS

### 12.1 GENERAL

The repair and defects in pressure-containing castings by peening or burning-in or by impregnation with other compounds is not allowed.

Repair by welding or by plugging shall be undertaken only when permitted by the material specification and shall only be applied with the procedures specified.

After weld repair, castings shall be heat treated, if specified in the material specification. A major weld repair shall always be followed by a suitable heat treatment.

Details of all major weld repairs and heat treatment shall be recorded and reported to PETROBRAS.

The use of asbestos or materials containing asbestos is prohibited.

### 12.2 MATERIAL CERTIFICATION

In order to ensure that the construction materials are in accordance with the data sheet, the requirements for the certification of the material test data are specified below and shall be adhered to.

All certificates shall contain the following information:

- Name of manufacturer;
- Purchase order number and date of issue;
- Identification number of certificate and its issue;
- Material specification(s);
- Material charge number, batch number or heat number;
- Mechanical properties recorded from test results;
- NDT method and results;
- Heat treatment procedure.