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	CLIENT: SRGE	SHEET: 1 of 18
	JOB: TELECOMMUNICATION TRANSMISSION	
	AREA: -	
TIC	TITLE: LTE TRANSMISSION SYSTEM	INTERNAL OI/CS

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PROJECT	PROJ-US	PROJ-US							
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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 LTE TRANSMISSION SYSTEM, for data, voice and video communications.

2. ABBREVIATIONS

ABNT	Brazilian Association of Technical Standards
ANATEL	Brazilian Telecommunication Authority
ANSI	American National Standards Institute
APC	Angled Physical Contact polishing
ART	Technical Responsibility Note
ASTM	American Society for Testing and Materials
CLC	European Committee for Electrotechnical Standardization - CENELEC
CREA	Brazilian Engineering Counsel
DIO	Optical Distribution Drawer
IEC	International Electrotechnical Commission
IEEE	Institute of Electric and Electronic Engineers
INMETRO	National Institute of Metrology
IMO	International Maritime Organization
IP	Internet Protocol
IP-XX	Ingress Protection Code
IS	Intrinsic Safe
ITU	International Telecommunication Union
LAN	Local Area Network
LSZH/LS0H	Low Smoke Zero Halogen
LTE	Long Term Evolution
MODU	Mobile Offshore Drilling Unit
OSI	Open Systems Interconnection
PTT	Push To Talk
RSSI	Receive Strength Signal Indicator
RSRP	Received Signal Received Power
RSRQ	Reference Signal Received Quality
SNR	Signal to Noise Ratio
SOLAS	Safety Of Life At Sea
VSWR	Voltage Standing Wave Ratio
WAN	Wide Area Network

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3. REFERENCE DOCUMENTS, CODES AND STANDARDS

3.1 International Standards

- a. IEC 1000-4-2: Electrical apparatus for explosive gas atmospheres - all parts
- b. IEC 60092-502: Electrical installations on ships
- c. IEC 60331: Tests for electric cables under fire conditions - circuit integrity – all parts
- d. IEC 60332: Flame-retardant characteristics of electric cables
- e. IEC 60529: degrees of protection provided by enclosures (IP code)
- f. IEC 60533: Electrical and electronic installations in ships - electromagnetic compatibility
- g. IEC 61000: electromagnetic compatibility (EMC) series - all parts
- h. IEC 61892-7: Mobile and fixed offshore units - electrical installations - part 7: hazardous area
- i. IMO MODU code: code for the construction and equipment of mobile offshore drilling units
- j. IMO SOLAS: international convention for the safety of life at sea
- k. ITU recommendation M.1801: Radio interface standards for broadband wireless access systems, including mobile and nomadic applications, in the mobile service operating below 6 GHZ
- l. ITU G.652D: Characteristics of a single-mode optical fibre and cable
- m. CENELEC TR 50427/2004: Assessment of inadvertent ignition of flammable atmospheres by radio-frequency radiation - guide
- n. 3GPP RELEASE 15: 3RD generation partnership project (3GPP)


3.2 Brazilian Standards

3.2.1. INMETRO - Instituto nacional de metrologia, qualidade e tecnologia

- a. Portaria Nº 115 (21/março/2022): Regulamento de avaliação da conformidade de equipamentos elétricos para atmosfera potencialmente explosivas, nas condições de gases e vapores inflamáveis e poeiras combustíveis

3.2.2. Ministério do trabalho

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

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b. NR-37: Segurança e saúde em plataformas de petróleo

3.2.3. ANATEL – Agência Nacional de Telecomunicações

- a. Resolução nº 625, 11/11/2013: Atribuição, a destinação e o regulamento sobre condições de uso de radiofrequências na faixa de 698 MHz a 806 MHz.
- b. Resolução nº 454, 11/12/2006: regulamento sobre condições de uso de radiofrequências nas faixas de 800 MHz, 900 MHz, 1.800 MHz, 1.900 MHz e 2.100 MHz
- c. Resolução nº 671, 03/11/2016: Regulamento de uso do espectro de radiofrequência
- d. Resolução nº 700, 28/09/2018: Regulamento sobre a avaliação da exposição humana a campos elétricos, magnéticos e eletromagnéticos associados à operação de estações transmissoras de radiocomunicação
- e. Resolução Nº 720 10/02/2020: Art. 29 - Regulamento sobre permissão de uso do espectro por empresas privadas em áreas não assistidas por serviços de interesse coletivo.
- f. Resolução nº 715/2019 - Aprova o Regulamento de Avaliação da Conformidade e de Homologação de Produtos para 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 In order to comply with the PETROBRAS Corporative Network, all the required materials shall be based on the technology indicated in this Technical Specification.
- 4.2 For PETROBRAS detailed project requirements, Installation, Configuration, Tests training and commissioning CONTRACTOR shall be complied with the Memorial Description 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.

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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 RF cables shall be protected by Coaxial RF Surge Protector/Lightning Arrestor before the ingress in the Accommodation Module.		
4.7	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.		
4.8	Brackets, bolts, nuts, washers and any other mechanical fixing elements shall be made in stainless steel.		
4.9	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.		
4.10	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).		
4.11	Any other available models of equipment with external body made of non-metallic materials approved by Classification Society shall be submitted for analysis and approval of PETROBRAS.		
4.12	Equipment and accessories shall be appropriate to be installed on places with marine atmosphere, hazardous areas (dust and gas explosive atmospheres) and in accordance with the classifications zone and groups established by IEC / ABNT.		
4.13	All equipment, materials and antennas, when applicable, shall be homologated by National Telecommunications Agency (ANATEL).		
4.14	CONTRACTOR shall present the “Certificate of homologation” issued by the Brazilian Telecommunications Regulatory Agency “ANATEL”, for the total characteristics specified. These Certificates shall be presented in the technical proposal and submitted to PETROBRAS for approval before the purchase order.		
4.15	Equipment and accessories shall attend the ingress protection degree, protection type, classifications zone and groups established by IEC / ABNT.		

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- 4.16 All equipment that will make part of the detailed design shall have type approval certificate for technical conformity with the International and National standardization organism: ABNT, IEC, INMETRO and ANATEL.
- 4.17 Equipment and materials shall be supplied packed suitable for long periods of storage and be protected against mechanical impact and adverse weather conditions.
- 4.18 For hazardous areas, it shall be deployed equipment for “increased safety”, “intrinsically safe” or “explosion proof” type, in accordance with classification area and applicable requirements standards. The employment of these equipment or any others available models shall be submitted for PETROBRAS analysis.
- 4.19 CONTRACTOR shall submit a Calculation Report with the total loss for each RF cables that will be used on this system before the purchase order for PETROBRAS analysis and approval. This Calculation Report must have information about:
- Distances between the radios and antennas,
 - Quantity connections,
 - Datasheet of the RF cables and connectors,
 - The RF power output in the Radio,
 - Total loss of the radiant system,
 - VSWR information of all RF connectors and antennas.
- 4.20 A proper table with measured values of VSWR at each device (antenna, coupler, splitter, radio) shall be presented comparing them to manufacturer values.
- 4.21 CONTRACTOR shall also perform a predictive survey using a software based on RF propagation algorithms and shall be submitted to Petrobras Approval.
- 4.22 CONTRACTOR shall submit a detailed drawing showing the internal loss and output power level of the LTE System; the external power level (EIRP – Effective Isotropic Radiated Power) expected with the coaxial cables, antennas and other components that will be used for this system, before the purchase order for PETROBRAS analysis and approval. This drawing shall be presented together to the Calculation Report for all System.
- 4.23 After the installation and the acceptance tests of the LTE System, coaxial cables network and antennas CONTRACTOR shall submit a new detailed drawing with the measurements of RF power levels all over the UNIT for PETROBRAS final analysis and definite approval.
- 4.24 In outdoor areas, exposed to marine atmosphere, CONTRACTOR shall avoid the galvanic corrosion of equipment, antennas, panels, boxes, coaxial cables fixing accessories. Galvanic insulation shall be implemented wherever contact between different metallic materials is needed. For reference, follow the example below:


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Figure 1 – Example of cable fixing

4.25 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 for against water, moisture, dirty and other environmental contaminants.

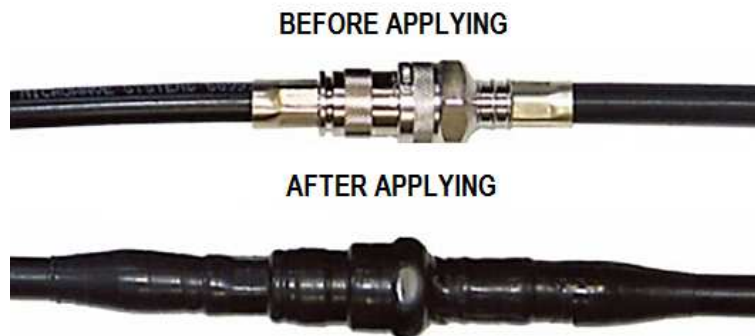



Figure 2 – Term-contractile material

4.26 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 3 – Example of flexible RF

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

4.27.1. Antennas’ positioning shall not impair the lightning protections system installation. Bidder shall define antennas positioning in compatibility with lightning protections system study.

4.28 CONTRACTOR shall install all coaxial cables in cable trays or cable ladder, except for radiant cables.

4.29 CONTRACTOR shall design, supply and install all cables type Flame Retardant and LSZH/LS0H.

4.30 In case of info specs conflict or mistake, PETROBRAS shall be asked for final decision.

5. SYSTEM DEFINITIONS

5.1 This document item shall clarify all definitions and specific requirements for LTE TRANSMISSION SYSTEM.

5.2 The LTE Frequency range shall comply with ANATEL’s standards (Resolução nº 625, 671 and 720) for private Networks in remote areas that allows the use of the 700 MHz spectrum in channels of 5 MHz FDD (Frequency Division Duplex), that is also called as LTE Band 28.


5.3 The LTE Frequency range shall comply with ANATEL’s standards (Resolução nº 454 and 657) for public Networks that allows the use of the 1800 MHz spectrum in channels of 10 MHz FDD (Frequency Division Duplex), that is also called as LTE Band 3.

5.4 The frequency channels will be defined by PETROBRAS during the detailed design.


5.5 The LTE System shall be able to cover an area of 20 km of radius around the FPSO unit.

5.6 In order to reach the coverage on the edge of a cell with 20 km radius, the irradiating components shall be installed on the telecom tower located on the antennas deck. The system shall be configurable to set the power level of the signal at the output of the transmitter.

5.7 The connection between the eNodeB (Evolved Node B) – in the FPSO or the center of the Cell – and the CPE (Customer Premises Equipment), at the remote unit or at the edge of the cell (20km of distance), shall be designed taking in consideration the use of regular CPE with external omni antenna available (ex.: Transmission power of 23dBm, and 5dBi gain).

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- 5.8 The Operational onboard coverage of the LTE system shall reach the entire outdoor area of the FPSO, inside closed topside modules and packages, engine room, accommodations and cranes' cabins with no shadow zones, in redundant mode. It means that the system shall be designed for a doubled coverage from two cells of two independent eNodeBs. For this operational coverage, its outdoor units and irradiating systems installed as far as possible. The indoor equipment of both eNodeB's shall be installed in the Telecom Upper Room.
- 5.9 Shadow zones are defined as locations where the LTE signal cannot be reached or received with signal power (RSRP – Reference Signal Received Power) lower than -100dBm.
- 5.10 The LTE network must also provide indoor coverage including the machinery room and the Central Control Room, considering additional sectors/cell for areas not covered by the main sector.
- 5.11 All irradiating devices at outdoor areas shall comply with IEC 60079-0 item 6.6 and CLC/TR50427.
- 5.12 The LTE system shall comply with, at least, release 15 of 3GPP.
- 5.13 The LTE system shall be composed, at least, by:
- 5.13.1. A solution, from the manufacturer Nokia, consisting of 01 (one) mini-core (EPC – Evolved Packet Core) with a CMU (Compact Mobility Unity) as a mobile packet core, to manage 02 (two) eNodeB's and all the devices onboard. This solution shall consider interoperability and compatibility issues with the solution currently implemented in the Petrobras network.
- 5.13.2. The eNodeB is understood as all the hardware necessary to develop a 3-sector cell, comprising the baseband units, when applicable, radio units and respective antenna sets, with mounting accessories.
- 5.13.3. The antenna sets must be of Outdoor Directional Dual-band (700MHz and 1800MHz) antenna type.
- 5.13.4. GPS signal, if required by Nokia vendor.
- 5.13.5. The EPC shall be physically installed in a dedicated rack of the Upper Telecom Room.
- 5.13.6. CONTRACTOR shall supply all licenses and softwares for full management of the system by at least 05 (five) simultaneous access, locally and remotely from PETROBRAS Network Operations Center.
- 5.13.7. The EPC shall have the capacity for 1.000 "subscribers" divided into portable communication devices and further implementation of IoT sensors compatible with NBloT and Cat M standards.
- 5.13.8. Contractor shall provide 02 (two) hundred SIM cards already configured to enroll all subscribers to the LTE EPC (Evolved Packet Core).

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- 5.13.9. The LTE mini-core onboard shall be integrated with the LAN (Local Area Network), allowing dataflow exchange between the LTE infrastructure and the IP network of the FPSO.
- 5.13.10. The LTE system onboard shall be able to be managed and configured remotely through the WAN (Wide Area Network) that supports FPSO's communication.
- 5.13.11. All licenses, certificates, databooks and passwords shall be delivered to PETROBRAS in order to have all information to operate the system.
- 5.13.12. The system can be a full-indoor solution, with only passive antennas at the outside area; or split in two parts: one part for indoor environment and the other for outdoor environment. However, if the outdoor module with electrical parts is needed, it shall be suitable for Zone 2 hazardous area.
- 5.13.13. The system shall coordinate the cells to manage the portable devices at the cell edge, using ICIC (inter-Cell Interference Coordination), eICIC, FeICIC, CoMP for frequency reuse 1 (to maximize spectrum efficiency).
- 5.13.14. Micro, pico and femto cells along the FPSO is expected in order to guarantee redundant coverage without shadow areas for real-time video streaming from at least 04 (four) simultaneous sources in Standard Definition (720 x 480) at the same position with upload transmission rates always higher than 4 Mbps and download rates higher than 6 Mbps.
- 5.13.14.1. Minimally, it is expected 02 (two) panel antenna sets in 700 MHz at Telecom tower towards industrial process plant; 02 (two) panel antenna sets in 700 MHz at Forecastle turned backwards to cover industrial process plant; 02 (two) sets of sectorized panel antennas in 700 MHz and 1800 MHz to cover platform 20 km surroundings.
- 5.13.15. Hardware/software for dispatch console able to manage and control each device; receive video streaming and export them to screen at the Central Control Room and also to a recording system or integrated with the recording device of the CCTV system.
- 5.13.16. This dispatch solution shall be able to divide the communication devices into at least 15 groups of interest for conversation in Push-To-Talk mode, where one voice dispatch inside one group is heard at all other devices of the same group. From the client software at the Central Control Room, it shall be possible to broadcast voice messages to all groups.

6. TECHNICAL REQUIREMENTS

- 6.1 The LTE Push-to-talk system shall be integrated with the UHF Active Repeater, to be able to hear and dispatch voice messages of all UHF radio groups to/from LTE devices. The requirements, number of UHF channels and other characteristics of the UHF System are described at I-ET-3010.00-5515-762-PPT-003 - HULL UHF ACTIVE REPEATER SYSTEM.

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6.1.1. It shall be provided an RF cabling interconnection from LTE cabinet to UHF Active Repeater cabinet through a diplexer device so that LTE signal can propagate UHF Active Repeater cabling and antennas around the vessel.

6.1.2. Splitters and couplers shall be able to carry LTE and UHF frequencies.

6.2 CONTRACTOR shall inform, for each antenna type, the following parameters:

- a. Gain in dBi;
- b. Polarization;
- c. Irradiation diagrams, highlighting:
- d. Opening in the horizontal and vertical plane (-3 dB);
- e. Value of VSWR;
- f. Value of cross polarization discrimination in dB;
- g. Antenna type;
- h. Wind load;
- i. Antenna weight and dimensions.

6.3 The main coverage to reach 360° with distance of 20km and onboard shall be installed using flat panel antennas composing sectors with at least MIMO 2x2 and minimum power of 46 dBm per sector.


6.3.1. The number of eNodeB's shall be enough to achieve the following minimum performance, at both required bands:

- a. In all the outdoor and industrial area on board the FPSO: upload transmission rates higher than 10 Mbps and download rates higher than 20 Mbps.
- b. Within a radius of 20 km around the FPSO: upload transmission rates higher than 1.75 Mbps and download rates higher than 11 Mbps.

6.3.2. The values of the performance evaluation parameters shall be provided, directly or indirectly (in this case, demonstrated by calculation memorial), through results generated from prediction tools for LTE Band 3 and LTE Band 28 networks, such as *Nokia NetAct Planner*, or similar.

6.3.3. Any inferior throughput rate shall be submitted to PETROBRAS approval.

6.4 Portable Communication Devices Requirements

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6.4.1. CONTRACTOR shall supply portable communication devices, as required at I-ET-3010.00-5511-768-PPT-001 – IT EQUIPMENT, compatible with the LTE infrastructure described in this document.

6.5 Power Supply – all equipment of the LTE system from both telecom rooms shall be fed by the -48 VDC specified in the “I-ET-3010.00-5264-769-PPT-001 – HULL TELECOM ENERGY SYSTEM”.

6.6 The LTE radio shall be connected to data core switches, which have SFPs interfaces to be filled with optic or electric interfaces to be supplied. In case of optic SFPs, such connection shall be done by means of media converters to be provided.


6.7 LTE system shall be able to work on both 700 MHz (band 28) and 1800 MHz (Band 3) frequency ranges.

6.8 CLOSED RACK FOR THE LTE SYSTEM

6.8.1. It shall be physically installed in a dedicated rack in Upper Telecom Room.

6.8.2. CONTRATOR shall provide, assemble and install CLOSED RACK, to installation of all system described below:

- a. It shall be closed, 19 inches standard, 44U height, minimum depth of 1000 mm (internal dimensions) and 800 mm of useful width (internal dimensions).
- b. It shall have AC sockets ABNT NBR 14136 standard 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 Ethernet cables and optic cables;
- g. Internal light only on the rear access;
- h. Complete earthing Kit;
- i. Color: RAL 7035;
- j. Every time a data rack is leaning the wall and it is not possible to access and open its rear door, the rack shall be swing frame type for easy access and maintenance.

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6.8.3. It shall be supplied cage nuts (M5) and screws (at least 15 mm) for all of the positions.

6.8.4. The number of racks that shall be installed at the Telecommunications **Upper** Room to accommodate the whole demand of network points and equipment of the structured local network, shall be in accordance with the star physical topology proposed herein and distribution requirements and the Detail Design Arrangement Document as well.

7. SCOPE OF SUPPLY

7.1 CONTRACTOR shall supply, install, test and configure the LTE SYSTEM within the scope of the Contract and in accordance with this Technical Specification.

7.2 CONTRACTOR shall be responsible for supplying all instruments to be used during tests in accordance with the Test Book purposed by CONTRACTOR and approved by PETROBRAS.

7.3 CONTRACTOR shall deliver to PETROBRAS a Calculation Report and a Site Survey Report, utilizing a software simulation, indicating the RSSI, RSRP, RSRQ, SINR levels, and the obtained downlink and uplink rates as a function of distance, in additional it shall elaborate a coverage map.

7.4 CONTRACTOR shall supply all hardware, licenses and software necessary for LTE TRANSMISSION SYSTEM operation and management.

7.5 CONTRACTOR shall hire a training program from the manufacturer, covering at least the following subjects:

7.5.1. Operations – including a functional view of the system, describing each component and its functions, all available functionalities, the limits and thresholds of the system, and a full explanation of the alarms and event logs.


7.5.2. Maintenance – minimum requirements and local configurations to allow a remote access, local configuration to restore the site, troubleshooting procedures and alarm identification.

7.5.3. Installation – minimum information to execute all installation activities of the system.

7.5.4. Management – training program of the management software for PETROBRAS to be able to configure, update, troubleshoot restore, and repair the system.

7.6 The training classes shall be divided in two groups of PETROBRAS telecom team, one group with classes in Brazil and in Portuguese language; and another group at shipyard in English. The classes at shipyard shall be given before the acceptance of the system. Each group shall not exceed 12 people.


7.7 CONTRACTOR shall present instructor's certificate issued from the manufacturer and have proved experience.

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- 7.8 All material, books, manuals and support documentation used in the training sessions shall be delivered to each PETROBRAS professional. It will be acceptable only Portuguese and English documentation.
- 7.9 All licenses and softwares for full management of the system by at least 05 (five) simultaneous access, locally and remotely from onshore PETROBRAS Network Operations Center.
- 7.10 02 (two) hundred SIM cards already configured to enroll all subscribers to the LTE EPC (Evolved Packet Core).
- 7.11 01 (one) closed rack.

8. DIMENSIONING CRITERIA


- 8.1 CONTRACTOR shall consider all info requirements on this Technical Specification for system dimension and Detailed Design.
- 8.2 CONTRACTOR shall ensure full LTE radio cover in the Accommodation Module (all decks), Hull Industrial Areas, forecastle, Topsides areas and Modules.
- 8.3 CONTRACTOR shall use to develop the calculation memory report a software for coverage simulation considering all antennas contribution.
- 8.4 CONTRACTOR shall use predictive software to provide a coverage heat map of the LTE System and submit the results to PETROBRAS approval to properly locate the antennas.
- 8.5 The heat map shall consider power level range colors with minimum 05 (five) levels, from target power level to system margin calculated.
- 8.6 Wherever there is an eventually closed space habited or with possibility to have people working in the module from package supply, the telecommunication service shall be attended.
- 8.7 CONTRACTOR shall consider the detailed design to provide all necessary infrastructure to LTE System, like a: energy power, equipment, panels, boxes and antennas support, cable trays and ladder.
- 8.8 CONTRACTOR shall ensure the proper power level at portable devices at anywhere in the Hull and Accommodation.
- 8.9 The calculation report shall consider the proper portable radio power transmission.
- 8.10 The minimum acceptance criteria at the entire unit shall be:
 - a. RSRQ greater than or equal to 12 dBm;
 - b. Idle SNR, Downlink and Uplink SINR greater than or equal to 15 dB;

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- c. Downlink and Uplink Modulation greater than or equal to 16QAM;
- d. Downlink RSRP greater than or equal to -100 dBm

9. COMMISSIONING

- 9.1 CONTRACTOR shall be responsible for developing a technical commissioning activity, check, test and evaluate the operation of equipment, panels, installations, protections and wireless coverage, in order to permit or authorize their use under normal operating conditions.
- 9.2 A technician with professional level certified by the manufacturer of the LTE equipment provided shall perform the Installation, configuration and Commissioning activities.
- 9.3 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. 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 site 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. Configuring an user to log into the device remotely: This operation enables a user to remotely log in to the device in the central equipment room to deploy services.
- 9.4 CONTRACTOR shall consider that the Acceptance Testing shall evaluate signal strength, voice intelligibility, data and videos quality. In addition, it will run the testing at 10 (ten) points selected by PETROBRAS, per Area or Module.
- 9.5 For enclosed environment, the tests above shall be released under condition of all doors closed and the measurement point, as far from to antenna.
- 9.6 The Petrobras shall realize a visual inspection to check the presence of all items listed on the detailed design and fill in the configurations and handbooks:
- a. Antennas systems;
 - b. Antennas cables;

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- c. Lightning protection;
- d. Masts, towers (stays, painting, lightning, ...);
- e. Wiring, security devices, frames, panels, racks, receivers, energy, software implantation;
- f. Handbooks;
- g. Marking (Equipment Homologation);

9.7 PETROBRAS shall develop a technical test to check:

- a. Energy power supply;
- b. LTE frequency/Channels programming;
- c. RF power output levels at the antennas;

9.8 CONTRACTOR shall follow verifications and commissioning activities in accordance with Contract documents and this Technical Specification.

9.9 CONTRACTOR shall submit the Calculation Report and Site Survey Report for Petrobras analyze and approval.

9.10 The final commissioning shall be done in site operation in Brazil, where the service and frequency is allowed to operate.


10. LEGALIZATION REQUIREMENTS

10.1 CONTRACTOR shall provide to PETROBRAS all documents and forms required to legalize the LTE System to be installed in the Petrobras FPSO Unit, subject of this technical specification, including the payment of the ART (technical responsibility term) to CREA.

10.2 CONTRACTOR shall be responsible to provide the “Formulário Simplificado para Licenciamento – ANATEL” and “Formulário ANATEL 165”, as well as the station and frequency forms, and all other documents necessary for the legalization of stations and frequencies with ANATEL, in compliance with applicable telecommunications law.

10.3 PETROBRAS shall receive the documents mentioned above at least, 200 days before the unit leaves the shipyard.

10.4 CONTRACTOR shall provide the requested signed report of ANATEL resolution number 700 about Evaluation of Human Exposure to Electric, Magnetic and

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11. SHUTDOWN TELECOMMUNICATIONS SYSTEM

- 11.1 To meet the requirements of IEC 60079-0 and CENELEC CLC / TR 50427, CONTRACTOR shall provide a shutdown telecommunication system to avoid ignition risks when flammable gases leakage was detected on the antenna deck.
- 11.2 The LTE system shall be turned off when the fire and gas panel detect flammable gases on the antenna deck.
- 11.3 This automation can be done in the electrical panel or inside the LTE cabinet.
- 11.4 Additional information shall be found in I-ET-3010.00-5264-769-PPT-002 HULL SHUTDOWN TELECOMMUNICATION SYSTEM.