	<b>TECHNICAL SPECIFICATION</b>		Nº: <b>I-ET-3010.00-5537-850-PEA-001</b>	
	CLIENT: <b>SRGE</b>		SHEET: <b>1 of 20</b>	
	JOB: <b>POSITIONING (POS)</b>			
	AREA: <b>-</b>			
<b>SUB</b>	TITLE: <b>POSITIONING AND NAVIGATION SYSTEMS FOR UEP (FPSO AND SS)</b>		<b>INTERNAL</b> SSUB/GDSO/STGO	

MICROSOFT WORD / V.2016 / I-ET-3010.00-5537-850-PEA-001\_C.docx


### INDEX OF REVISIONS

REV.	DESCRIPTION AND/OR REVISED SHEETS
0	ORIGINAL ISSUE
A	ISSUE FOR CESSÃO ONEROSA
B	GENERAL REVISION
C	REVISED WHERE INDICATED

	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE	27/01/09	27/01/09	ABR/01/22	OCT/25/2022					
DESIGN	US-SUB/GDS	US-SUB/GDS	STGO	STGO					
EXECUTION	TARDIN	TARDIN	Y3S7	Y3S7					
CHECK	ISABEL	ISABEL	CY22	CY22					
APROVAL	FERRÃO	FERRÃO	X187	X187					


INFORMATION IN THIS DOCUMENT IS PROPERTY OF PETROBRAS, BEING PROHIBITED OUTSIDE OF THEIR PURPOSE

FORM OWNED TO PETROBRAS N-0381 REV. L

	<b>TECHNICAL SPECIFICATION</b>	Nº <b>I-ET-3010.00-5537-850-PEA-001</b>	REV. <b>C</b>
	AREA: -	SHEET: 2 of 20	
	TITLE: <b>POSITIONING AND NAVIGATION SYSTEM FOR UEP (FPSO AND SS)</b>	INTERNAL SUB/SSUB/GDSO	

INDEX

1	SUBJECT.....	3
2	ABBREVIATIONS .....	3
3	REFERENCE DOCUMENTS, CODES AND STANDARDS.....	3
4	GENERAL REQUIREMENTS .....	4
5	SYSTEM DEFINITIONS.....	5
6	TECHNICAL REQUIREMENTS .....	6
7	SCOPE OF SUPPLY .....	9
8	COMMISSIONING .....	12
9	INSTALLATION AND INTEGRATION.....	14
10	LEGALIZATION REQUIREMENTS.....	18
11	APPENDIX – GNSS ANTENNA LOCATION .....	19

	<b>TECHNICAL SPECIFICATION</b>	Nº <b>I-ET-3010.00-5537-850-PEA-001</b>	REV. <b>C</b>
	AREA: -	SHEET: 3 of 20	
	TITLE: <b>POSITIONING AND NAVIGATION SYSTEM FOR UEP (FPSO AND SS)</b>		INTERNAL SUB/SSUB/GDSO

## 1 SUBJECT

The subject of this document is to establish the criteria and basic characteristics for the detailed design, supply, installation and commissioning of a Positioning and Navigation Systems that shall be installed in PETROBRAS FPSO Unit.

## 2 ABBREVIATIONS

AHRS- Attitude and Heading Reference System

CB – Citizen Band

DOF- Diagram of Offset

EM – Electro Magnetic

EOT – End of Transmission

FPSO - Floating Production Unit

DGPS- Differential Global Positioning System

GNSS - Global Navigation Satellite System

GPS- Global Positioning System

GNSS- Global Navigation Satellite System

NMEA – National Marine Electronic Association

PETRONAV - PETROBRAS Navigation software

POS- Positioning

PNS- Positioning Navigation System

RRMS- Rigid Riser Monitoring System

RTCM- Radio Technical Commission for Maritime Services

SPI - Integrated Positioning System


UHF – Ultra High Frequency

UPS- Uninterruptible Power Supply

## 3 REFERENCE DOCUMENTS, CODES AND STANDARDS

### 3.1 International Electrotechnical Commission (IEC)

- i. IEC 60945: Maritime navigation and radio communication equipment and systems – General requirements – Methods of testing and required test results, Fourth Edition, 2002
- ii. IEC 61108: GNSS Part 1: Global positioning system (GPS) - Receiver equipment, 2003
- iii. IEC 61108: GNSS Part 2: Global navigation satellite system (GLONASS) – Receiver equipment, 1998
- iv. IEC 61108: GNSS Part 3: Galileo receiver equipment, 2010

	<b>TECHNICAL SPECIFICATION</b>	Nº <b>I-ET-3010.00-5537-850-PEA-001</b>	REV. <b>C</b>
	AREA: -	SHEET: 4 of 20	
	TITLE: <b>POSITIONING AND NAVIGATION SYSTEM FOR UEP (FPSO AND SS)</b>	INTERNAL SUB/SSUB/GDSO	

v. IEC 61108: GNSS Part 4: Shipborne DGPS and DGLONASS maritime radio beacon receiver equipment, 2004

vi. IEC 61162-1: Digital interfaces Part 1: Single talker and multiple listeners, 2016

vii. IEC 61993-2: AIS Part 2: Class A shipborne equipment of the universal AIS, 2018

**3.2 International Marine Contractors Association (IMCA)**

IMCA S 012: Guidelines on Installation and Maintenance of DGNSS-Based Positioning Sys, 2011.

**3.3 International Telecommunication Union (ITU)**

ITU-R M.1371-5: Technical characteristics for an AIS using TDMA in the VHF maritime mobile band.

**3.4 National Marine Electronics Association (NMEA)**

NMEA 0183: Standard for Interfacing Marine Electronics Devices

**3.5 Brazilian Standards**

i. Portaria INMETRO nº 115 (21/março/2022): Regulamento de avaliação da conformidade de equipamentos elétricos para atmosferas potencialmente explosivas, nas condições de gases e vapores inflamáveis e poeiras combustíveis.

ii. NR-10: Segurança em instalações e serviços em eletricidade

iii. NR-37: segurança e saúde em plataformas de petróleo

iv. ANATEL: Resolutions from Agência Nacional de Telecomunicações.

v. NORMAM-01/DPC: Normas da Autoridade Marítima para Embarcações Empregadas na Navegação em Mar Aberto.

**3.6 Classification Society**


The detailed design shall be submitted to approval by a well-known Classification Society. The design and installation shall take into account their requirements and comments.

**3.7 International Maritime Organization (IMO)**

IMO SN/Circ.227 - Guidelines for the installation of a shipborne Automatic Identification System (AIS).

**4 GENERAL REQUIREMENTS**


**4.1** For more technical requirements details to antennas mounting and cables launching, the CONTRACTOR shall consider, at least, the guideline on item 5 of “Harmonization of GMDSS requirements for radio installations on board SOLAS ship”, issued by IMO and IEC standards.

	<b>TECHNICAL SPECIFICATION</b>	Nº <b>I-ET-3010.00-5537-850-PEA-001</b>	REV. <b>C</b>
	AREA: -	SHEET: 5 of 20	
	TITLE: <b>POSITIONING AND NAVIGATION SYSTEM FOR UEP (FPSO AND SS)</b>		INTERNAL

- 4.2** For PETROBRAS detailed design requirements for Installation, Configuration, Tests training and commissioning, the CONTRACTOR shall comply with the DESCRIPTIVE MEMORANDUM I-MD-3010.00-5510-760-PPT-001 – GENERAL CRITERIA FOR TELECOMMUNICATIONS DESIGN.
- 4.3** For telecommunications symbols, the Detailed Design shall comply with the Technical Specification: I-ET-3000.00-0000-940-P4X-002 – SYMBOLS FOR PRODUCTION UNITS DESIGN.
- 4.4** For telecommunications TAGs, the Detailed Design shall comply with the Technical Specification: I-ET-3000.00-1200-940-P4X-001 – TAGGING PROCEDURE FOR PRODUCTION UNITS DESIGN.
- 4.5** All electrical requirements for telecom package shall be in accordance with I-ET-3010.00-5140-700-P4X-003 – ELETRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE, I-ET-3010.00-5140-700-P4X-001 - SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS, I-DE-3010.00-5140-700-P4X-003 - GROUNDING INSTALLATION TYPICAL DETAILS and I-ET-3010.00-5140-700-P4X-005 - REQUIREMENTS FOR HUMAN ENGINEERING DESIGN FOR ELECTRICAL SYSTEMS OF OFFSHORE UNITS.
- 4.6** All systems shall be installed in appropriated rack in the Telecommunication Upper Room located in the accommodation module.
- 4.7** The Positioning Navigation System monitor shall be installed inside the CCR – Central Control Room.
- 4.8** According to I-ET-3010.00-5140-700-P4X-003 – ELETRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE, the Positioning and Navigation System shall be fed by 220 VAC UPS unit.

## 5 SYSTEM DEFINITIONS

- 5.1** During the hook up and pull in operations, the SPI (Integrated Positioning System) software, developed by PETROBRAS, uses the position and heading sensors and a pair of UHF radios to send FPSO positioning data for all vessels involved, and transmit vessel positions to the FPSO receivers. The same process happens aboard all other vessels. Therefore, SPI software allows all maritime units to be displayed on the same screen of the positioning and navigation software.
- 5.2** After the oil production kicks off, PETRONAV (PETROBRAS Navigation software) runs position monitoring from position, heading and attitude sensors. Through the DOF (Diagram of Offset) system, this position monitoring allows faster assessment of possible damage to the mooring system, enabling a faster decision-making. This is an important tool to increase the FPSO operational safety.
- 5.3** The content of this document to describe the equipment requirements for FPSO control during critical operations as towing, hook up, riser connection/disconnections (pull in / pull out), mooring lines tensioning and maintenance, supply and offloading operations. The systems described in this technical specification will also allow monitoring of FPSO displacement in order to calculate riser stresses and alarm in case of mooring line snapping, as well as monitoring all vessels within range.

	<b>TECHNICAL SPECIFICATION</b>	Nº <b>I-ET-3010.00-5537-850-PEA-001</b>	REV. <b>C</b>
	AREA: -	SHEET: 6 of 20	
	TITLE: <b>POSITIONING AND NAVIGATION SYSTEM FOR UEP (FPSO AND SS)</b>		INTERNAL SUB/SSUB/GDSO

## 6 TECHNICAL REQUIREMENTS

### 6.1 GNSS RECEIVER

6.1.1 GNSS (Global Navigation Satellite System) independent receivers with the following minimum specifications:


- a. To comply with IEC 61108-1:2003 (GPS) and IEC 61108-2:1998 (GLONASS), with integrated solution;
- b. The firmware shall be able to be upgraded to newer GNSS constellations (IEC 61108-3:2010) or another one;
- c. To comply with IEC 60945:2002 (general requirements for marine equipment);
- d. Operating all available frequencies of GNSS, like L1, L2 and L5 GPS frequencies; L1 and L2 GLONASS, Galileo frequencies E5, E6, L1 and frequencies as well as newer GNSS frequencies that become available.
- e. The GNSS receivers shall be able to get correction RTCM SC104 v2.3 data from DGNSS UHF devices, PETROBRAS intranet (TCP/IP) and from a commercial service;
- f. Provide at least GNS, ZDA, GSV and GGA data according to IEC 61162-1:2010 (NMEA 0183);
- g. It shall be provided an Ethernet port to connect to PETROBRAS LAN Network;
- h. The equipment shall be able to access remote data and remote configuration;
- i. At least 2 (two) serial EIA-232 ports.

### 6.2 DGNSS UHF CORRECTIONS RECEIVING SYSTEM

6.2.1 UHF radio/modem receiver with the following minimum specifications:

- a. Be compatible with PETROBRAS DGNSS Network,
- b. Runs with Pacific Crest PDL HPB or ADL Vantage Pro, with Transparent with EOT Timeout protocol and modulation type GMSK;
- c. Operate in 450 MHz - 470 MHz range with 12.5 KHz bandwidth per channel;
- d. Have 7dBi gain omnidirectional antenna and impedance compatible with receiver.
- e. Enable, at any time, channel configuration (USB key permanence);
- f. The UHF receiver shall be configured to provide RTCM SC104 v2.3 DGNSS corrections from PETROBRAS stations to GNSS receivers.

6.2.3 As a reference PETROBRAS uses SPS 855 Trimble Receiver and Trimble Zephyr Model 2 Antenna. Equipment with similar or a better quality specification will be accepted.

	<b>TECHNICAL SPECIFICATION</b>	Nº <b>I-ET-3010.00-5537-850-PEA-001</b>	REV. <b>C</b>
	AREA: -	SHEET: 7 of 20	
	TITLE: <b>POSITIONING AND NAVIGATION SYSTEM FOR UEP (FPSO AND SS)</b>	INTERNAL	
		SUB/SSUB/GDSO	

### 6.3 GNSS SATELLITE CORRECTION SERVICE

6.3.1 GNSS satellite correction service (augmentation), throughout the life of the charter, which meets the following minimum specifications:

- a. Having less than 1 meter of horizontal accuracy (95%) through real-time correction.
- b. Have 99.8% availability for periods of 30 days on all area offshore.
- c. Receive multi constellation, GNSS, through at least two different communication satellites.
- d. The service shall be configured to correct the signal from GNSS receivers, and its hardware may form with the GNSS receiver a single device or not.

6.3.2 PETROBRAS will be in charge to provide GNSS satellite service contract for site operation.


6.3.3 CONTRACTOR shall provide satellite correction service during the commissioning at shipyard.

### 6.4 ATTITUDE AND HEADING REFERENCE SYSTEM (AHRS)

6.4.1 Attitude and heading reference system which meets the following minimum specifications:

- a. True heading accuracy: 0.1° secLat (2 sigma, 95%);
- b. Pitch and roll accuracy: 0.02° (2 sigma, 95%);
- c. Heave accuracy: 5 cm or 10% whichever higher (2 sigma, 95%);
- d. It shall not have moving parts in its basic principle, shall not be based on geomagnetic effects and shall be independent of GNSS;
- e. To comply with IEC 60945:2002 (general requirements for marine equipment);
- f. Having two data outputs. One port shall provide the HDT message, according to IEC 61162-1:2010 (NMEA 0183) and in other port shall provide TSS1 (Teledyne TSS Ltd);
- g. It shall be provided an Ethernet port to connect to PETROBRAS LAN Network.
- h. The equipment shall be able to remote data access and remote configuration.

6.4.2 As a reference PETROBRAS uses IX BLUE Quadrans Fiber Optic Gyroscope. Similar or a better quality specification will be accepted.

	<b>TECHNICAL SPECIFICATION</b>	Nº <b>I-ET-3010.00-5537-850-PEA-001</b>	REV. <b>C</b>
	AREA: -	SHEET: 8 of 20	
	TITLE: <b>POSITIONING AND NAVIGATION SYSTEM FOR UEP (FPSO AND SS)</b>		INTERNAL SUB/SSUB/GDSO

## 6.5 COMPUTER SYSTEM FOR MONITORING AND NAVIGATION

6.5.1 Information technology system with the following minimum specifications:

- a. Computer and peripherals with Windows 10 Professional license. CONTRACTOR is responsible for any Windows version and hardware upgrade required by PETROBRAS;
- b. Multi-serial boards (8 ports) or equivalent devices with original drivers;
- c. Serial (8 ports) / ethernet (1-port) converter. As a reference, PETROBRAS uses MOXA NPort 5600-DT.
- d. Monitors 24" (at least) LCD or LED with original drivers;
- e. To comply with IEC 60945:2002 (general requirements for marine equipment).
- f. It shall be delivered an electrical switch according to item 6.12 of I-ET-3010.00-5517-768-PPT-001 HULL DATA NETWORK.

## 6.6 INTEGRATED POSITIONING SYSTEM (SPI)

6.6.1 Radio/modem UHF transceiver to coordinate integrated operations of mobilization and demobilization with other vessels, with the following minimum specifications:


- a. Operate in compatible mode with the PETROBRAS SPI system, which uses Pacific Crest ADL Vantage Pro or ADL Vantage 35;
- b. Operate in 450 MHz - 470 MHz range with 12.5 KHz bandwidth per channel;
- c. Have an omnidirectional antenna, with power of 250 W / VSWR <1.5:1, 7dBi gain and impedance compatible with UHF transceiver;
- d. CONTRACTOR shall provide all tools or accessories that are necessary to reconfigure the channel table and other radio settings. In case of Pacific Crest devices, this means a Dealer USB Dongle shall also be acquired by CONTRACTOR.
- e. Transmitting power with 25 W or more with possibility to reduce power to 5W or less if it is necessary.

6.6.2 As a reference, PETROBRAS uses Pacific Crest ADL Vantage 35.

## 6.7 KVM MONITOR CONSOLE

- a. Integrated KVM Console with 17" LCD monitor, keyboard and touchpad in a 1U height rack mountable drawer;
- b. 17" LCD screen support resolution up to 1280x1024@60Hz
- c. Input power: 240Vac, 60Hz or -36V ~ -72V DC from Telecom (-) 48 VDC energy system.



	<b>TECHNICAL SPECIFICATION</b>	Nº <b>I-ET-3010.00-5537-850-PEA-001</b>	REV. <b>C</b>
	AREA: -	SHEET: 9 of 20	
	TITLE: <b>POSITIONING AND NAVIGATION SYSTEM FOR UEP (FPSO AND SS)</b>		INTERNAL SUB/SSUB/GDSO

- d. One KVM extender interface to connect cabinet to monitor, keyboard and mouse in Central control room (CCR).

## 6.8 Interface with HSHMS System

- 6.8.1 As per required by I-ET-3010.00-1351-140-P4X-002 DIGITAL TWIN FOR HULL STRUCTURAL INTEGRITY MANAGEMENT, information from Positioning System shall be forwarded by LAN to HSHMS System.

## 7 SCOPE OF SUPPLY

7.1 CONTRACTOR shall supply, install, test and commission the POSITIONING AND NAVIGATION SYSTEM and give the necessary training to PETROBRAS personnel, within the scope of the Contract and in accordance with this Technical Specification.

7.2 The POSITIONING AND NAVIGATION SYSTEM shall be composed by the following items described below:

### 7.2.1 GNSS RECEIVER

02 (two) GNSS (Global Navigation Satellite System) independent receivers, with all cables, antennas and accessories needed to complete installation system.

### 7.2.2 DGNSS UHF CORRECTIONS RECEIVING SYSTEM


7.2.2.1 01 (one) GNSS satellite correction service, with all cables, antennas and accessories needed to complete installation system.

7.2.2.2 GNSS satellite correction service (augmentation), throughout the life of the charter, which meets the following minimum specifications:

- a. Having less than 1 meter of horizontal accuracy (95%) through real-time correction;
- b. Have 99.8% availability for periods of 30 days on all area offshore;
- c. Receive multi constellation, GNSS, through at least two different communication satellites;
- d. The service shall be configured to correct the signal from GNSS receivers and its hardware may form with the GNSS receiver a single device or not.

### 7.2.3 GNSS SATELLITE CORRECTION SERVICE

01 (one) GNSS satellite correction service, with all cables, antennas and accessories needed to complete installation system.

	<b>TECHNICAL SPECIFICATION</b>	Nº <b>I-ET-3010.00-5537-850-PEA-001</b>	REV. <b>C</b>
	AREA: -	SHEET: 10 of 20	
	TITLE: <b>POSITIONING AND NAVIGATION SYSTEM FOR UEP (FPSO AND SS)</b>		INTERNAL

#### 7.2.4 ATTITUDE AND HEADING REFERENCE SYSTEM (AHRS)

01 (one) attitude and heading reference system with all accessories needed to complete installation system.

#### 7.2.5 COMPUTER SYSTEM FOR MONITORING AND NAVIGATION

- a. 02 (two) industrial computers and peripherals, for rack 19" installation;
- b. 02 (two) multi-serial boards (8 ports);
- c. 01 (one) serial (8 ports) / Ethernet (1-port) converter;
- d. 01 (one) KVM monitors console for 19" rack installation;
- e. 01 (one) monitor 24 inches with mouse and keyboard to be installed in CCR Room;
- f. 01 (one) KVM IP Switch.


#### 7.2.6 INTEGRATED POSITIONING SYSTEM (SPI)

02 (two) radio/modem UHF transceivers with all cables, antennas and accessories needed for a complete installation of the system.

#### 7.2.7 POSITIONING AND NAVIGATION SYSTEM RACK

7.2.7.1 CONTRATOR shall provide and install (01) one CLOSED RACK, for all ABSOLUTE POSITIONING SYSTEM indoor equipment installation. This rack shall follow the specifications below:

- a. It shall be closed, 19 inches standard, 42U height, minimum depth of 1000 mm (internal dimensions) and 800 mm of useful width (internal dimensions).
- b. It shall have AC universal standard sockets for 19 inches standard. This AC universal standard sockets shall be equipped, at least, 04 (four) AC outlets in additional for PETROBRAS future use.
- c. Glazed door at the front: Single-pane safety glass, 3 mm, including 130° hinge, and security lock;
- d. Sheet steel bi-parting rear door, including 130° hinge and security lock;
- e. A cooling system shall be installed for each cabinet and it shall be composed by 02 (two) fans on the bottom to inflate cold air inside and 02 (two) fans on the top to exhaust heated air to be collected by exhausters on ceiling. Additional clarifications for HVAC at I-MD-3010.00-5510-760-PPT-001 GENERAL CRITERIA FOR TELECOMMUNICATIONS DESIGN;
- f. 04 (four) vertical cable organizer, for RF cables and controller's cable: two in front and two on rear;

	<b>TECHNICAL SPECIFICATION</b>	Nº <b>I-ET-3010.00-5537-850-PEA-001</b>	REV. <b>C</b>
	AREA: -	SHEET: 11 of 20	
	TITLE: <b>POSITIONING AND NAVIGATION SYSTEM FOR UEP (FPSO AND SS)</b>		INTERNAL SUB/SSUB/GDSO

- g. Internal light only on the rear access;
- h. Complete earthing Kit;
- i. Color: RAL 7035.
- j. 01 (one) electrical switch according to item 6.12 of I-ET-3010.00-5517-768-PPT-001 HULL DATA NETWORK.


7.2.7.2 POS SYSTEM equipment shall be connected to both Unit's UPS bus bar A and B by means of an ATS device with enough outputs outlets to power each required equipment.

7.2.7.3 Automatic Transfer Switch (ATS) features required:

- a. The ATS device shall provide reliable, redundant power to single-corded equipment loads. The ATS device shall have 02 (two) input power cords supplying power to the connected loads.
- b. The ATS device shall have built-in network connectivity, which allows for remote management via Web, Telnet, SNMP and SSH.
- c. Input: 02 (two) inputs for two separate power sources (A, B).
- d. Outputs: 08 (eight) outputs (minimum) to power equipment.
- e. Transfer time: 10ms maximum.
- f. Visual singling operation mode indication by frontal LEDs.
- g. 19" standard for rack installation.

## 7.2.8 TOPOGRAPHIC SURVEY

- a. CONTRACTOR shall perform a topographic survey to measure the distances in all three directions (x, y and z) of the following equipment:
  - i. GNSS antennas
  - ii. AHRS sensor
  - iii. Center and edge of helideck
  - iv. Riser supports
  - v. Fair leaders
  - vi. Reference Center of the FPSO Project
  - vii. Reference Targes for DP vessels approach
  - viii. Bases of cargo cranes
- b. A suitable reference point for the measures shall be chosen and indicated clearly in the report.
- c. The drawing shall show the edge of platform, bridge, helideck and flare truss.

	<b>TECHNICAL SPECIFICATION</b>	Nº <b>I-ET-3010.00-5537-850-PEA-001</b>	REV. <b>C</b>
	AREA: -	SHEET: 12 of 20	
	TITLE: <b>POSITIONING AND NAVIGATION SYSTEM FOR UEP (FPSO AND SS)</b>		INTERNAL SUB/SSUB/GDSO

- d. Measures shall be taken with a total station equipment and shall have decimetric accuracy. The report shall indicate the methodology used to achieve the required accuracy.
- e. The topographic survey shall provide the horizontal heading inside the Telecommunication Upper Room to ensure AHRS accuracy after the installation.
- f. Digital files of recorded measures may be requested by PETROBRAS to verify the information of the report.

## 8 COMMISSIONING

### 8.1 CABLE INTEGRITY

8.1.1 The following tests shall be executed for all RF cables after installation:


- a. Electrical continuity.
- b. Insulation test with megohmmeter.
- c. Signal attenuation measurement at the frequencies used by each device (GNSS: 1176 MHz, 1191 MHz, 1207 MHz, 1227 MHz, 1246 MHz, 1278 MHz, 1575 MHz, 1602 MHz, UHF: 460 MHz). Attenuation shall not be greater than 10 dB.

### 8.2 GNSS RECEIVERS

- a. GNSS receivers shall be properly configured to work with SIRGAS 2000 or WGS84 (1150 realization) datum.
- b. Satellite correction service shall be active during commissioning.
- c. The following parameters shall be noted: geographic coordinates, number of tracked satellites for each constellation, HDOP, estimated horizontal error (if available).
- d. Every NMEA serial output shall be configured in 9600 bps, 8 bits, no parity, 1 stop bit. Only GGA and ZDA messages in 1Hz shall be left configured.
- e. Every NMEA serial output shall be captured and verified.
- f. TCP/IP NMEA output shall be captured and verified.
- g. Network/IP configuration shall be made according to parameters provided by PETROBRAS.

### 8.3 AHRS

- a. AHRS device shall be configured to receive latitude and time input from GNSS receivers.
- b. Every serial output shall be configured in 9600 bps, 8 bits, no parity, 1 stop bit.
- c. Every output shall be configured in 1Hz.

	<b>TECHNICAL SPECIFICATION</b>	Nº <b>I-ET-3010.00-5537-850-PEA-001</b>	REV. <b>C</b>
	AREA: -	SHEET: 13 of 20	
	TITLE: <b>POSITIONING AND NAVIGATION SYSTEM FOR UEP (FPSO AND SS)</b>		INTERNAL
		SUB/SSUB/GDSO	

- d. Every serial and TCP/IP output shall be captured and verified.
- e. Network/IP configuration shall be made according to parameters provided by PETROBRAS.

#### 8.4 UHF TRANSCEIVERS FOR SPI

- a. Transceivers shall be configured according to item 10.
- b. SWR test: transceivers shall be put in maximum power (25W) to transmit NMEA messages in 1 Hz. During transmission, an RF Wattmeter shall be used to measure SWR (Standing Wave Ratio), which shall not be greater than 1.5.
- c. Functional test: transceiver A shall be configured to send any kind of NMEA messages and transceiver B shall receive all messages without discontinuity or loss. The same test shall be done with transceiver B sending messages to transceiver A.
- d. Repeater test: transceiver A shall be configured to send any kind of NMEA messages in 0.5 Hz or lower. Transceiver B shall be put in repeater mode and its LED indicators, Rx and Tx, shall blink in sequence showing reception and retransmission of each message.


#### 8.5 INTEGRATED TEST

8.5.1 The following tests shall be done with the two GNSS receivers and the AHRS together:

- a. Using each GNSS receiver position (satellite correction shall be active) and the heading given by AHRS, the FPSO Reference Center shall be calculated considering the offsets indicated in the Topographic Survey (item 7.7). The two solutions shall be logged for 3 minutes, and the average difference shall not be greater than 1 meter.
- b. Using each GNSS receiver position (satellite correction shall be active) and the offsets indicated in the Topographic Survey (item 7.7), the FPSO heading shall be calculated and compared with the heading given by AHRS. Values shall be logged for 3 minutes, and the average difference shall not be greater than 1 degree.
- c. Using an external AIS receiver, the position broadcasted by the FPSO AIS shall be compared with the position of GNSS receiver A for 1 minute. Thereon, the GNSS-AIS switch will be switched to B and the position broadcasted by the FPSO AIS shall be compared with the position of GNSS receiver B for 1 minute. The heading broadcasted by the FPSO AIS shall be compared with the AHRS heading for 1 minute. The average difference shall not be greater than 0.5 meter for position and 1 degree for heading. The GNSS-AIS switch will return to position A.

8.5.2 The following verifications, at least, shall be verified as scope of commissioning activities in accordance with Contract and this Technical Specification.

- a. Check hardware and network environments;

	<b>TECHNICAL SPECIFICATION</b>	Nº <b>I-ET-3010.00-5537-850-PEA-001</b>	REV. <b>C</b>
	AREA: -	SHEET: 14 of 20	
	TITLE: <b>POSITIONING AND NAVIGATION SYSTEM FOR UEP (FPSO AND SS)</b>	INTERNAL SUB/SSUB/GDSO	


- b. Basic commissioning: after checking the physical environment of the products, check whether, the basic information such as software system, license, and system time is correct, ensuring that the system is running properly;
- c. After checking physical environments, check basic information for accuracy. The basic information includes the software system, licenses, and system time. This ensures that the local equipment works properly and suits interconnection commissioning;
- d. Device check: Check devices to ensure that the device status meet deployment requirements and prepare for access commissioning and basic service commissioning;
- e. Check and record values of VSWR, return loss and distance to fail obtained from properly calibrated Anritsu Cell Master Tool or similar for each device installed.
- f. CONTRACTOR shall configure the UHF receivers frequencies.

## 9 INSTALLATION AND INTEGRATION

### 9.1 INSTALLATION AND INTEGRATION OF EQUIPMENT, ANTENNA AND SENSORS

The equipment, antennas, sensors and positioning systems shall be installed according to the following criteria:

- a. CONTRACTOR shall provide, in addition to installation, all cables and suitable connectors;
- b. The choice of cables and connectors shall ensure the integrity of positioning data on the computer, monitor, peripherals and PETROBRAS LAN Network; as a reference, PETROBRAS uses coaxial LMR400 cables;
- c. The installation of GNSS system shall follow the guidelines of the IMCA S 012 publication. The distance between the GNSS antennas (baseline) shall be larger than 30 meters;
- d. For GNSS and UHF installation, the maximum accepted signal attenuation due to cable and connector losses is 10 dB;
- e. The installation and calibration of the FPSO sensors shall be made by manufacturers or their representatives. The manufacturer or their representatives shall make a report informing the deviation values obtained in the facility;
- f. Stern device (UHF Transceiver A) shall be connected to the positioning computer;
- g. The UHF Transceiver A antenna shall be installed on the top of the antennas mast or in the highest place in the stern area;
- h. PETROBRAS strongly recommends that all antennas shall be installed over Antenna Deck or Telecom Tower.
- i. All equipment shall be homologated by National Telecommunications Agency (ANATEL)

	<b>TECHNICAL SPECIFICATION</b>	Nº <b>I-ET-3010.00-5537-850-PEA-001</b>	REV. <b>C</b>
	AREA: -	SHEET: 15 of 20	
	TITLE: <b>POSITIONING AND NAVIGATION SYSTEM FOR UEP (FPSO AND SS)</b>	INTERNAL	
			SUB/SSUB/GDSO

- j. A simple switch shall receive positioning data (GNS or GGA) from both GNSS receivers and shall send the chosen data (default: receiver A) to the AIS device specified in the I-ET-3010.00-5515-762-PPT-002. Furthermore, the heading data (HDT) from AHRS shall be sent to the AIS device specified in the I-ET-3010.00-5515-762-PPT-002.

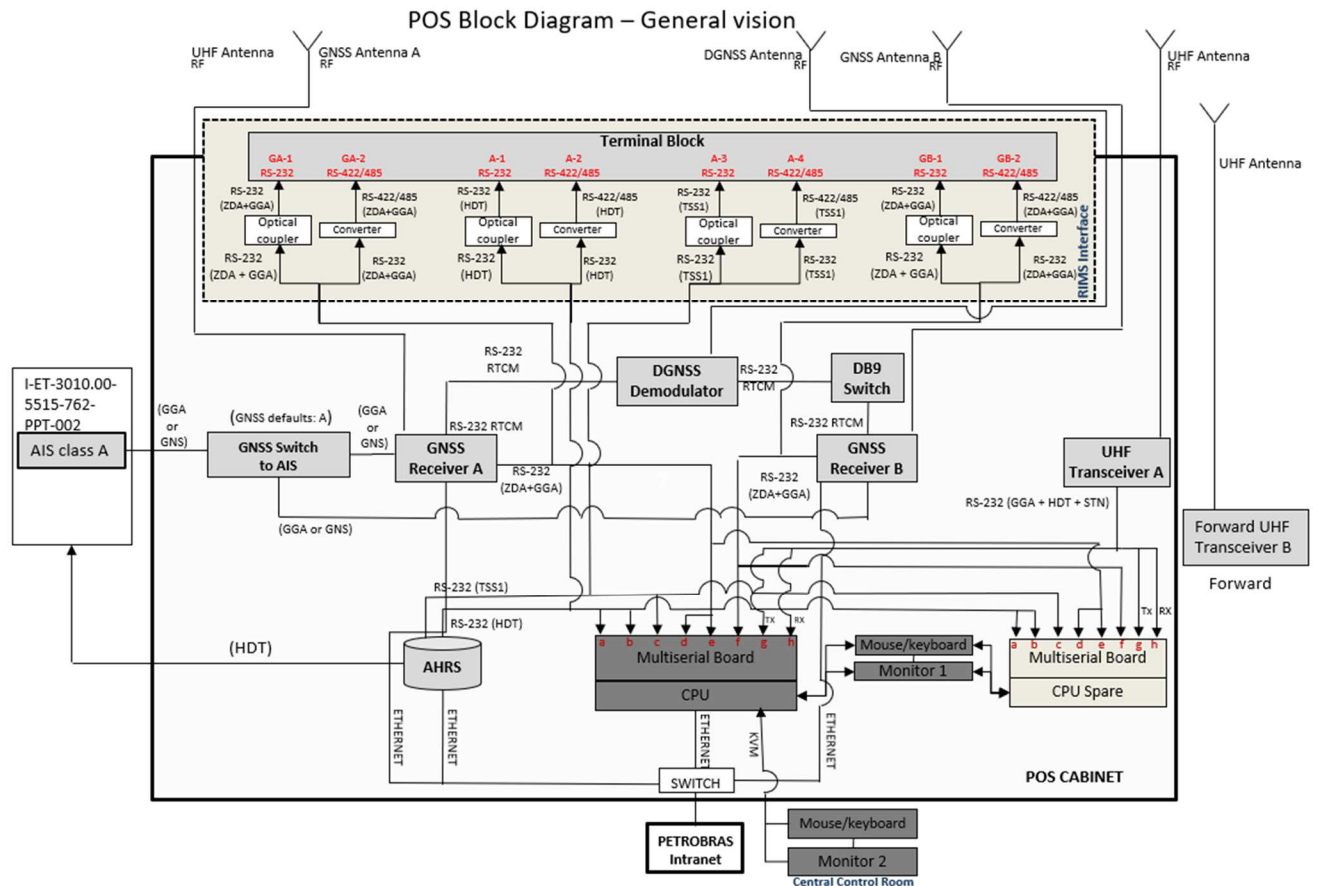


Figure 1 - POS Block Diagram


## 9.2 CABLES AND ANTENNA INSTALLATION

9.2.1 On outdoor areas, exposed a marine atmosphere, the CONTRACTOR shall beware to mitigate the galvanic corrosion of equipment, antennas, panels, boxes, coaxial cables fixing accessories. For reference, follow an example:



Figure 2 – Example of cable fixing



	<b>TECHNICAL SPECIFICATION</b>	Nº <b>I-ET-3010.00-5537-850-PEA-001</b>	REV. <b>C</b>
	AREA: -	SHEET: 16 of 20	
	TITLE: <b>POSITIONING AND NAVIGATION SYSTEM FOR UEP (FPSO AND SS)</b>	INTERNAL SUB/SSUB/GDSO	

9.2.2 CONTRACTOR shall utilize term-contractile materials (adhesive lined heat shrink tube) to protect cable splices and connections between cables and antennas. It shall create a barrier for against water, dirt and other environmental contaminants.

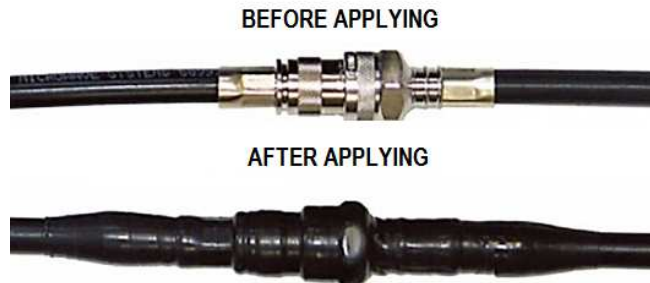


Figure 3 – Term-contractile material

9.2.3 In order to avoid extra efforts on the connection of the RF cable to the antenna, the use of a flexible RF tail will be mandatory to make this connection.



Figure 4 – Example of flexible RF

9.2.4 All antennas shall be adequately positioned on the Unit as to provide maximum efficiency with minimum interference risk or possibility of “shadow” zones.


9.2.5 Lightning protection – It shall be used a lightning protection in all antennas to protect the equipment in case of a stroke of lightning. The lightning protector can be installed in internal area close to FPSO structure.

### 9.3 POSITIONING AND NAVIGATION SYSTEM INSTALLATION AND INTEGRATION

9.3.1 The information technology system for positioning and navigation system shall be installed according to the following criteria:

- a. Both computers shall be mounted into the rack and shall remain turned on;
- b. The rack location shall be installed in the Telecommunications Upper Room. Monitor 1 shall be installed in the POS rack and Monitor 2 shall be installed in the Central Control Room (CCR).
- c. **Computers** shall receive the data from all sensors with integrity;



	<b>TECHNICAL SPECIFICATION</b>	Nº <b>I-ET-3010.00-5537-850-PEA-001</b>	REV. <b>C</b>
	AREA: -	SHEET: 17 of 20	
	TITLE: <b>POSITIONING AND NAVIGATION SYSTEM FOR UEP (FPSO AND SS)</b>		INTERNAL SUB/SSUB/GDSO


- d. CONTRACTOR shall provide a PETROBRAS LAN Network port (Ethernet) to connect to the switch inside the Positioning rack;
- e. The Positioning Desk shall be a space dedicated for survey technicians to work during mooring operations. Besides the monitor (monitor 2), keyboard and mouse connected to the system rack, it shall have 01 (one) available VHF marine radio and 01 (one) telephone (PETROBRAS) nearby.
- f. Eight fixed IPs shall be requested to PETROBRAS and configured on both GNSS receivers, AHRS sensor and any equipment with Ethernet interface that PETROBRAS deems necessary to connect them to the PETROBRAS LAN Network;
- g. External interface system (RRMS - Rigid Riser Monitoring System, or another external system): each GNSS Receiver shall have its own one serial output (NMEA 0183 – ZDA and GGA messages) and AHRS shall have one output for heading (NMEA 0183 – HDT message) and another one for attitude (TSS1 protocol), according to the following minimum criteria:
  - i. One optical coupler for each GNSS Receiver;
  - ii. Two optical coupler for AHRS;
  - iii. Each serial output shall be available as one DB-9F optically coupled RS-232 and as one terminal block four wire, full duplex, RS-422 and RS-485;
  - iv. All serial output shall be integrated in a terminal block. Figure 1 above shows this scheme and additional details.
- h. The FPSO Class A AIS shall receive dynamic data input from GNSS receivers and AHRS specified on this document, exactly as IMO SN/Circ.227 (items 4.1, 4.2 and 4.3). Figure 1 above shows this scheme and additional details. The AIS Reference point of position (SN/Circ.227 item 5.2) shall be the GNSS antenna A. A possible AIS password to change the Reference point (SN/Circ.227, 5.2) shall be easily available.

## 9.4 UHF TRANSCEIVERS CONFIGURATION

### 9.4.1 PARAMETERS

Transceivers shall be configured with the following parameters:

- a. Bandwidth: 12,5 kHz
- b. Link Rate: 4800 bps
- c. Modulation Type: GMSK
- d. Scan Mode: Manual
- e. Sensibility: Low
- f. Serial Interface: 9600 bps, Transparent Protocol with EOT timeout (50 ms)
- g. Transmission Power Options: 2W, 10W, 15W, 20W, 25W

	<b>TECHNICAL SPECIFICATION</b>	Nº <b>I-ET-3010.00-5537-850-PEA-001</b>	REV. <b>C</b>
	AREA: -	SHEET: 18 of 20	
	TITLE: <b>POSITIONING AND NAVIGATION SYSTEM FOR UEP (FPSO AND SS)</b>		INTERNAL SUB/SSUB/GDSO

#### 9.4.2 FREQUENCY PLAN

The UHF frequency plan to be configured on each radio shall be:

Channel	Frequency
1	459,250 MHz
2	459,275 MHz
3	459,400 MHz
4	459,425 MHz
5	459,450 MHz
6	469,250 MHz
7	469,275 MHz
8	469,400 MHz
9	469,425 MHz
10	469,450 MHz

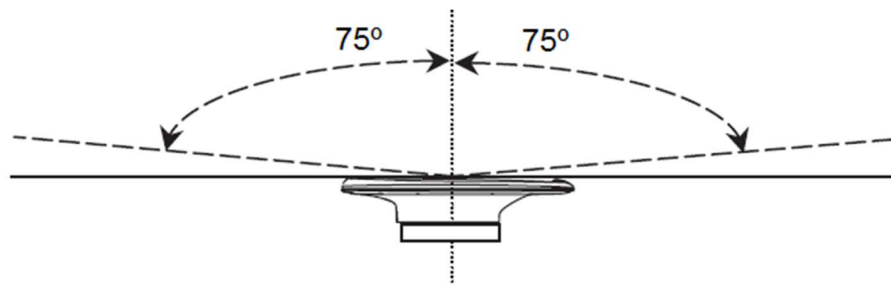
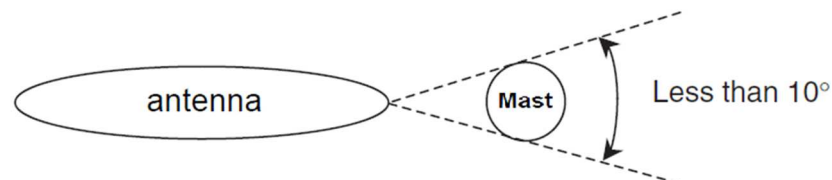
Table 1: frequency plan

### 10 LEGALIZATION REQUIREMENTS

- 10.1** CONTRACTOR shall provide to PETROBRAS all documents and forms required to legalize the UHF System to be installed in the FPSO Unit, subject of this technical specification, including the payment of the ART (Technical responsibility term) to CREA.
- 10.2** PETROBRAS will be responsible for the procedures in order to legalize the UHF System.

**11 APPENDIX – GNSS ANTENNA LOCATION**
**11.1** The GNSS antenna location shall:

- a. Be on the highest place, with no structure blocking the receiver's view of horizontal line.
- b. Shall not be close to stays, electrical cables, metal masts, CB radio antennas, cellular phone antennas, air-conditioning units, transmitting antennas, radar array, satellite communication equipment or any source of EM interference;
- c. Shall not be in areas that experience high vibration, excessive heat, electrical interference or strong magnetic fields;


 Fig A1 – Antenna shall be installed where the field of view against zenith is at least  $\pm 75^\circ$ .


Mast diameter	Min. separation distance
10 cm	1.5 m
30 cm	3 m

 Fig A2 – Minimum separation of antennas to nearby structures, the horizontal angle to the interfering object shall be less than  $10^\circ$ .

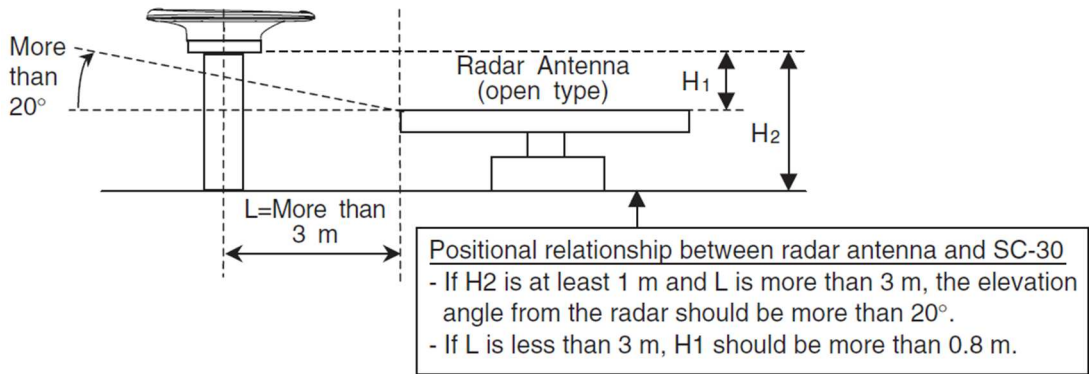


Fig A3 – Minimum separation distances from radar antenna.

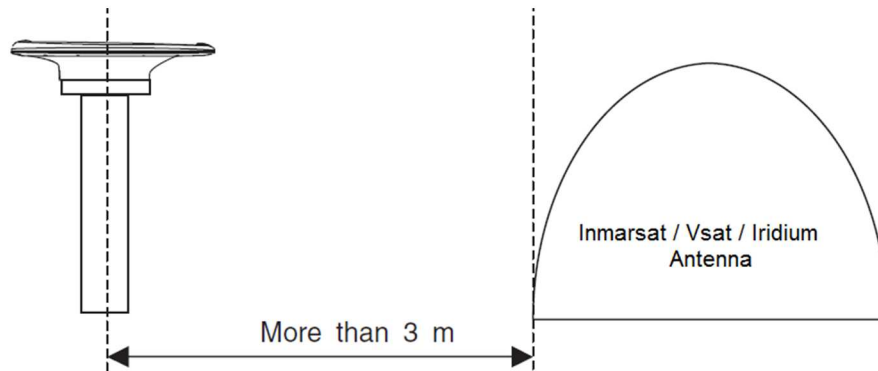


Fig A4 – Minimum separation distances from Inmarsat / VSAT / Iridium antenna.