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	JOB: POSITIONING (PRS)	
	AREA: -	
TIC	POSITIONING REFERENCE SYSTEMS FOR OFFSHORE LOADING SYSTEM	INTERNAL OI/CS


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DATE	ABR/08/22	OCT/25/2022	NOV/10/2022						
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EXECUTION	Y3S7	Y3S7	Y3S7						
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APPROVAL	X187	X187	X187						

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1. SUBJECT

- 1.1 The subject of this document is to establish the criteria and basic characteristics for the detailed design, supply, installation and commissioning of a Positioning Reference System with telemetry compatible with the existing systems installed on dynamically positioned shuttle tanker that shall be installed in PETROBRAS FPSO Unit.
- 1.2 The Positioning Reference System with telemetry shall be installed in FPSO Unit and be composed by:
- a. DARPS 232 – GPS/GLONASS positioning system that integrates relative positioning for a vessel referenced to another vessel, transmitted to the vessel over an UHF link;
 - b. LONG-RANGE MICROWAVE SYSTEM – Microwave position reference sensor system for use in long range marine Dynamic Positioning applications;
 - c. MULTITARGET LASER-BASED REFERENCE SYSTEM – Prismatic targets to allow auto tracking laser system from shutter tanks.
 - d. DARPS 900B – DARPS 232 plus Telemetry System.
 - e. Microwave short range radar transponder - Microwave position reference sensor system for use in short range marine Dynamic Positioning applications.

2. ABBREVIATIONS


ABNT	Brazilian Association of Technical Standards
ANATEL	National Telecommunications Agency
CCR	Central Control Room
DARPS	Differential Absolute and Relative Positioning System
DPST	Dynamically Positioned Shuttle Tanker
DPS	Dynamic Positioning System
IEC	International Electrotechnical Commission
IMO	International Maritime Organization
INMETRO	National Institute of Metrology, Standardization and Industrial Quality
IP	Internet Protocol
IP-XX	Ingress Protection - XX
IS	Intrinsic Security
ITU	International Telecommunication Union
LAN	Local Area Network
LRMS	Long-Range Microwave System
LSZH	Low Smoke Zero Halogen
MHz	Megahertz
PRS	Positioning Reference Systems
UHF	Ultra High Frequency

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3. REFERENCE DOCUMENTS, CODES AND STANDARDS

3.1 International Standards

- a. IEC 1000-4-2: Electrostatic discharge (ESD) requirements
- b. IEC 60079: Electrical apparatus for explosive gas atmospheres - all parts
- c. IEC 60092-502: Electrical installations on ships
- d. IEC 60331: Tests for electric cables under fire conditions - circuit integrity – all parts
- e. IEC 60529: Degrees of protection provided by enclosures (IP Code)
- f. IEC 60533: Electrical and electronic installations in ships - electromagnetic compatibility
- g. IEC 60945: Maritime navigation and radiocommunication equipment and systems – general requirements – methods of testing and required test results
- h. IEC 60950: Information technology equipment - safety
- i. IEC 61000: Electromagnetic compatibility (EMC) series - all parts
- j. IEC 61108-1: Maritime navigation and radiocommunication equipment and systems - global navigation satellite systems (GNSS) - part 1: global positioning system (GPS) - receiver equipment - performance standards, methods of testing and required test results
- k. IEC 61162-1: Maritime navigation and radiocommunication equipment and systems – digital interfaces – part 1: single talker and multiple listeners
- l. IEC 61892-7: Mobile and fixed offshore units - electrical installations - part 7: hazardous area
- m. CISPR 22: Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement
- n. EN 55022: Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement
- o. IMO MODU Code: Code for the Construction and Equipment of Mobile Offshore Drilling Units.
- p. IMO SOLAS: International Convention for the Safety of Life at Sea.
- q. IMO - Harmonization of GMDSS requirements for radio installations on board SOLAS ship (IMO COMSAR/Circ.32 16 August 2004)

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- r. IEEE 802.1Q™-2005: "IEEE standard for Local and metropolitan area networks: Virtual Bridged Local Area Networks".
- s. IEEE 802.2™-1989: "Information Processing Systems - Local Area Networks - Part 2: Logic link control".

3.2 Brazilian Standards

3.2.1. INMETRO

- a. INMETRO PORTARIA 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.

3.2.2. NR's – Normas Regulamentadora

- a. NR-10: Segurança em instalações e serviços em eletricidade.
- b. NR-37: Segurança e saúde em plataformas de petróleo.
- c. It shall be followed all others NR's – Normas Regulamentadoras (Regulatory Standards) from Ministério do Trabalho (Brazilian Ministry of Labor) applicable to this Technical Specification.

3.2.3. ANATEL – Regulations of Agência Nacional de Telecomunicações.

3.2.4. DPC – Departamento de Portos e Costas.


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

3.3 Classification Society


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

4. GENERAL REQUIREMENTS

- 4.1 For more technical requirements details to antennas mounting and cables launching, 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.

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- 4.2 For PETROBRAS detailed design requirements for installation, configuration, tests training and commissioning, 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 NITS 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 Positioning Reference System is composed by the following main systems that work together to allow safety shutter tank and support/supply vessels safety approximation and offloading services:
- a. DARPS 232
 - b. Long-Range Microwave System
 - c. Multitarget Laser-Based Reference System
 - d. DARPS 900B
 - e. Microwave short range radar transponder
- 4.6.1. Every device of Positioning Reference System to be supplied and integrated shall be confirmed by CONTRACTOR and by the system manufacturer.
- 4.6.2. All systems shall be installed in appropriated racks in the Telecommunication Upper Room closer to antenna top deck in Accommodation Module and in Forecastle, close to stern offloading area and they shall be interconnected to each other whenever required by Vendor.
- 4.6.3. Multitarget Laser-Based Reference System are passive standalone devices not installed inside racks, but properly located close to offloading areas for offloading purposes and along both platform sides for support/supply vessels safety approximation support.
- 4.6.4. Microwave short range radar transponder are active devices not installed inside rack, but properly located along both platform sides for support/supply vessels safety approximation support.

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- 4.6.5. The DARPS monitor, Long-Range Microwave System (LRMS) monitor and DARPS 900B monitor shall be installed inside the CCR – Central Control Room able to receive information from both PRS cabinets (Accommodation and Forecastle) according to the offloading (stern or bow) area chosen to be used.
- 4.6.6. Any equipment or device, like network switches, media converters (serial to optic or serial to ethernet) and so on, as well as fiber optic cables required by Vendor to allow intercommunication between DARPS stations (stern and bow) and AHRS redundancy shall be provided.
- 4.6.7. All KVM devices in PRS cabinets and CCR shall also be provided in order to allow to proper source for monitors to display the right information collected in each PRS cabinet.
- 4.6.8. The DARPS 900B Telemetry controllers, as light control unit, signal light-tower, alarm buzzer, alarm silencer button and light test button shall be installed inside the CCR – Central Control Room, one for each Telemetry System required in stern and in bow.
- 4.6.9. All these systems shall be installed at each offloading area, according to their localization in the current project.
- 4.6.10. All external equipment required herein for Positioning Reference System shall have their installation and assemblage easily accessible for maintenance purposes, whose place of installation shall be approved by PETROBRAS.
- 4.6.11. The following schematic diagram presents a typical arrangement of the proposed solution for POSITIONING REFERENCE SYSTEMS for offloading purposes.

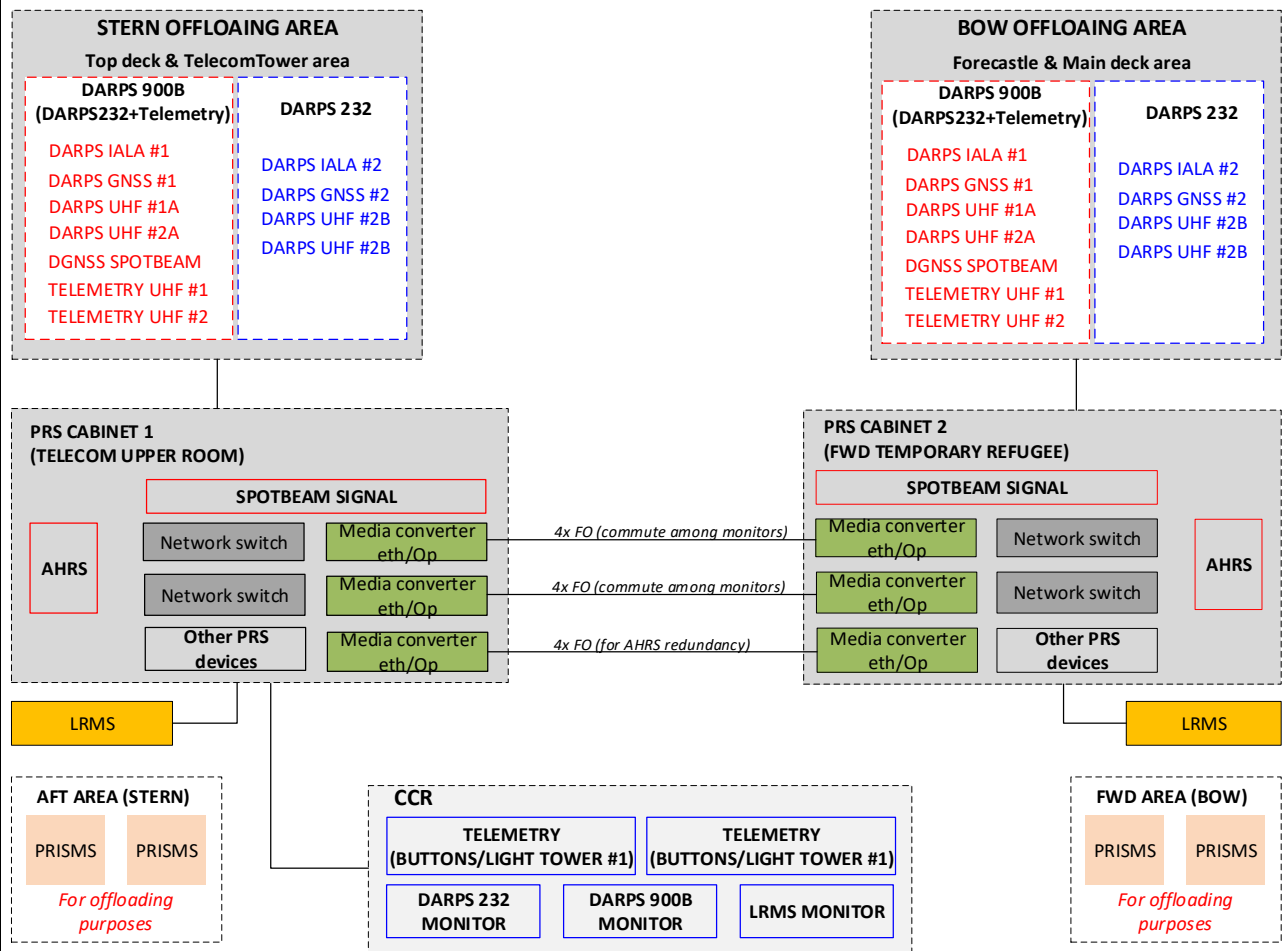




Figure 1: PRS System Overview proposal for offloading purposes

5. SYSTEM REQUIREMENTS


- 5.1 CONTRACTOR shall provide all materials to full installation of all equipment and deliver a list with all equipment and its respective quantities.
- 5.2 For all RF cables, before they ingress to radios consoles, it shall be protected by Coaxial RF Surge Protector/Arrestor.
- 5.3 Equipment and accessories installed in outdoor or industrial areas shall be suitably rugged and their external bodies shall be made in non-metallic material, suitable for harsh environments and in accordance with IEC and ABNT standards, apart from the ones whose classification area require to be metallic as Ex-d junction boxes.
- 5.4 Brackets, bolts, nuts, washers and any other mechanical fixing elements shall be made in stainless steel.
- 5.5 In case of difficulty for supplying some accessory with external body made with non-metallic materials, it will be necessary to submit them for analysis and approval of PETROBRAS.

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- 5.6 It shall be avoided equipment and accessories with their external bodies built in aluminum alloy. Anything different shall be submitted to PETROBRAS approval. In case of approval, this alloy shall not contain in its composition more than 0.25 % of copper and shall comply with the ASTM-B-179 standard (ANSI alloy 356.1).
- 5.7 In outdoor areas, exposed to marine atmosphere, CONTRACTOR shall avoid the galvanic corrosion of junction boxes supports, horns supports and bolts. Galvanic insulation shall be implemented wherever contact between different metallic materials is needed.
- 5.8 The equipment and accessories shall attend the ingress protection degree standard IEC 60529, protection type defined in IEC 61892 and IEC 60079 for electrical devices installed in hazardous areas.
- 5.9 In all junction boxes the cable glands shall be installed facing lateral sides and/or bottom side. Cable glands installed facing upward are not acceptable. It also are not acceptable any opening facing the upward of the box, even if it is closed by cover plug.
- 5.10 In order to avoid humidity and water ingress inside the junction boxes, CONTRACTOR shall apply appropriate material in the screw thread, bolts, cable glands, cover plugs and joints, according to IEC 60079 and IEC 60529.
- 5.11 All radios shall be homologated by ANATEL (Brazilian Government Telecommunication Authority) for its respective usage in the system.
- 5.12 Antennas shall be homologated by ANATEL as per Resolution nº 715/2019 (Certificação e homologação de produtos para telecomunicações) according to their types, gain and purposes: basically, point-to-point antennas requires homologation whereas point-to-area do not.
- 5.13 All equipment that will make part of technical proposal shall have type approval certificate by Classifying Society and technical conformity with the International and National standardization organism: IMO, ABNT, IEC, INMETRO and ANATEL.
- 5.14 The equipment and materials shall be supplied packed suitable for long periods of storage and be protected against mechanical impact and adverse weather conditions.
- 5.15 Equipment and materials shall be supplied with cable passage holes sealed with plastic plugs in the holes to be used, and definitive plugs (made of the same material as the equipment and accessories), in the spare holes.
- 5.16 For the hazardous areas shall be employed equipment for “increased safety” and/or “intrinsically safe” type. The employment of explosion-proof type equipment or any others available models shall be submitted for analysis of PETROBRAS.
- 5.17 All grounding bus bars shall be of tin-plated copper and painted with green strips.
- 5.18 Connections to the grounding network for equipment and boxes shall be made by means of bolted terminals.

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- 5.19 CONTRACTOR shall submit the Calculation Report with the total loss for each RF cables that will be used for this system before the purchase order for PETROBRAS analysis and approval. This Calculation Report shall have information about:
- a. Distances between the radios and antennas;
 - b. Quantity connections;
 - c. Datasheet of the equipment, antennas, RF cables and connectors;
 - d. The RF power output in the radio;
 - e. The RF power expected in antenna (without considering the antenna gain); and
 - f. Total loss of the radiant system.
- 5.20 All RF cables shall be tested and certified with appropriate instrument. All tests results shall be submitted to PETROBRAS approval. The parameters tested shall be, at least, but not limited to:
- a. VSWR;
 - b. Distance to fault (VSWR);
 - c. Return Loss; and
 - d. Cable Loss.
- 5.21 Uninterruptible Power Supply System (UPS)
- 5.21.1. Positioning Reference System regarding to offloading services and equipment shall be powered by FPSO AC-UPS;
- 5.21.2. Each Positioning Reference 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.
- 5.21.3. Automatic Transfer Switch
- 5.21.3.1. The ATS device shall have the following features:
- 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.
- 5.22 Microwave short range radar transponder applied to support/supply vessel safety approximation shall be powered by FPSO Normal Panel.

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6. DARPS TECHNICAL REQUIREMENTS

6.1 Differential Absolute and Relative Positioning System

- 6.1.1. DARPS 232 system where the radio transmission in UHF band to avoid interference and where TDMA technique (Time Division Multiple Access) allow several users to utilize same transmission channel.
- 6.1.2. The DARPS system shall receive GPS/GLONASS satellite signals.
- 6.1.3. DARPS is a GPS based system which uses simultaneously gathered GPS data from high performance sensors on remote and own vessel to compute distance to the target.
- 6.1.4. The DARPS system shall receive heading signals from, at least, one GYROCOMPASS source.
- 6.1.5. The DARPS receptors shall have their antenna properly located according to manufacturer specification.
- 6.1.6. Interfaces
- a. Serial ports: 08 (eight) isolated ports, 6 configurable between RS-232 and RS-422;
 - b. Ethernet/LAN;
 - c. USB.
- 6.1.7. Data Outputs
- a. Message formats: NMEA 0183 v 3.0, Proprietary.
 - b. Message types: ABBDP, ARABB, DPGGA, DTM, GBS, GGA, GLL, GNS, GRS, GSA, GST, GSV, PKNOR, PSKPS, PSKRB, RMC, VBW, VTG, ZDA.
- 6.1.8. Data Inputs
- a. DGPS/DGLONASS corrections: RTCM-SC104 v 2.2, 2.3, Seastar XP, Seastar G2.
 - b. RTK corrections: RTCM-SC104 v 2.3, 3.0, 3.1 and CMR.
 - c. Gyro compass: NMEA 0183 HDT, HRC, HDM, EM3000, PSXN10, PSXN 23 and Robertson LR22 BCD format.
- 6.1.9. Additionally, the following items shall be provided:
- a. Antenna cable for the GPS, IALA and UHF antennas;
 - b. Serial cable (Gyrocompass heading signal to all DARPS stations);
 - c. Power cable to all DARPS (from UPS).

6.1.10. Remarks:

- a. Any other part considered needed to interface DARPS with other systems shall be provided and installed by CONTRACTOR.
- b. Radios and protocols: TDMA (Time Division Multiple Access) radios and protocols allowing more than one transmitter to use the same frequency without interference and a distribution of data from one to several users (Units).
- c. The Positioning Reference System (PRS) shall have an ATTITUDE AND HEADING REFERENCE SYSTEM (AHRS) inside each cabinet of each offloading station to provide the heading signal. Such AHRS's shall be interconnected so that one can provide heading signal to other station in case of failure.
- d. All cables shall be according to the manufacturer specification.
- e. It shall be installed a 24" monitor in CCR to mirror signals from each DARPS 232 station by means of a manual commuter device.

6.1.11. DARPS 232 System overview:

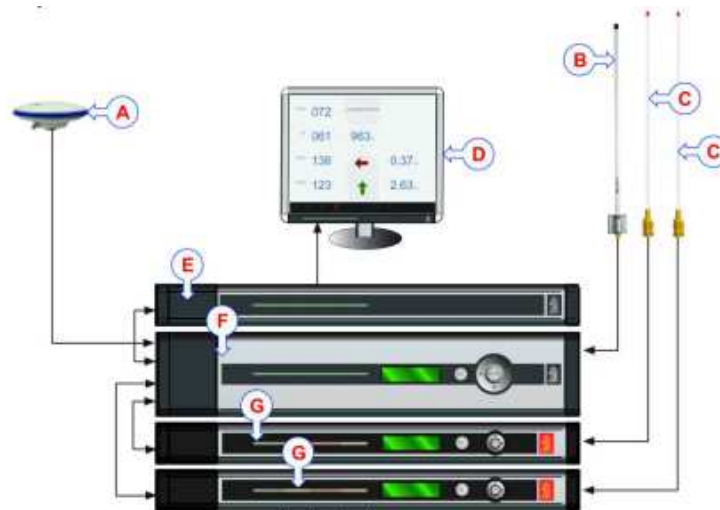



Figure 2: DARPS System Overview

Legend:

- A - GNSS antenna
- B - IALA antenna
- C - UHF antenna
- D - Monitor
- E - HMI Unit
- F - Processing Unit
- G - SeaGnal MB45/MB85 Radio Unit

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6.2 ATTITUDE AND HEADING REFERENCE SYSTEM (AHRS)

6.2.1. 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 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.
- i. IMO approved type.

6.2.2. AHRS device supply and integration shall be confirmed by CONTRACTOR and by the system manufacturer.

7. LONG-RANGE MICROWAVE TECHNICAL REQUIREMENTS


7.1 The Long-Range Microwave System is a microwave-based position reference system that provides accurate positional data to marine DP (dynamic positioning) control systems. It enables automated approach and station keeping relative to a rig or platform, or to another vessel.

7.2 The Long-Range Microwave is a microwave position reference system of the range-bearing type.

7.3 The Long-Range Microwave shall be compatible with similar system already installed on Petrobras Units and approved by Petrobras.

7.4 The standard Long-Range Microwave system consists of:

- a. User-configurable for the Mobile Station and for the Fixed Station. CONTRACTOR scope is only the fixed station.
- b. The Long-Range Microwave Control PC: a marine specification computer, running the control software.
- c. Long-Range Microwave Client PC(s): optional computers used where more than one installation of the Long-Range Microwave System Dashboard software is required;

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- d. Hand-held Operating Panel (or Pendant), if applicable to system.
- e. It shall be installed a 24" monitor in CCR to mirror signals from each LRMS station by means of a manual commuter device.

7.5 The standard specification for Long-Range Microwave system:

7.5.1. Frequency

- a. Frequency band: 9200 - 9300 MHz

7.5.2. Azimuth Measurement

- a. Range: 0 – 280°
- b. Display resolutions: 0.001 or 0.01 degree
- c. Data update rate: 0.25 s (4Hz)
- d. Inherent accuracy: ±0.003 degree
- e. Overall accuracy: 0.02 degree standard deviation

7.5.3. Distance Measurement

- a. Range: 10 – 10,000m
- b. Display resolutions: 0.1m
- c. Data update rate: 0.25s (4Hz)
- d. Overall absolute accuracy 1m standard deviation

7.5.4. Network Connections


- a. Ethernet cable Cat. 6 STP (Shielded Twisted Pair)
- b. Connector RJ45 units - 10Mbps connection

7.5.5. Supported DP Telegram Formats

- a. ADB, BCD, ASCII 16, 17, 22
- b. Custom strings shall be available on request

8. MULT TARGET LASER-BASED REF. SYSTEM TECHNICAL REQUIREMENTS

8.1 The system is a laser-based positioning sensor designed for repetitive, high accuracy range and bearing measurements from offshore support vessels and other marine structures.

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- 8.2 The system is a very straightforward system, where there is a vessel with laser light and another vessel target with a prism: the time the laser light goes to the prism and return is proportional a distance between the vessels. The prism needs to be installed on a nearby structure.
- 8.3 The active system is installed in the shuttle tanker or in any support/supply vessel and the prismatic target is installed in the FPSO.
- 8.4 The system is primarily used as a dynamic positioning (DP) reference sensor measuring the position of an offshore vessel relative to a platform.
- 8.5 The prismatic target must have a cluster with 06 (six) prism with 150 degrees of coverage.
- 8.6 For offloading purposes, it shall be installed 02 (two) target units with 06 (six) prisms located in each offloading area at starboard and at portside areas.
- 8.7 For safety approximation of support/supply vessels it shall be installed target units with 06 (six) prisms not equidistantly located to each other along both platform sides at portside and at starboard and also in turret if it is the case.

9. TELEMETRY SYSTEM TECHNICAL REQUIREMENTS

9.1 DARPS 900B TELEMETRY

- 9.1.1. The DARPS 900B system consists of the DARPS, currently installed on dynamically positioned shuttle tanker and in the FPSO and two (02) controllers for the telemetry system, which have UHF transmitters (Telemetry Radio # 1 and Telemetry Radio # 2).
- 9.1.2. DARPS 900B Telemetry system enhances control and safety during offloading operations by providing real-time 'green-line' offloading control activated manually or automatically.
- 9.1.3. The system is based on dual controllers operating in parallel on different frequencies for enhanced redundancy.
- 9.1.4. Exclusive 'one-to-one' communication links are established between the Telemetry systems on the FPSO and the Shuttle Tanker in the 450 MHz frequency band.
- 9.1.5. It shall be installed a 24" monitor in CCR to mirror signals from each DARPS 900B station by means of a manual commuter device.

9.1.5.1. INTERFACE SPECIFICATIONS

- a. Serial ports: 1 x RS-232; 2 x RS-232 galvanically isolated with common ground;

- b. Network: 1 connection;
- c. USB: 1 connection.

9.1.5.2. RADIO FREQUENCY SPECIFICATIONS

- a. Frequency Range: 450 to 470 MHz
- b. Channel spacing: 12.5 kHz
- c. Sensitivity: <-115 dBm for BER=10⁻⁵

9.1.6. The purpose of the telemetry system is to transmit and receive data, through radio signals, between the shuttle tanker and the FPSO, and consists of two control units installed in the FPSO and two other controller units installed in the shuttle tanker, as illustrated in the Figure 3.

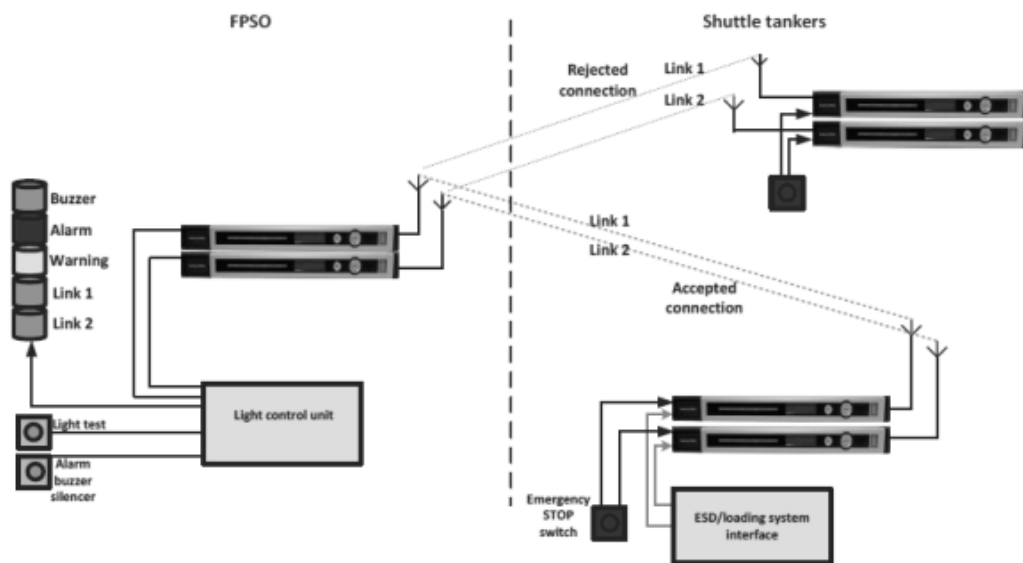



Figure 3: Telemetry System Overview

9.1.7. The data to be transmitted from the shuttle tanker to the FPSO are:

- a. Green line status = OK
- b. Green line status = Failure
- c. Communication failure between radios.

9.1.8. The indication of “READY TO OPERATE” (“LOADING: READY / NOT READY”) occurs when the set of green signal lights is on. In sequence, it should be the permission button for the pump is activated (“PUMPING PERMITTED: YES / NO”)

9.1.9. The green line is connected to the telemetry system in such a way that an eventual

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failure of some “green line break” function will result in a signal being sent to the FPSO with the goal of stopping the pumping. The pumping stop action can be automatic or manual as defined in the FPSO automation project.

9.1.10. The green line signal that enables the offloading operation is provided by the bow loading system PLC in the form of a dry contact. This contact remains closed as long as all conditions necessary for offloading are being met and will be opened whenever any of the green line conditions cease to exist.

9.1.11. The failure information of the green line in the dynamically positioned shuttle tanker, will be transmitted to the FPSO, through the telemetry system that must immediately take necessary protective measures to avoid the occurrence of a pressure rise in the offloading system.

9.2 TELEMETRY SYSTEM SETUP

9.2.1. The technological solution adopted for offloading telemetry consists of upgrading the DARPS system used as a position reference system in operations between FPSOs and dynamically positioned shuttle tanker.

9.2.2. The DARPS system shall be manufactured by Kongsberg Maritime AS, currently used in offloading operations in order to monitor the absolute and relative positions between the FPSO and the relief vessel.

9.2.3. The Offloading telemetry system, DARPS 900B SYSTEM, also developed by Kongsberg, is integrated into the DARPS system and presents the configuration indicated in Figure 4:

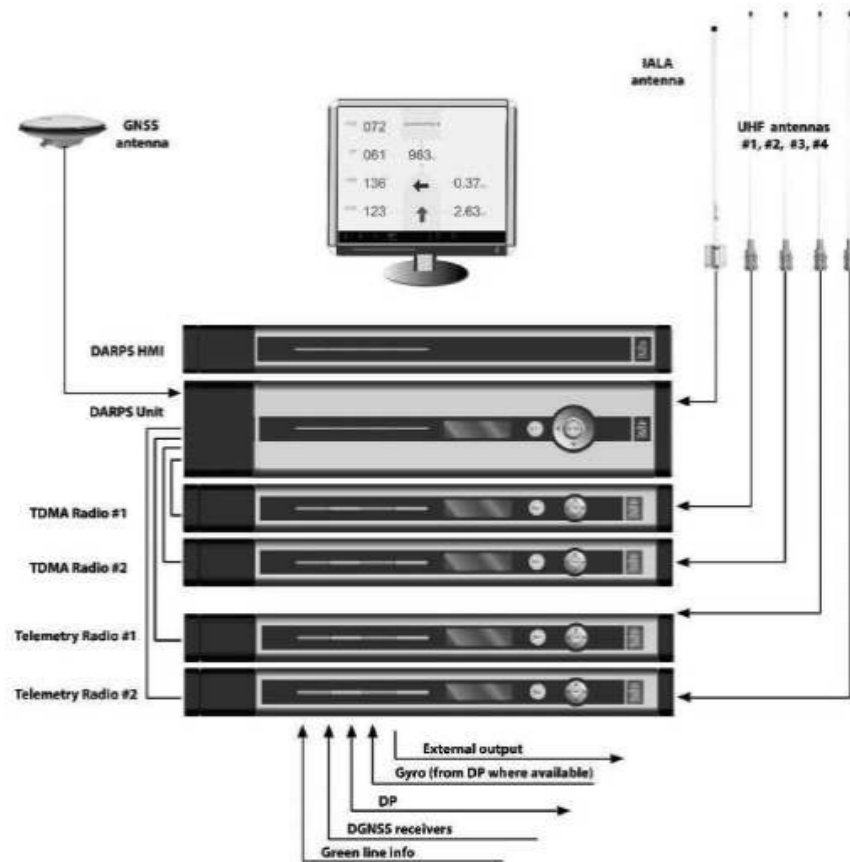



Figure 4: Integration between DARPS 900B System and DARPS System

9.3 Configuration on FPSO SITE

9.3.1. The integration of the telemetry part with DARPS will allow the visualization of the status of the green line on the screen of the DARPS 1 system itself, as shown below:

9.3.2. On board the FPSO, the telemetry system will be equipped with a status signal with the following setting: Audible alarm, RED light, YELLOW light, BLUE light (1), and BLUE light (2).

- BLUE lights: When lit, they indicate that the corresponding UHF links are active, the messages "Permission to Loading" or "NO Permission to Loading" will be shown on the telemetry controller screen.
- YELLOW light: When lit, it indicates that the two UHF links are inactive (manual control of the offloading operation must be started).
- RED light: When lit, it indicates that the sign "NO Permission to Loading" was received from the relief vessel via DP (ESD-1 or ESD-2) or indicates that the emergency key has been triggered. In all these cases, the interruption of load transfer must be started immediately (Stop Pumps).

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10. MICROWAVE SHORT RANGE RADAR TRANSPONDER

10.1 DESCRIPTION

10.1.1. Transponder for DP positioning relative system, based on radar signal (microwave) supposed to be working in support/supply vessels.

10.2 FEATURES

- a. Frequency/Operation Band: 9.2 to 9.3 GHz;
- b. Compatibility with any RadaScan interrogator from Wartsila;
- c. Intrinsically safe, suitable for an explosive atmosphere environment;
- d. It shall be supplied with an internal battery with an autonomy of about 48 hours;
- e. It shall be supplied with a 220V power supply intrinsically safe for operation without depending on the battery.

10.3 Each fixed radar transponder shall be installed at platform guard rail towards open sea, in a proper support easy to be man accessed and maintained without any ladder or scaffold.

10.4 Any junction box proper to classified area shall be provided according to system manufacturer requirements for each equipment or set of equipment.

11. SCOPE OF SUPPLY

11.1 CONTRACTOR shall supply, install, test and commission for all systems described herein and required by Vendors and give the necessary training to PETROBRAS personnel, within the scope of the Contract and in accordance with this Technical Specification.

11.2 DIFFERENTIAL ABSOLUTE AND RELATIVE POSITIONING SYSTEM

11.2.1. It shall be based on DARPS 232 System as minimally specified in table below for each offloading area:

ITEM	SPM TURRET	SPREAD MOORED SYSTEM
DARPS 232 module or higher	One (01)	Two (02)
Cabinet 42U	One (01)	Two (02)
Keyboard with roller-ball, 19" rack mount.	One (01)	Two (02)
GPS/Glonass antenna	One (01)	Two (02)
GNSS antenna mounting kit	One (01)	Two (02)
DGPS IALA Beacon antenna	One (01)	Two (02)
Seatex Demodulator 3710 (Spotbeam)	One (01)	Two (02)
DGPS Spotbeam Antenna	One (01)	Two (02)
DARPS User Manual	One (01)	One (01)
DARPS Installation Manual	One (01)	One (01)
DARPS Site Manual	One (01)	One (01)
Interconnection cable, 1.5 m	Five (05)	Ten (10)
Main's cable, 1.5 m	Five (05)	Ten (10)
Antenna mounting rod	One (01)	Two (02)
Seatex TDMA, 450 Transceiver Module	Two (02)	Four (04)
Connector, Low loss cable	Ten (10)	Twenty (20)
UHF antenna	Two (02)	Four (04)
Dual TDMA programming/data cable -Network	One (01)	Two (02)
Dual TDMA programming/data cable -Serial	One (01)	Two (02)
Industrial Display TFT, AC, 15" rack VGA Monitor	One (01)	Two (02)
Rack keyboard with trackball	One (01)	Two (02)
Monitor 24"/keyboard switch at CCR	One (01)	One (01)
DARPS Network switch	One (01)	Two (02)
KVM for monitors/keyboard/mouse at CCR	One (01)	Two (02)
Attitude and Heading Reference System	One (01)	Two (02)

Table 1: DARPS 232 system

11.2.2. Optical fiber solution will be need for transmit data from Forward side to CCR.

11.2.3. These quantities shall be confirmed by CONTRACTOR and by the system manufacturer.


11.3 LONG-RANGE MICROWAVE SYSTEM

11.3.1. The Long-Range Microwave components to be installed for each offloading area on FPSO are minimally specified in table below.

ITEM	SPM TURRET	SPREAD MOORED SYSTEM
Long-Range Microwave System	One (01)	Two (02)
Junction box	One (01)	Two (02)
Remote Interface Cabinet (RIFC)	One (01)	Two (02)
Local Interface rail (LIFR)	One (01)	Two (02)
Processing Unit	One (01)	Two (02)
Mouse and Keyboard	One (01)	Two (02)
Monitor 24"	One (01)	One (01)
Power and data cabel, Pigtail fixed to Sensor Unit	One (01)	Two (02)
Power Cable (Junction box to Remote interface cabinet)	One (01)	Two (02)
Ethernet Cable (Junction box to Remote Interface cabinet)	One (01)	Two (02)
Power cable to Remote Interface cabinet (input)	One (01)	Two (02)
Data Cable (Remote Interface cabinet to LIFR)	One (01)	Two (02)
Ethernet cable (LIFR to Processing Unit)	One (01)	Two (02)
RS 422 to DP	One (01)	Two (02)
Cable for keyboard and mouse	One (01)	Two (02)
VGA Cable	One (01)	Two (02)

Table 2: LRMS system

- 11.3.2. Optical fiber solution will be needed for transmit data from Forward side to CCR.
- 11.3.3. The same 15" industrial monitor inside each PRS cabinet required for DARPS 232 shall also be used to display LRMS information of that system. So, any additional device shall be supplied as per indicated by manufacturer to share this monitor among systems.
- 11.3.4. The system cannot have movable antennas, that need to be fixed to main equipment body.
- 11.3.5. The system must have a specified range minimum 10 meters and maximum of 5000 meters, with an accuracy of 1 meter.
- 11.3.6. The system shall be installed a way that provides 250-degree minimum coverage for spread-moored FPSO's and 180 degree maximum coverage for turret-moored FPSO's.
- 11.3.7. Signal handling must be robust in all-weather condition without significantly degrade in performance.
- 11.3.8. Wherever distance from the fixed antenna location to the operator station exceeds 100 meters, either a high-quality low-loss copper cable (double-shielded of type

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ToughCAT-7 or better), or a fiber optic solution shall be used for data communication.

- 11.3.9. The microwave system shall be installed with best possible view towards the DPST, with sufficient height to reduce local shading/blocking.
- 11.3.10. Operator station shall be located in the Central Control Room or as instructed by PETROBRAS.
- 11.3.11. The system must have an easy operational display unit, visualizing bearing and distance to the DPST.
- 11.3.12. User manual must be provided by vendor.
- 11.3.13. The microwave-based relative positioning system shall have power feed from an UPS. Installation of the system components according to vendors Installation Manual.
- 11.3.14. These quantities shall be confirmed by CONTRACTOR and by the system manufacturer.

11.4 MULTITARGET LASER-BASED REFERENCE SYSTEM

11.4.1. For offloading purposes

- a. 02 (two) units: for Single Point Moored (Turret) Units an optical laser positioning system target comprising 01 (one) set of 02 (two) targets prismatic with 6 prism cluster must be provided.
- b. 04 (four) units: for Spread Moored Units 02 (two) sets comprising 02 (two) targets prismatic with 6 prism cluster shall be provided and installed on each offloading station (forward and aft).

11.4.2. For support/supply vessel safety approximation

- a. 09 (nine) units: for Single Point Moored (Turret) Units it shall be supplied 09 (nine) targets prismatic with 6 prism cluster to be installed 03 (three) on portside, 03 (three) on starboard, 02 (two) on turret tower, 01 (one) at end stern.
- b. 08 (eight) units: for Spread Point Moored Units it shall be supplied 08 (eight) targets prismatic with 6 prism cluster to be installed 04 (four) on portside and 04 (four) on starboard, along platform sides and not equidistantly to each other.
- c. 08 (eight) units: for semi-submersible or fixed moored Units it shall be supplied 08 (eight) targets prismatic with 6 prism cluster to be installed 04 (four) on portside and 04 (four) on starboard, along platform sides and not equidistantly to each other.
- d. 02 (two) standalones: not mattering the type of Unit, it shall be additionally

supplied 02 (two) standalone targets prismatic with 6 prism cluster to be installed under operational demand, which shall be delivered inside suitable transport cases.

11.4.3. Drawing showing the schematic for one CLUSTER (Figure 5):

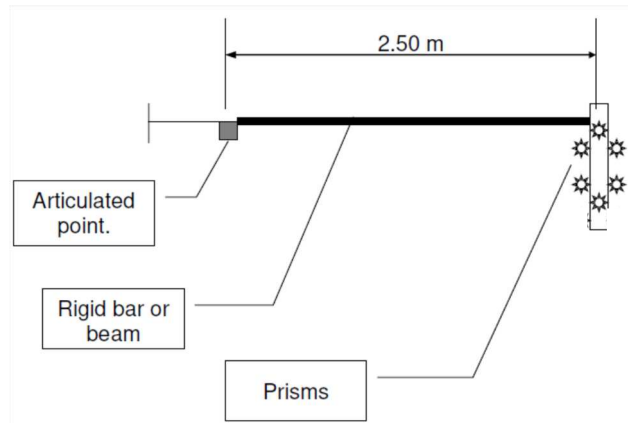


Figure 5: Schematic for one CLUSTER and installation example

11.4.4. Each fixed set of prism unit shall be installed whenever possible at platform guard rail towards open sea, in a proper support easy to be man accessed and maintained without any ladder or scaffold.

11.5 TELEMETRY SYSTEM

11.5.1. It shall be based on DARPS 900B system for each offloading area as minimally specified in tables below:

ITEM	SPM TURRET	SPREAD MOORED SYSTEM
DARPS 232 module or higher	One (01)	Two (02)
Cabinet 42U	One (01)	Two (02)
GPS/Glonass antenna	One (01)	Two (02)
GNSS antenna mounting kit	One (01)	Two (02)
DGPS IALA Beacon antenna	One (01)	Two (02)
DARPS User Manual	One (01)	One (01)
DARPS Installation Manual	One (01)	One (01)
DARPS Site Manual	One (01)	One (01)
Interconnection cable, 1.5 m	Five (05)	Ten (10)
Mains cable, 1.5 m	Five (05)	Ten (10)
Antenna mounting rod	One (01)	Two (02)
Seatex TDMA, 450 Transceiver Module	Two (02)	Four (04)
Connector, Low loss cable	Ten (10)	Twenty (20)
UHF antenna	Two (02)	Four (04)
Dual TDMA programming/data cable -Network	One (01)	Two (02)
Dual TDMA programming/data cable -Serial	One (01)	Two (02)
Monitor 24"/keyboard switch at CCR	One (01)	One (01)
DARPS Network switch	One (01)	Two (02)
KVM for monitors/keyboard/mouse at CCR	One (01)	Two (02)

Table 3: DARPS 232 applied to Telemetry

ITEM	SPM TURRET	SPREAD MOORED SYSTEM
DARPS 900B Telemetry controllers	One (01)	Two (02)
Light control unit	One (01)	Two (02)
Signal light-tower	One (01)	Two (02)
Alarm buzzer	One (01)	Two (02)
Alarm silencer button	One (01)	Two (02)
Light test button	One (01)	Two (02)
Telemetry UHF antennas	Two (02)	Four (04)
UHF TDMA Radio OMTS Units (Seignal Radio)	Two (02)	Four (04)
Main's cable of 1.5 m	Two (02)	Four (04)
Connector	Four (04)	Eight (08)

Table 4: DARPS 900B Telemetry itself

- 11.5.2. Optical fiber solution will be needed for transmit data from Forward side to CCR.
- 11.5.3. The same 15" industrial monitor inside each PRS cabinet required for DARPS 232 shall also be used to display Telemetry (DARPS 900B) information of that system. So, any additional device shall be supplied as per indicated by manufacturer to share this monitor among systems.
- 11.5.4. These quantities shall be confirmed by CONTRACTOR and by the system manufacturer.

11.6 MICROWAVE RADAR TRANSPONDER

- 11.6.1. 05 (five) fixed short range radar transponders for FPSO Spread Mooring type platforms, they shall be installed as follow: 03 (three) on port side (one further forward, another amidships and a third further aft) and 01 (one) on starboard near the cargo handling area and 01 (one) on starboard at amidships.
- 11.6.2. 04 (four) fixed short range radar transponders for Turret FPSO type platforms they shall be installed as follow: 01 (one) on port side near the cargo handling area, 01 (one) on starboard near the cargo handling area and 02 (two) on the turret at diametrically opposite sides.
- 11.6.3. 04 (four) fixed short range radar transponders for semi-sub or fixed platforms they shall be installed as follow: 01 (one) on each face (eg North; South; East; West).
- 11.6.4. 01 (one) standalone short range radar transponder: not mattering the type of Unit, it shall be additionally supplied 01 (one) standalone transponder to be installed under operational demand, with the possibility of being installed along the entire platform perimeter at any side, which shall be delivered inside suitable transport case.

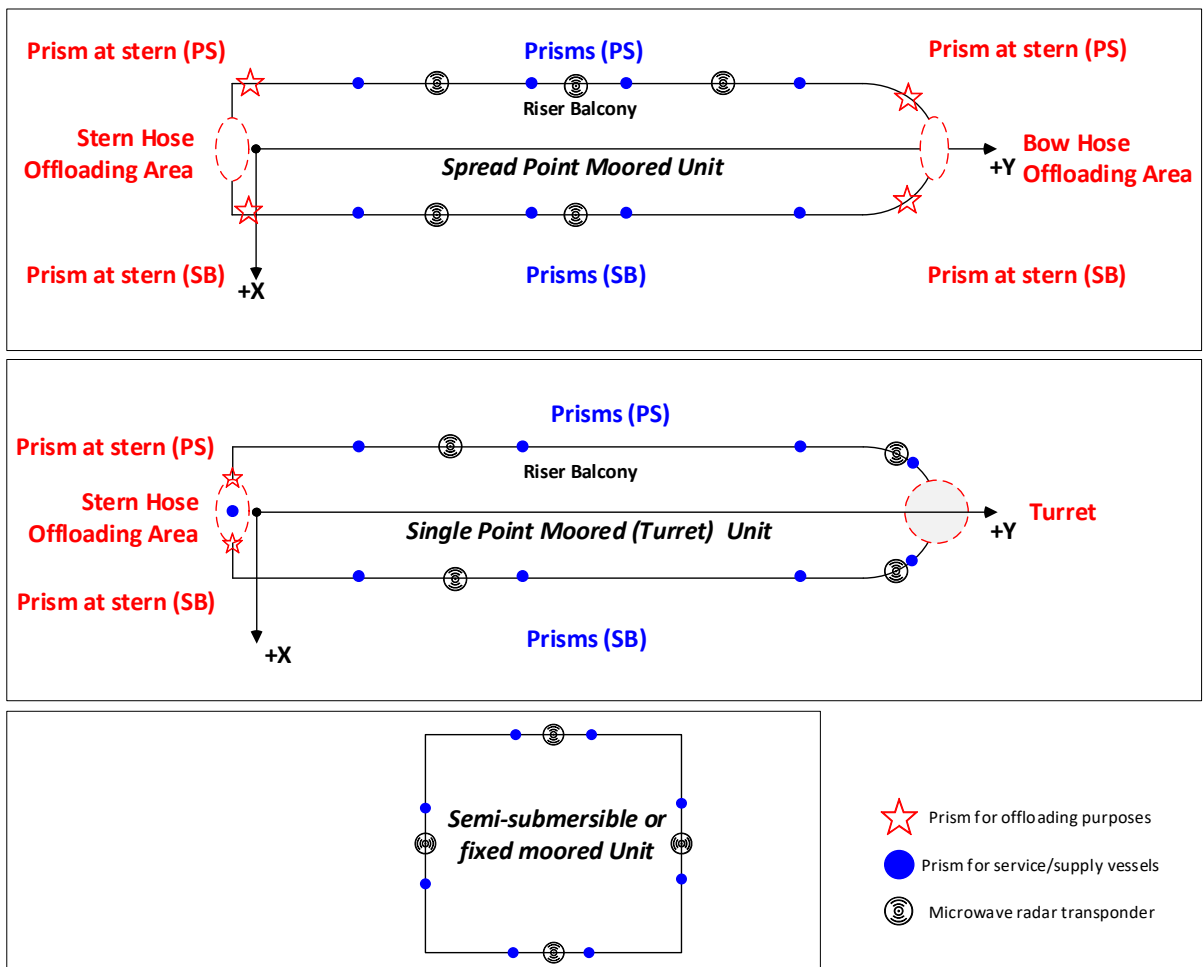



Figure 6: Schematic prims and radar short range radar transponder's locations

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11.7 SYSTEM RACK

11.7.1. CONTRATOR shall provide and install 02 (two) closed racks, for all POSITIONING REFERENCE SYSTEM indoor equipment installation. These racks 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. Vertical cable organizer, for RF cables and controllers cable;
- g. Internal light only on the rear access;
- h. Complete grounding Kit;
- i. Color: RAL 7035.
- j. 01 (ATA) for cabinet powered by UPS bus bar A and B and any required circuit breaker.

11.8 TOPOGRAPHY SURVEY

11.8.1. In order to achieve the specified accuracy of the system, the different sensor parts of the system have to be surveyed. The position (coordinates) each sensor shall be referred to the vessel coordinate system.

11.8.2. The sensors in use in this system are:

- a. GNSS antennas (position).
- b. Long-Range Microwave System
- c. Multitarget laser-based prisms

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- 11.8.3. A specialized service shall be hired to carry out a dimensional inspection on board the FPSO for offloading operations.
- 11.8.4. The data of this dimensional inspection will later be used for the calibration of Position Reference Systems DARPS, Long-Range Microwave System and Multitarget laser-based prisms, so that it is possible to operate with oil cargo vessels equipped with dynamic positioning system.
- 11.8.5. The dimensional inspection shall be carried out using a topography, or similar equipment with compatible precision, in order to measure angles and distances from equipment for a receiving target placed at the point to be measured.
- 11.8.6. CONTRACTOR shall carry out measurements throughout the FPSO on the main deck on both sides in order to generate a good reference plane and so establish a coordinate reference system.
- 11.8.7. Each measure shall be made using different common points, in order to make it possible to obtain measurements between the different measured points.
- 11.8.8. All the measured points shall be in the same common reference system of coordinates in relation to the ship.
- 11.8.9. CONTRACTOR shall carry out the measurement of the positions (X, Y, Z) following systems:
- a. Bow and stern GPS antennas (DARPS system);
 - b. Stern and bow Long-Range Microwave System;
 - c. Stern and bow, port and starboard Multitarget laser-based prisms;
 - d. Stern and bow Offloading hoses;
 - e. Stern and bow Hawser (connection point);
 - f. Bow end;
 - g. Stern end;
 - h. Other points that allow future use.
- 11.8.10. The figure 7 is an example of the measurement to be made, as well as the common system of coordinate reference adopted:

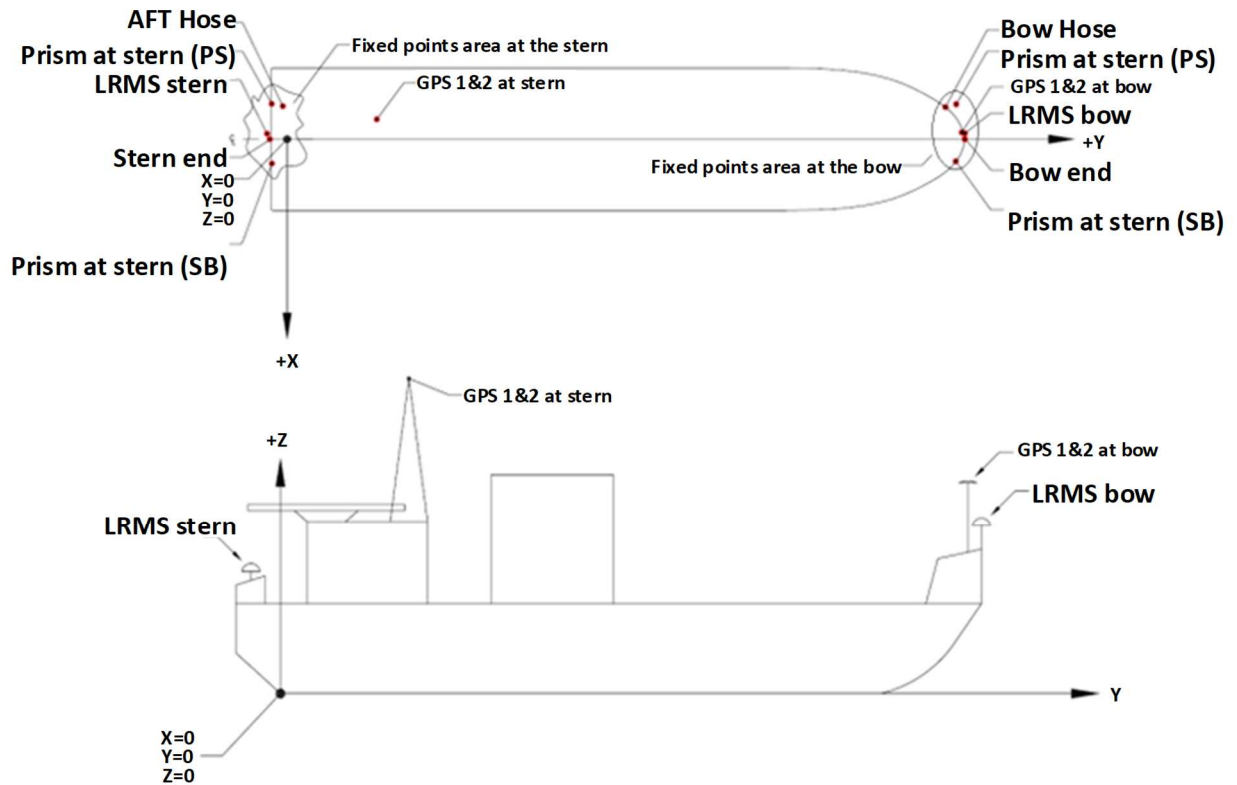


Figure 7: Example of the measurement

11.8.11. Notes:

- Accuracy of measurements should be +/- 2 mm
- All coordinates must be in meters (m)
- Angles must be in degrees (0 360°)
- Dimensions must be in millimeters (mm)
- The survey's ambient temperature shall be reported in the final report
- Coordinate reference point should be the stern point (AP) (X = 0, Y = 0, Z = 0), or extreme stern point
- X = 0 at the center line
- Y = 0 at stern point (the distance from the main structure being mentioned, eg: 9.100m aft of aft frame of Superstructure)
- Z = 0 in the Baseline (the distance from the Main Deck being mentioned in the center line)
- Positive X axis for starboard
- Positive Y axis towards the bow
- Positive Z axis up

11.9 FINAL REPORT

11.9.1. At the end of the dimensional inspection, a report with measurements shall be issued with the minimum information:

- Position references;
- Work procedure (such as the measurements that were taken);
- Specification of the equipment used;
- Documental references (if used).

11.9.2. Following example of table with all measurements in relation to the measurement points:

POINTS NEAR BOW				
SENSORS	X(+Stb)	Y(+Fwd)	Z(+Up)	DESCRIPTION
LRMS	-4,107	238,500	29,741	Center top LRMS
Prismatic port	-3,102	239,002	28,982	Prismatic prisms port
Prismatic stb	9,914	239,018	28,813	Prismatic prisms stb
Hose	4,899	239,404	31,432	Center wheel (no hose installed)
Hawser (absolute bow)	-0,001	239,404	24,896	Absolut bow point
Spare hose	12,945	228,127	31,260	Center spare hose
GPS 2 fore	-0,902	227,925	41,354	GPS at top mast
HAWSER IS ABSOLUT BOW POINT ON HULL				

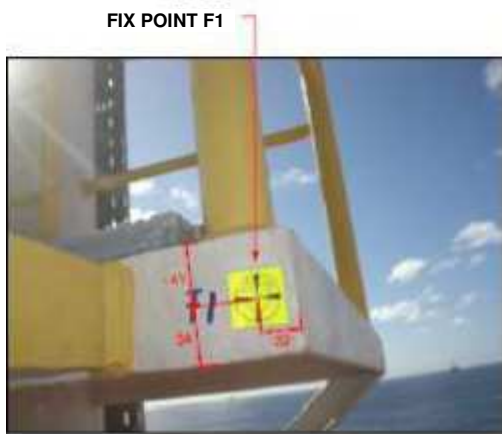
POINTS NEAR STERN				
SENSORS	X(+Stb)	Y(+Fwd)	Z(+Up)	DESCRIPTION
LRMS	0,216	-21,743	36,712	Center top LRMS
Prismatic port	-10,088	-9,850	21,617	Prismatic prisms port
Prismatic stb	10,927	-9,745	21,576	Prismatic prisms stb
Hose	5,164	-12,435	23,112	Center hose
Hawser (absolute bow)	-3,020	-10,415	22,604	Asbolut ster point
GPS 1 AFT	18,045	35,677	44,027	GPS 1 trimble SPS MSK
GPS 2 aft	-18,954	35,686	44,056	GPS 2 trimble SPS MSK
GPS/GLONASS DP 1	-9,443	34,815	10,330	Top compass deck
GPS AIS	9,386	34,816	40,097	Furuno GPS A S
Helideck	-4,328	-9,652	38,175	Center helideck
HAWSER IS ABSOLUT STERN POINT ON HULL				

FIX points some previous FPSO, as example				
Point ID	X(+Stb)	Y(+Fwd)	Z(+Up)	DESCRIPTION
F1	14,505	27,971	40,287	FIX Points
F2	6,371	32,898	40,516	FIX Points
F3	-6,309	32,916	40,528	FIX Points
F4	9,669	34,965	38,953	FIX Points
F5	3,496	29,531	40,016	FIX Points
F6	8,363	38,744	38,98	FIX Points
MARKED FIXED POINTS (REF. POINTS)				

Table 5: SURVEYED ITEMS sample

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11.9.3. Following photos of all the measured points, as example:




LOOKING AFT



LOOKING PORT

Figure 8: sample photos of real installation

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LRMS ANTENNA (FORE)



LOOKING FWD/STB

LRMS ANTENNA (AFT)



LOOKING AFT

Prismatic STB (AFT)



CENTER HOSE (AFT)

LOOKING AFT

HAWSER (AFT)




Prismatic PORT (AFT)

LOOKING AFT

Figure 9: sample photos of real installation

12. COMMISSIONING

- 12.1 CONTRACTOR with the assistance of the manufacture representatives shall done the initial commissioning and set up of the positioning reference system in the Shipyard.
- 12.2 The final commissioning and set up of the positioning reference system shall be done in the FPSO final operation site area during an offloading operation together with a DP shuttle tanker. CONTRACTOR with the assistance of the manufacturer's representatives shall do this work.
- 12.3 All set-up and tests will be performed with assistance from the manufacturer representative.

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12.4 PETROBRAS will perform an acceptance test for the positioning reference systems.

13. CABLES AND ANTENNA INSTALLATION

13.1 In outdoor areas, exposed to marine atmosphere, CONTRACTOR shall beware to mitigate the galvanic corrosion of junction boxes supports, antennas supports, panels, bolts and any other parts. Galvanic insulation shall be implemented where contact between different metallic materials is necessary. For reference only, follow the example in Figure 10:



Figure 10: Insulation to avoid galvanic corrosion

13.2 CONTRACTOR shall utilize tubing term-contractile materials (adhesive lined heat shrink tube) as a sealant form for ending, cable splices or bundling of cables. It shall create a barrier against water, moisture, dirty and other environmental contaminants. The Figure 11 shows an example:

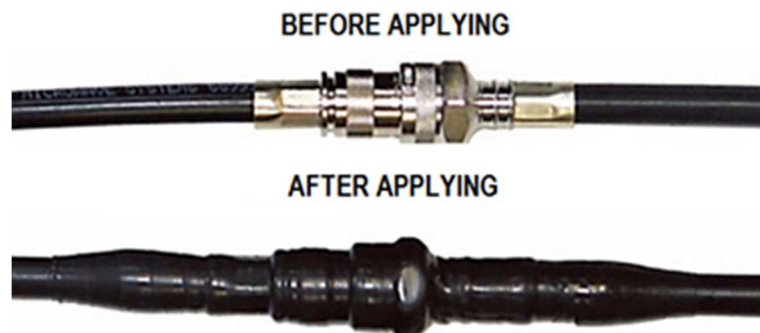


Figure 11: Connection protection

13.3 In order to avoid extra efforts on the connection of the RF cable to the antenna, the use of a flexible RF tail shall be mandatory to make this connection, as shown in Figure 12 and Figure 13:


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Figure 12: RF flexible tail



Figure 13: Connection between RF cable and RF flexible tail

13.4 All antennas shall have its access area identified with its TAG and system painted on the floor as shown the examples in Figure 14.

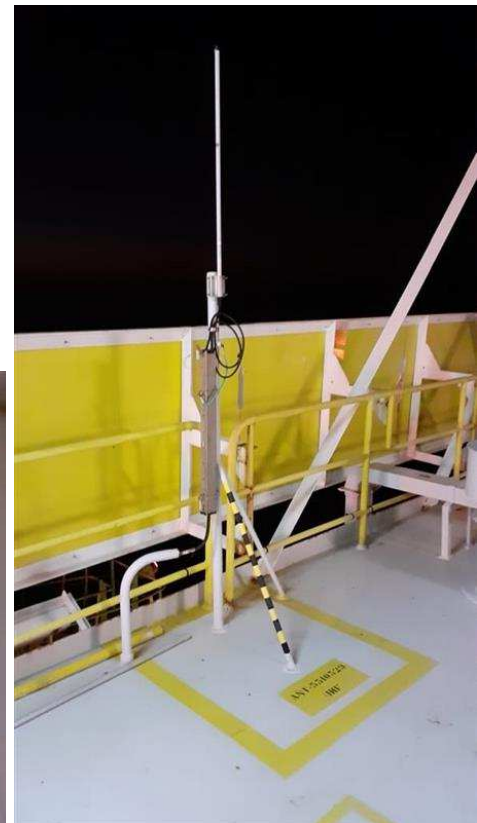



Figure 14: Examples of antenna identification on the floor

13.5 All antennas shall be adequately positioned on the Unit as to provide maximum efficiency with minimum interference risk or possibility of “shadow” zones. Shadow zones are understood as areas where the RF signal level is not sufficiently strength for a properly operating of the system.

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13.6 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 shall be installed in internal area close to FPSO structure.

13.7 GNSS antennas

13.7.1. GNSS antennas are critical for operation and their location on the FPSO must have high priority. GNSS antennas shall be separated both horizontally and vertically to reduce the risk of in-band interference. The GNSS antenna shall have an unobstructed line of sight to the sky.

13.7.2. GNSS/DGNSS antennas shall not be placed within the Mini C antenna beam (15 degrees below the Mini C antenna's horizontal plane). The vertical separation shall be at least 1.5 meters.

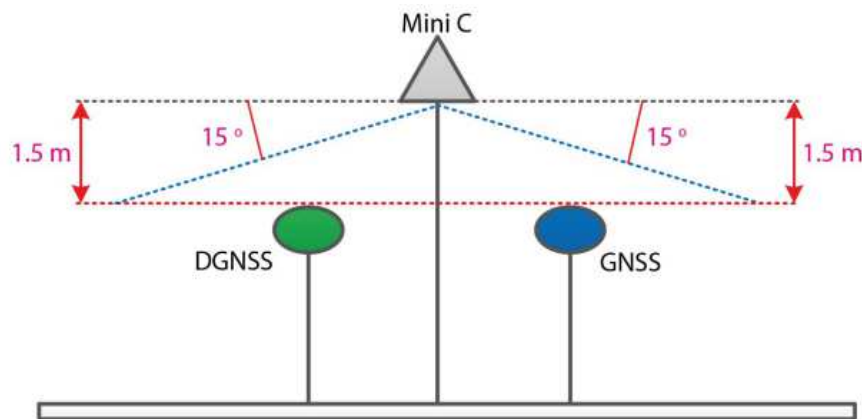


Figure 15: Antennas installation requirements


14. LEGALIZATION REQUIREMENTS

14.1 CONTRACTOR shall provide to PETROBRAS all documents and forms required properly filled to legalize the UHF System to be installed in PETROBRAS FPSO Unit, subject of this technical specification, including the payment of the ART (technical responsibility term) to CREA and assigned report of non-ionizing radiation.

14.2 CONTRACTOR shall provide the requested signed report of ANATEL resolution number 700 about Evaluation of Human Exposure to Electric, Magnetic and Electromagnetic Fields Associated with the Operation of Radiocommunication Transmitting Stations.

14.3 CONTRACTOR will be responsible for the procedures in order to legalize the UHF System.

14.4 These documents shall be available to PETROBRAS 200 days before the FPSO Sail Away.

	TECHNICAL SPECIFICATION	Nº: I-ET-3010.00-5537-76F-PPT-001	REV. B
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			OI/CS

15. FREQUENCY PLAN

15.1 The frequency used for offloading telemetry system is described below:

- 15.1.1. Radio frequency range goes from 450 to 470 Mhz, with spacing channels of 12,5 Khz, with is enough to Kongsberg configure the systems and services.
- 15.1.2. Radios for DARPS232 will use UHF frequency 450.XXX and radios for OMTS (DARPS900B) will use UHF frequency 455.XXX, where XXX and YYY depends on each shuttle tanker to be used, whose information will be informed by Kongsberg during its commissioning works.