REVISION INDEX

REV	DESCRIPTION AND/OR SHEETS REACHED
0	Original

	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE	24/01/2025								
PROJECT	GDSO								
EXECUTION	KK2F								
VERIFICATION	CMMX								
APPROVAL	N1G8								

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1 INTRODUCTION

1.1 SYSTEM DEFINITIONS

This Technical Specification outlines the requirements for the FPSO (Floating Production Unit) Positioning and Navigation Systems, operating for PETROBRAS in Brazilian offshore basins.

During the hook up and pull in operations, e.g., the SPI (*Sistema de Posicionamento Integrado* – Integrated Positioning System) software, developed by Petrobras Geodesy Department, 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.

After the oil production kick off, PETRONAV (Petrobras Navigation Software) run 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.

The content of this document describes 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 to calculate riser stresses and alarm in case of mooring line snapping, as well as monitoring all vessels within range.

1.2 ABREVIATIONS

AIS - Automatic Identification System

AHRS- Attitude and Heading Reference System

FPSO - Floating Production Unit

GPS- Global Positioning System

GNSS- Global Navigation Satellite System

NMEA – National Marine Electronic Association

PETRONAV - PETROBRAS Navigation software

KVM – Keyboard, Video (monitor), Mouse

POS - Positioning and Navigation Systems

RRMS- Rigid Riser Monitoring System

RTCM- Radio Technical Commission for Maritime Services

SPI - Integrated Positioning System

UHF – Ultra High Frequency

UPS- Uninterruptible Power Supply

VHF- Very High Frequency

1.3 REFERENCE DOCUMENTS, CODES AND STANDARDS

a) International Electrotechnical Commission (IEC)

i. IEC 60945 - Maritime navigation and radiocommunication equipment and systems – General requirements – Methods of testing and required test results, 2002
ii. IEC 61108-1 - GNSS Part 1: Global positioning system (GPS) - Receiver equipment, 2003
iii. IEC 61108-3 - GNSS Part 3: Galileo receiver equipment, 2010
iv. IEC 61162 - Digital interfaces Part 1: Single talker and multiple listeners, 2010
v. IEC 62320-1 - Automatic identification system (AIS) - Part 1: AIS Base Stations - Minimum operational and performance requirements, methods of testing and required test results, 2015
vi. IEC 62320-2 - Automatic identification system (AIS) - Part 2: AIS AtoN Stations - Operational and performance requirements, methods of testing and required test results, 2016

b) International Marine Contractors Association (IMCA)
IMCA S 012 - Guidelines on Installation and Maintenance of DGNSS-Based Positioning Sys, 2011

c) International Telecommunication Union (ITU)
ITU-R M.1371-4 - Technical characteristics for an AIS using TDMA in the VHF maritime mobile band

d) National Marine Electronics Association (NMEA)
NMEA 0183 – Standard for Interfacing Marine Electronics Devices

e) 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.

f) 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.

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

1.4 GENERAL REQUIREMENTS

a) 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) All systems shall be installed in appropriated rack in the Telecommunication Upper Room located in the accommodation module.

c) The Positioning Navigation System monitor shall be installed inside the CCR – Central Control Room.

d) Positioning and Navigation System shall be fed by 220 VAC UPS unit.

2 TECHNICAL REQUIREMENTS

2.1 GNSS RECEIVER

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

h) To be conform with IEC 61108-1 (GPS) and IEC 61108-3 (Galileo), with integrated solution.

i) To receive and process Galileo E6-B HAS-SIS technology.

j) To comply with IEC 60945 (general requirements for marine equipment).

k) Have at least 0.5m of internal accuracy.

l) The GNSS receivers shall be able to get correction RTCM SC104 v2.3 data from PETROBRAS intranet (TCP/IP) and from a commercial service (according to **item 2.2**).

m) Provide at least GNS, GPZDA and GPGGA data according to IEC 61162-1 (NMEA 0183).

n) It shall have an Ethernet port to connect to PETROBRAS LAN Network.

o) The equipment shall provide status and configuration through a web browser interface. Data output shall also be available through TCP/IP (equipment as the server). A PETROBRAS team shall be able to access the data and configure the GNSS receivers from remote office.

p) At least 2 (two) interfaces/data ports, one serial and the other ethernet. An IEC60945 external converter can be delivered to meet this requirement.

q) Have representation and technical support in Brazil.

r) The power supply of the antennas shall be through the same cable up to 100m long.

2.2 GNSS SATELLITE CORRECTION SERVICE

01 (one) GNSS satellite correction service (augmentation), throughout the charter time, which meets the following minimum specifications:

a) Having less than 1 meter of horizontal accuracy (95%) through real-time correction.

b) It may use DGNSS (Differential GNSS) or PPP (Precise Point Position) technology.

c) Have 99.8% availability for periods of 30 days on all area offshore.

d) Receive multi constellation, GNSS, through at least two different communication satellites.

e) The service shall be configured to correct the signal of both GNSS receivers (item 2.1) and its hardware may form with the GNSS receiver a single device or not.

f) The maintenance is according with item 7.

g) During the life of the charter, the FPSO SELLER shall contract the correction service.

2.3 ATTITUDE AND HEADING REFERENCE SYSTEM (AHRS)

01 (one) attitude and heading reference system which meets the following minimum specifications:

a) True heading accuracy: 0.5° RMS, without GNSS or magnetic input.

b) Pitch and roll accuracy: 0.5° RMS.

c) Heave accuracy: 10 cm or 10% whichever higher.

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 (general requirements for marine equipment).

f) Having two data outputs. One port shall provide the HDT message, according to IEC 61162-1 (NMEA 0183) and in other port shall provide TSS1 protocol.

g) It shall have an Ethernet port to connect to PETROBRAS LAN Network.

h) The equipment shall provide remote configurations to a specific Petrobras office through a web browser interface via PETROBRAS Network / TCP-IP. Data output shall also be available through TCP/IP (equipment as the server).

i) The device shall not require calibration throughout its useful life

j) As a reference Petrobras uses IX BLUE Quadrans Fiber Optic Gyroscope. Similar or better-quality specification will be accepted.

2.4 VERTICAL REFERENCE UNIT - VRU

01 (one) attitude sensor (inclinometer) with the following minimum specifications:

a) Pitch and roll dynamic accuracy: 0.5° RMS.

b) It shall not have moving parts in its principle, shall not be based on geomagnetic effects and shall be independent of GNSS.

c) To comply with IEC 60945 (general requirements for marine equipment).

d) It shall have one Ethernet port to connect to PETROBRAS LAN Network to provide TSS1 protocol.

e) The equipment shall provide remote configurations to a specific Petrobras office through a web browser interface via PETROBRAS Network / TCP-IP. Data output shall also be available through TCP/IP (equipment as the server).

f) The device shall not require calibration throughout its useful life.

2.5 COMPUTERS

a) It shall be supplied and installed four (04) computers.

   a. Two (02) computers shall be installed as a processing unit in a 19” rack (Computer 01 and Computer 02).
   b. One (01) computer shall be installed at the CCR (Computer 03).
   c. One (01) computer shall be installed at the positioning desk (Computer 04)
   d. Both Computer 03 and Computer 04 shall have access to both processing unities (Computer 01 and Computer 02) as a remote desktop solution.

b) Computer 01 and Computer 02 shall follow the minimum requirements below:

   a. Processor: Clock of 3 GHz or higher
      64 bits
   b. Memory: 16GB or higher
      Standard DDR4 or higher
      Frequency 2100MHz or higher
   c. Hard disk: 1TB
      Interface SATA
   d. At least (04) four USB V3.0 ports or higher
   e. At least (03) three Ethernet ports (10/100/1000baseT)

f. Video card with PCI Express X16 with 02 GB RAM (minimum)

g. Windows 11 Pro 64 bit or higher, license in Portuguese.

c) Computer 03 and Computer 04 shall have the minimum requirements below:

a. Processor: Clock of 3 GHz or higher
64 bits
Shall support virtualization technology

b. Memory: 16 GB or higher
Standard DDR4 or high
Frequency 2100 MHz or high

c. Hard disk: 1TB
Interface SATA

d. At least (02) two ethernet ports.

e. At least (03) three USB v3.0 ports or higher.

f. Operational system: Windows 11 Pro 64 bit or higher with TPM 2.0, license in Portuguese.

d) 03 (three) monitors with the following minimum specifications:

a. One monitor 24" (at least) LCD or LED with integrated speakers for Computer 03, at Central Control Room.

b. One monitor 24" (at least) LCD or LED with integrated speakers, mouse and keyboard for Computer 04, to be installed on the positioning desk (for towing operations).

c. One monitor 19” (at least) LCD or LED, mouse and keyboard, inside the POS Cabinet with rackmount. This monitor shall be capable of switching between the Computer 01 and Computer 02.

d. As default, all monitors shall transmit the screen image of the computer 01.

e. After the commissioning, the mouse and keyboard of the Computer 03 might be removed.

e) All computers shall receive the standard PETROBRAS image installed by PETROBRAS and shall be connected to the PETROBRAS network.

f) SELLER is responsible for any operational system upgrades and hardware upgrades required by PETROBRAS at any time until the commissioning final acceptance.

g) 02 (two) serial-to-ethernet converters (8 ports) or equivalent devices. As a reference, PETROBRAS uses MOXA NPort 5600-DT Series.

a. Each computer shall have its own serial-to-ethernet converter.

b. Each serial-to-ethernet converter shall receive the signals from the GNSS Receiver A (ZDA+GGA), GNSS Receiver B (ZDA+GGA), AHRS (HDT), AHRS (TSS1), VRU (TSS1), SPI A (TX) and SPI A (RX).

c. Each serial-to-ethernet converter shall be connected to the switch, making data available on the PETROBRAS Network.

d. Equivalent devices may be accepted if the compatibility of the system, its redundancy characteristics and signals are maintained. More details about these connections are shown in Figure 1 – POS Block Diagram.

h) 01 (one) 16-port industrial unmanaged ethernet switch. As reference, PETROBRAS uses Cisco Catalyst 9300 Series Switches.

i) To comply with IEC 60945:2002 (general requirements for marine equipment).

2.6 INTEGRATED POSITIONING SYSTEM (SPI)

a) 02 (two) radio/modem UHF transceivers to coordinate integrated operations of mobilization and demobilization with other vessels, with the following minimum specifications:

b) Operate in compatible mode with the PETROBRAS SPI system, which uses Trimble TDL 450H.

c) Operate in 450 MHz - 470 MHz range with 12.5 kHz bandwidth per channel.

d) Have an omnidirectional antenna, with power of 250 W / VSWR <1.5:1, 7dBi gain and impedance compatible with UHF transceiver.

e) SELLER shall configure the TX and RX frequencies according to the FREQUENCY PLAN (item 6.2).

f) Transmitting power with 25 W or more with possibility to reduce power to 5W or less if it is necessary.

g) SPI shall be connected to the TELECOM shutdown system.

2.7 AIS ATON STATION

a) 01 (one) AIS AtoN Station Type 3 with the following minimum specifications:

b) To comply with IEC 62320-2 Type 3 (AIS AtoN T3) or IEC 62320-1 (AIS Base Station).

c) In addition to working with Type 3 standard messages, it shall transmit messages 6, 8 and 23.

d) The device shall input/output Type 3 and additional messages by an ethernet port through appropriate IEC 61162-1 (NMEA 0183) sentences.

e) The equipment shall provide automatic streaming and control to a specific Petrobras office through a web browser interface via PETROBRAS Network / TCP-IP. Data output shall also be available through TCP/IP (equipment as the server).

f) Have appropriate VHF and GPS antennas.

g) As a reference, PETROBRAS uses CNS Systems - VDL 7000 AIS/ASM/VDE Base Station.

3 INSTALLATION AND INTEGRATION

3.1 EQUIPMENT, ANTENNA AND SENSORS

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

a) SELLER shall provide, in addition to installation, all cables and suitable connectors.

b) The choice of cables and connectors must 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) should 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) The antennas of UHF Transceivers for SPI shall be installed as follows: Transceiver A antenna shall be installed on the top of the antennas mast or in the highest place in the stern area; Transceiver B antenna shall be installed in a place with suitable height in the forward area, so it can properly receive the signal of Transceiver A, since it will be used as a repeater.

g) SPI-A-UHF and AIS-VHF antennas shall be installed over wing deck or Telecom Tower. Installation project shall be previously submitted to PETROBRAS.

h) The installation of POS shall follow the POS Block Diagram (FIGURE 1).

3.2 CONNECTIONS ON AIS CLASS A, GNSS, AND AHRS

a) The AIS Class A of the FPSO (equipment with the scope of supply is defined on item 4 of I-ET-0600.00-5510-760-PPT-601 – TELECOM MASTER SPECIFICATIONS FOR BOT UNITS) shall receive NMEA 0183 GGA or GNS signal from GNSS Receiver A.

b) The AIS Class A shall receive NMEA 0183 HDT signal from AHRS.

3.3 SYSTEM RACK

a) 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.
   f. 04 (four) vertical cable organizer, for RF cables and controller's cable: Two in front and two on rear;
   g. Internal light only on the rear access.
   h. Complete earthing Kit.
   i. Color: RAL 7035.
   j. 01 (one) electrical switch according to item 14.2 of I-ET-0600.00-5510-760-PPT-601 - TELECOM MASTER SPECIFICATIONS FOR BOT UNITS.

a) 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.

b) 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 has 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.

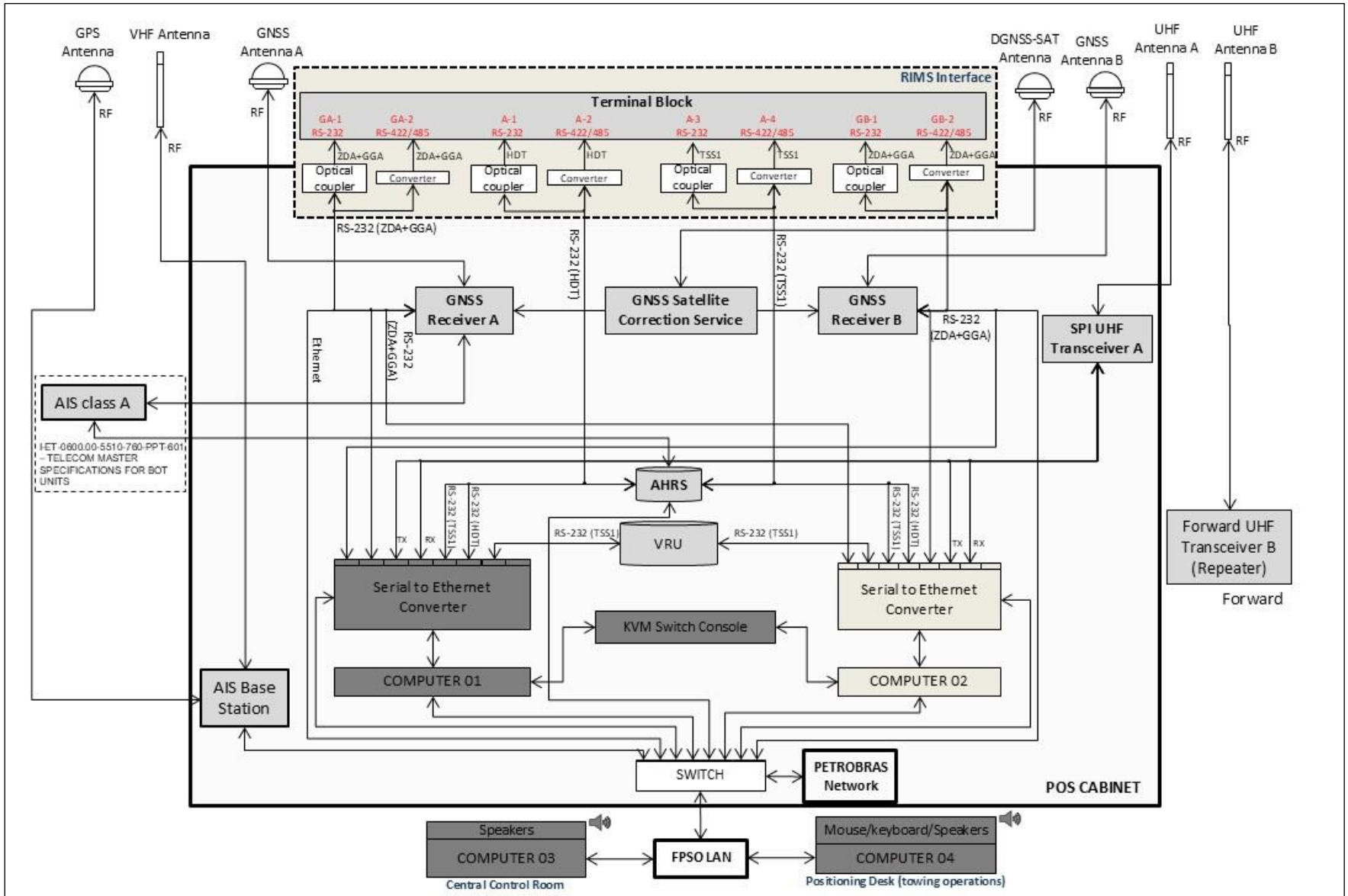


Figure 1 – POS Block Diagram.

3.4 SYSTEM

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

a) Both Computer 01 and Computer 02 shall be mounted into a rack and shall remain turned on.

b) The rack location shall be installed in the TER (Telecommunications Equipment Room). Monitor 1 shall be installed in the POS rack, Monitor 2 shall be installed in the Positioning Desk and Monitor 3 shall be installed in the Central Control Room.

c) The positioning system shall be powered by the FPSO UPS in 220 VAC/60 Hz, and other voltages (12 VDC and 24 VDC) to power the equipment and sensors shall be obtained internally in the package with the use of rectifiers.

d) The Positioning Desk shall be a space dedicated for survey technicians to work during mooring operations. Besides the monitor, keyboard and mouse connected to the system rack, it shall have 01 (one) VHF marine radio and 01 (one) telephone (PETROBRAS) nearby. It shall be preferably located in a room near the TER.

e) Prior to the commencement of operations, the computers of the POS rack shall be configured by PETROBRAS.

f) All computers belonging to this system shall also be configured according to Geodesy Department Software Kit and recommendations.

g) Fixed IPs shall be requested to PETROBRAS and configured on the devices. An Ethernet interface (switch) is necessary to connect them to the PETROBRAS LAN Network.

h) External interface system (RRMS - Rigid Riser Monitoring System, or equivalent 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:

- One optical coupler for each GNSS Receiver;
- Two optical couplers for AHRS;
- Each serial output shall be available as one DB-9F optically coupled RS-232 and as one terminal block four wire, full duplex, RS422/485;
- All serial output shall be integrated in a terminal block. Figure 1 above shows this scheme and additional details.

3.5 TOPOGRAPHIC SURVEY

a) SELLER shall perform a topographic survey to measure the distances in all three directions (x, y and z) of the following equipment:
   a. GNSS antennas
   b. AHRS sensor
   c. VRU
   d. Center of helideck
   e. Riser supports
   f. Fair leaders
   g. Reference Center of the FPSO Project

b) A suitable reference point for the measures shall be chosen and indicated clearly in the report.

c) Measures shall be taken with a total station equipment and shall have decimetric accuracy. AHRS and VRU heading and inclination shall be surveyed at 0.5º angular accuracy. The report shall indicate the methodology used to achieve the required accuracy.

d) The drawing shall show the edge of platform, bridge, helideck and flare truss.

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.

4 COMMISSIONING

4.1 CABLE INTEGRITY

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.

4.2 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.

h) Remote access to the configuration window of the GNSS, AHRS and INCLINOMETER shall be tested. Any information about logins and passwords shall be noted at the commissioning report.

i) The signals from the GNSS, AHRS and INCLINOMETER shall be available on the Ethernet Switch through TCP/IP and on both computers through the Ethernet Switch and the COM ports.

j) GNSS devices shall be connected to the PETROBRAS Network through the Ethernet Switch.

4.3 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.

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.

f) AHRS device shall be connected to the PETROBRAS Network through the Ethernet Switch.

4.4 UHF TRANSCEIVERS FOR SPI

a) Transceivers shall be configured according to item 6.

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.

4.5 INTEGRATED TEST

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.

5 UHF TRANSCEIVERS CONFIGURATION

5.1 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, 4W, 10W, 15W, 20W, 25W

5.2 FREQUENCY PLAN

a) Channel 11 and channel 12 have different frequencies from transmitting and receiving signals. The frequencies shall be configured on the SPI Radios following the following parameters:

Channel	TX Frequency (MHz)	RX Frequency (MHz)
1	459.250	459.250
2	459.275	459.275
3	459.400	459.400
4	459.425	459.425
5	459.450	459.450
6	469.250	469.250
7	469.275	469.275
8	469.400	469.400
9	469.425	469.425
10	469.450	469.450
11	459.250	459.275
12	459.275	459.250

Table 1: frequency plan

6 POSITIONING AND NAVIGATION SYSTEM MAINTENANCE

Throughout the term of the charter, SELLER shall maintain positioning system according to the following criteria:

a) The responsibility for the installation, calibration, maintenance or replacement of all equipment is responsibility of the FPSO SELLER.

b) In case of diverging signals from any device, PETROBRAS will request its calibration or repair.

c) The FPSO SELLER shall update the firmware of the systems every 5 years, or when manufacturers inform it is necessary.

d) Preventive and corrective maintenance plan for all POS, with 9 (nine) months intervals, containing at least following items:

   a. Inspection of all POS, e.g., equipment, antennas, cables and connectors.

   b. A Report containing:

      i. Description of inspection, regarding sub item d) a.

      ii. Sample digital files (at least one minute duration) for each message sensor. For example, for GNSS receivers, a file containing NMEA 0183 protocol. The purpose of this item is to follow up the operability of each sensor.

      iii. A photo showing POS cabinet and all sensor installed inside it.

e) During the life of the charter, the FPSO SELLER shall ensure the operability of all items of this document in full-time and the non-compliance will result in partial unavailability of positioning conditions.

7 DOCUMENTATION AND ACCEPTANCE

7.1 DOCUMENTATION

The FPSO SELLER shall provide the following documentation:

a) Manual of all equipment, positioning systems and software available to PETROBRAS.

b) Installation, configuration and calibration report of the FPSO sensors.

c) General Report:

   a. Stating the model of all equipment, antennas and sensors.

   b. Containing the general arrangement of the FPSO showing top, front, back and lateral (right and left) views as well as the main dimensions (overall length, hull depth, etc).

   c. Containing a layout diagram of all antennas' position in scale.

   d. Containing an electrical wiring diagram showing connections between all equipment involved in the system, connector types and power supplies.

   e. A diagram of devices in POS rack and/or inside the telecommunication room.

d) A vector CAD file in format *.dgn, *.dwg or *.dxf. with all pertinent and required drawings, e.g., general arrangement and layout antennas.

e) Report describing the topographic survey of item 4.4.

f) Photographs of the installations before the FPSO leaves the shipyard.

g) Homologation Certified emitted by Brazilian National Telecommunications Agency (ANATEL).

h) Commissioning report containing results of tests specified in item 5.

7.2 SYSTEM ACCEPTANCE

After the system is installed and commissioned, PETROBRAS will visit the FPSO, before the navigation to the offshore location, to conduct a Site Acceptance Test to verify if all items are in accordance with the requirements of this technical specification.

8 APPENDIX

Acceptable GPS reallocating

The installation GNSS location shall:

- Be on the highest place, with no structure blocking the receiver's view of sky;
- Can 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;
- Can not be in areas that experience high vibration, excessive heat, electrical interference or strong magnetic fields;

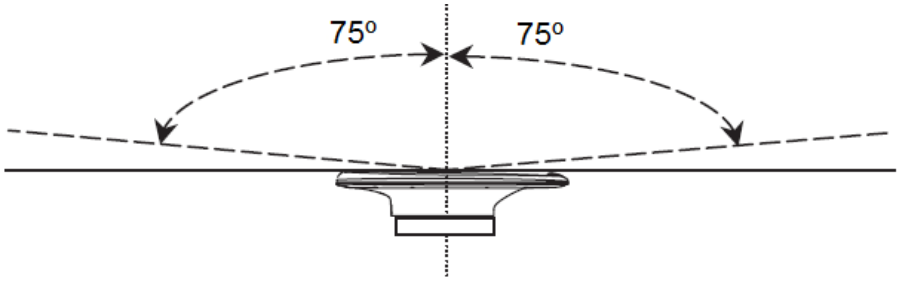
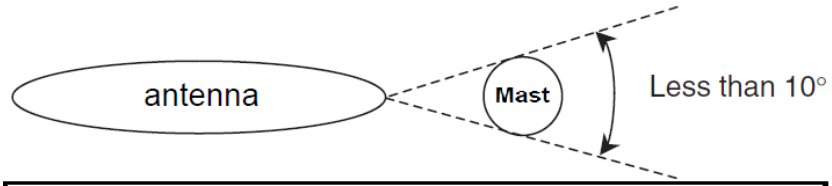
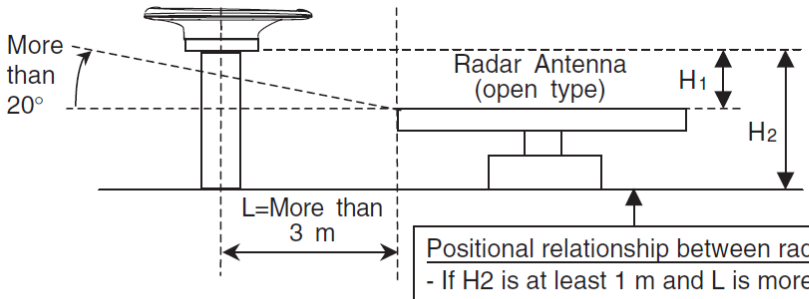


Fig A1 – Antenna shall be installed where the field of view against zenith is at least ±75º.



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 10º.



Positional relationship between radar antenna and SC-30
- If H2 is at least 1 m and L is more than 3 m, the elevation angle from the radar should be more than 20°.
- If L is less than 3 m, H1 should be more than 0.8 m.

Fig A3 – Minimum separation distances from radar antenna.

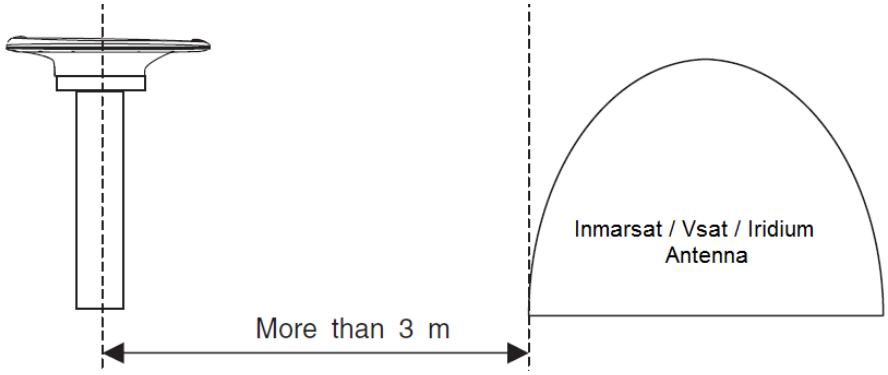


Fig A4 – Minimum separation distances from Inmarsat / Vsat / Iridium antenna.