

	TECHNICAL SPECIFICATION			Nr: I-ET-3010.00-5515-762-PPT-003					
	CLIENT: SRGE			SHEET: 1 of 27					
	JOB: OPERATIONAL RADIO								
	AREA: -								
TIC	TITLE: HULL UHF ACTIVE REPEATER SYSTEM			INTERNAL					
				OI/CS					
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	TECHNICAL SPECIFICATION	Nr: I-ET-3010.00-5515-762-PPT-003	REV. B
	AREA:	-	SHEET: 2 of 27
	TITLE:	HULL UHF ACTIVE REPEATER SYSTEM	

INTERNAL
O/CS

INDEX

1. SUBJECT	3
2. ABBREVIATIONS.....	3
3. REFERENCE DOCUMENTS, CODES AND STANDARDS	4
4. GENERAL REQUIREMENTS.....	6
5. SYSTEM DEFINITIONS	9
6. TECHNICAL REQUIREMENTS.....	10
7. SCOPE OF SUPPLY	19
8. DIMENSIONING CRITERIA	20
9. COMMISSIONING.....	24
10. LEGALIZATION REQUIREMENTS	26


	TECHNICAL SPECIFICATION	Nr: I-ET-3010.00-5515-762-PPT-003	REV. B
	AREA:	-	SHEET: 3 of 27
	TITLE:	HULL UHF ACTIVE REPEATER SYSTEM	
			OI/CS

1. SUBJECT

- 1.1 The subject of this document is to establish the criteria and basic characteristics for the detailed design, supply and installation of the HULL UHF ACTIVE REPEATER SYSTEM that shall be installed in PETROBRAS FPSO Unit.
- 1.2 The HULL UHF ACTIVE REPEATER SYSTEM shall be composed by equipment, cables (leaked feeder and coaxial RF cable), materials and accessories needed to install and guarantee the communication among UHF portable transceivers located in PETROBRAS's FPSO Unit, without any shadow area (shadow areas are understood as an area where the communication between UHF radios is not possible because of low signal level).
- 1.3 This solution shall be integrated with the RF Cables Network located on the MAIN DECK, TOPSIDE AREAS and MODULES, to allow the complete coverage of UHF signals for all areas of the Unit for guarantee the communication of the UHF-SPM (Production and Maintenance Service).
- 1.4 Additionally, each UHF active repeater shall have installed the licenses for the Brazilian region to connect with PETROBRAS SmartPPT system in order to establish an UHF radio communication from Remote Control Room located in PETROBRAS onshore base station. The licenses needed in the Remote Control Room shall also be provided together with the UHF system.

2. ABBREVIATIONS

ABNT	Associação Brasileira de Normas Técnicas - Brazilian Association of Technical Standards
AC	Alternate Current
AM	Amplitude Modulation
ANATEL	Agência Nacional de Telecomunicações - Brazilian Telecommunication Authority
ANSI	American National Standards Institute
ART	Anotação de Responsabilidade Técnica - Technical Responsibility Note
ASTM	American Society for Testing and Materials
CREA	Conselho Regional de Engenharia e Agronomia - Brazilian Engineering Counsel
DECEA	Brazilian Department of Airspace Control
DC	Direct Current
DIO	Distribuidor Interno Óptico - Optical Distribution Drawer
DMR	Digital Mobile Radio
EMC	Electromagnetic Compatibility
ETSI	European Telecommunications Standards Institute
FM	Frequency Modulation
FPSO	Floating, production, storage and offloading
GPS	Global Positioning System
IEC	International Electrotechnical Commission
IEEE	Institute of Electric and Electronic Engineers
INMETRO	Instituto Nacional de Meteorologia - National Institute of Metrology
IMO	International Maritime Organization
IP	Internet Protocol


	TECHNICAL SPECIFICATION	Nr: I-ET-3010.00-5515-762-PPT-003	REV. B
	AREA:	-	SHEET: 4 of 27
	TITLE:	HULL UHF ACTIVE REPEATER SYSTEM	
			INTERNAL
			OI/CS

IP-XX	Ingress Protection Code
IS	Intrinsically Safe
ITU	International Telecommunication Union
LAN	Local Area Network
LSZH	Low Smoke Zero Halogen
MODU	Mobile Offshore Drilling Unit
NCC	Net Connection Corporation
NOC	Network Operation Center
OSI	Open Systems Interconnection
PLL	Phase Locked Loop
PoE	Power Over Ethernet
PTT	Push To Talk
RF	Radio Frequency
SINAD	Signal-to-noise and distortion ratio
SMNP	Simple Network Management Protocol
SOLAS	Safety Of Life At Sea
UHF	Ultra High Frequency
UPS	Uninterruptible Power Supply
UTP	Unshielded Twisted Pair
VAC	Volts Alternate Current
VDC	Volts Direct Current
VHF	Very High Frequency
VSWR	Voltage Standing Wave Ratio
WAN	Wide Area Network

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 60332: Flame-retardant characteristics of electric cables.
- f. IEC 60529: Degrees of protection provided by enclosures (IP code).
- g. IEC 60533: Electrical and electronic installations in ships - electromagnetic compatibility.
- h. IEC 60945: Maritime navigation and radiocommunication equipment and systems – general requirements – methods of testing and required test results.
- i. IEC 61000: electromagnetic compatibility (EMC) series - all parts.

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.00-5515-762-PPT-003	REV. B
	AREA:	-	SHEET:
	TITLE:	HULL UHF ACTIVE REPEATER SYSTEM	5 of 27 INTERNAL OI/CS

- j. IEC 61892-7: Mobile and fixed offshore units - electrical installations - part 7: hazardous area.
- k. IEC 61892-1: Mobile and fixed offshore units – Electrical installations – Part 1: General requirements and conditions.
- l. ETSI TS 102 361-1 - Air interface protocol.
- m. ETSI TS 102 361-2 - Voice and General services and facilities.
- n. ETSI TS 102 361-3 - Data protocol.
- o. ETSI TS 102 361-4 - Trunking protocol.
- p. CISPR 22 - Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement.
- q. EN 55022 - Information technology equipment – Radio disturbance characteristics – Limits and methods of measurement.
- r. IMO MODU Code - Code for the Construction and Equipment of Mobile Offshore Drilling Units.
- s. IMO Resolution A.1021 – Codes on Alerts and Indications.
- t. IMO Resolution A.801 – Provision of Radio Services for the Global Maritime Distress and Safety System.
- u. IMO SOLAS – International Convention for the Safety of Life at Sea.

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

3.2.3. ANATEL – Agência Nacional de Telecomunicações

- a. Resolução nº 558, 20/12/2010: Regulamento sobre Canalização e Condições de Uso de Radiofrequências na Faixa de 450 MHz a 470 MHz.

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.00-5515-762-PPT-003	REV. B
	AREA:	SHEET:	
	TITLE:	6 of 27	
	HULL UHF ACTIVE REPEATER SYSTEM		INTERNAL
			OI/CS

- b. Resolução nº 628, 06/12/2013: Alteração do Regulamento sobre Condições de Uso de Radiofrequências, na Faixa de 450 MHz a 470 MHz, pelo Serviço Limitado Privado no Âmbito dos Aeroportos Nacionais.
- c. Resolução nº 700, 28/09/2018: Avaliação da Exposição Humana a Campos Elétricos, Magnéticos e Eletromagnéticos Associados à Operação de Estações Transmissoras de Radiocomunicação.
- d. 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 PETROBRAS Corporative Network all the materials necessities shall be based on the technology indicated in this Technical Specification.
- 4.2 For PETROBRAS Detailed Design requirements, 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 UNITS DESIGN.
- 4.5 For telecommunications infrastructure materials, accessories, cable trays cable ladder, the Detailed Design shall comply with 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.

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.00-5515-762-PPT-003	REV. B
	AREA:	-	SHEET: 7 of 27
	TITLE:	HULL UHF ACTIVE REPEATER SYSTEM	
			INTERNAL
			OI/CS

- 4.6 Coaxial RF lightning arrestor shall protect all RF cables, before the ingress in the system rack.
- 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.
- 4.7.1. Couplers and splitters non EX-d shall be placed in a non classified and safe area or inside 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 equipment and accessory with external body made with non-metallic materials, CONTRACTOR shall 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 In order to avoid electrolytic corrosion, contacts between different metallic materials shall be prevented. Galvanic insulation shall be implemented where contact between different metallic materials is necessary.
- 4.12 Any other available models of equipment with external body made of non-metallic materials approved by Classification Society shall be submitted for analysis of PETROBRAS.
- 4.13 Equipment and accessories shall be appropriate to be installed on places with marine atmosphere, hazardous areas (dust and gas explosive atmospheres) and attend the classifications zone and groups established by IEC / ABNT.
- 4.14 All equipment shall be homologated by ANATEL (Brazilian National Telecommunications Agency) for their respective usages requested in this technical specification.
- 4.15 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.
- 4.16 CONTRACTOR shall present the “Homologation Certified” emitted by the Brazilian “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.

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.00-5515-762-PPT-003	REV. B
	AREA:	SHEET:	
	TITLE:	8 of 27	
	HULL UHF ACTIVE REPEATER SYSTEM		INTERNAL
			OI/CS

- 4.17 Equipment and accessories shall attend the ingress protection degree, protection type, classifications zone and groups established by IEC / ABNT.
- 4.18 All equipment that will make part of the technical proposal shall have Classification Society type approval certificate for technical conformity with the International and National standardization organism: ABNT, IEC, INMETRO and ANATEL.
- 4.19 All equipment shall be able to digital technology in accordance with ANATEL Resolutions: N° 558 and N° 628 and compatible with Operational Radio System.
- 4.20 Equipment and materials shall be supplied packed suitable for long periods of storage and be protected against mechanical impact and adverse weather conditions.
- 4.21 For hazardous areas, it shall be employed equipment for “increased safety”, “intrinsically safe” or “explosion proof” type, in accordance with classification area. The employment of these equipment or any others available models shall be submitted for PETROBRAS analysis.
- 4.22 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 must have information about:
- a. Distances between the radios and antennas;
 - b. Quantity of connections;
 - c. Datasheet of the RF cables and connectors;
 - d. The RF power output in the Radio;
 - e. Total loss of the radiant system;
 - f. RF power output levels at the antennas (downlink);
 - g. RF power reception input level at the coupler (uplink).
 - h. RF power reception input level at the repeater radios (uplink).
- 4.23 CONTRACTOR also shall perform a predictive survey. Moreover, it shall be done with a software based on RF propagation algorithms and shall be submitted to PETROBRAS Approval.
- 4.24 CONTRACTOR shall submit a detailed drawing showing the internal loss and output power level of the UHF System network, the external power level expected with the leaked feeder/radiant cables, coaxial cables, antennas, directional couplers, splitters 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.
- 4.25 After the installation and the acceptance tests of the UHF Active Repeater System, Coaxial and Leaked Feeder/Radiant Cables Network, CONTRACTOR shall submit a new detailed drawing with the measurements of RF power level by all UNIT for PETROBRAS final analysis and definite approval.

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.00-5515-762-PPT-003	REV. B
	AREA:	-	SHEET: 9 of 27
	TITLE:	HULL UHF ACTIVE REPEATER SYSTEM	
			OI/CS

4.26 The Coaxial and Leaked Feeder/Radiant Cables Network installed in Topside Modules shall be connected in the UHF signal, from the UHF Active Repeater Rack installed in the HULL (Telecom Lower Room), through an interconnection box located on an external area of ACCOMMODATION. The UHF power levels at interface (interconnection box) shall be at least:

- a. DOWNLINK – Transmission (from Hull network to Topsides network): 29dBm;
- b. UPLINK – Reception (from Topsides network to the Hull network): - 75dBm.

4.27 The supply of interface box between Hull and Topside (CDC) is scope of this Technical Specification.

4.28 The connections to the Topside Active Repeater network are scope of this Technical Specification.

4.29 Bi-directional amplifiers (BDA) shall not be used.

4.30 The UHF active repeater system shall be powered by essential AC panel and by a dedicated DC battery charger.

4.31 All splitters or couplers installed above de ceiling shall have a ceiling access panel in order to guarantee the maintenance. This access shall be tagged with the respective equipment TAG.

4.32 CONTRACTOR shall consider the following ETSI standards, for DMR interface definition: TS 102 361-1; TS 102 361-2; TS 102 361-3 and TS 102 361-4, for UHF Active Repeater detailed design.

5. SYSTEM DEFINITIONS

5.1 The UHF active repeater system shall enable 10 (ten) simultaneous communication channels and shall use coaxial and radiating cables and antennas. The frequency plan will be defined by PETROBRAS during the detailed project.

5.2 The UHF active repeater equipment shall be manufactured by Motorola and housed in 19 inches closed rack.

5.3 It shall be guaranteed the downlink power level greater than -75 dBm anywhere in the Hull and Accommodation.

5.4 It shall be guaranteed the uplink power level greater than -75 dBm from anywhere in the Hull and Accommodation.

5.5 To allow the reuse of frequencies shall be foreseen the encoding functionality.

5.6 Protection against reverse polarity of power supply, excessive voltage, current, temperature and mismatch of the radiating system.

5.7 The frequency plan and operational protocols shall be configured by software.

- 5.8 All equipment installed inside the rack shall be grounded in the rack grounding kit.
- 5.9 The UHF active repeater system shall have IP Interface for SMNP remote supervision system.
- 5.10 The following drawing exemplifies the UHF Active Repeater System block diagram:

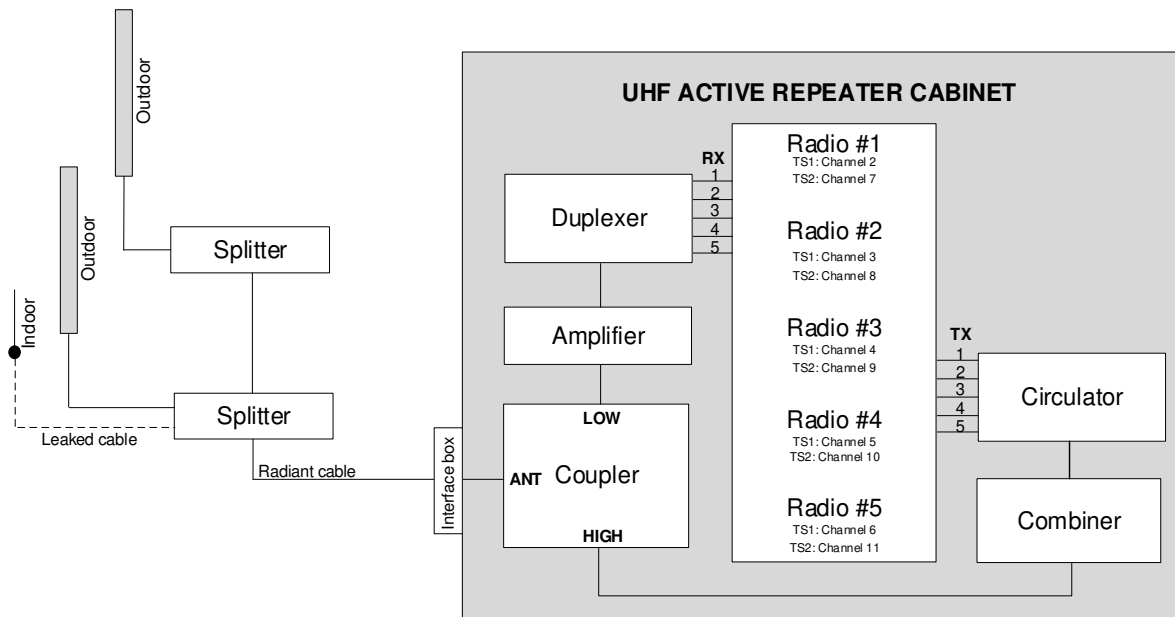



Figure 1: Active Repeater System arrangement

6. TECHNICAL REQUIREMENTS

6.1 UHF Active Repeater Rack


- 6.1.1. All equipment shall be installed in a 19" standard rack, including repeaters, circulators, coupler, combiner, power supplies and batteries chargers, with the following characteristics:
- It shall be closed, 19 inches standard, 44U height, minimum depth of 1000 mm (internal dimensions) and 800 mm of useful width (internal dimensions).
 - 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.
 - Glazed door at the front: Single-pane safety glass, 3 mm, including 130° hinge, and security lock;
 - Sheet steel bi-parting rear door, including 130° hinge and security lock;

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.00-5515-762-PPT-003	REV. B
	AREA:	SHEET:	
	TITLE:	11 of 27	
	HULL UHF ACTIVE REPEATER SYSTEM		INTERNAL
			OI/CS

- 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 organizers, for RF and electric cables;
- g. Internal light only on the rear access;
- h. Complete grounding Kit;
- i. Color: RAL 7035.

6.2 UHF Active Repeater Cabling Network

- 6.2.1. CONTRACTOR shall design, supply and install this technical solution with UHF Active Repeater as indicated, for to make possible and to guarantee the communications anywhere in the unit, from portable transceiver to portable transceiver eliminating the effects of signal obstructions in confined areas.
- 6.2.2. The coaxial cables shall be dimensioned to operate in wide band (up to 2.4 GHz) to allow the installation of new services in this range and also to better allow WLAN (Wi-Fi) coverage at 2.4 GHz band inside closed rooms, cabins and offices. The cables shall be in accordance with IEC standards.
- 6.2.3. The coaxial cables shall be grounded according to manufacturer along their paths.
- 6.2.4. As BUYER operationally uses UHF Active Repeater System during emergency situations, such system and cabling shall be considered as an emergency one.
- 6.2.5. CONTRACTOR shall design, supply and install all coaxial cables LSZH/LSOH and type Flame Retardant, except where they shall be Fire resistant according to Classifying Society.
- 6.2.6. Other requirements in according with Classifying Society
 - a. Cables for circuits that shall operate under fire conditions, such as those installed in topsides Process areas, and cables crossing machinery space category A, as defined by SOLAS, shall be certified for circuit integrity under fire conditions, according to IEC60331. CONTRACTOR shall attend this requirement without additional costs to PETROBRAS. The Classifying Society shall supply a list with the places or one document of rules to be followed by CONTRACTOR, where will show these requirements.
 - b. CONTRACTOR shall submit the detailed design with the cables list for approval by the PETROBRAS and Classifying Society.

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.00-5515-762-PPT-003	REV. B
	AREA:	-	SHEET:
	TITLE:	HULL UHF ACTIVE REPEATER SYSTEM	12 of 27 INTERNAL O/CS

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

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

6.3 UHF Active Repeater

6.3.1. The system shall allow the simultaneous (bidirectional) repetition and no interference in, at least, 10 (ten) channels.

6.3.2. Transmitter

- a. Transmit, at least, 02 (two) channels (Tx₁/Rx₁ & Tx₂/Rx₂) simultaneously;
- b. Signal coverage in the UHF band 450 - 470 MHz;
- c. Output Power: less than 45 watts nominal, 100% continues, with the possibility of reduction without degradation of features;
- d. Minimum Frequency Stability: +/- 2.5 ppm;
- e. Attenuation of spurious emission: higher than 70dB;
- f. Attenuation for noise FM: 45 dB or higher;
- g. Audio distortion: less than or equal to 5%;
- h. Nominal Impedance 50 Ohms;
- i. Connectors: N Female.

6.3.3. Receiver

- a. Receive, at least, 02 (two) channels (Tx₁/Rx₁ & Tx₂/Rx₂) simultaneously;
- b. Receiver sensitivity of -116 dBm at 0.35µV or 12 dB SINAD Squelch threshold and at -119 dBm;
- c. Minimum Frequency Stability: +/- 2.5 ppm
- d. Adjacent Channel Rejection (Selectivity) 70 dB or higher
- e. Audio Response: within 300 – 3000 Hz with an adequate response curve;
- f. Audio distortion: less than or equal to 5%;
- g. Nominal Impedance 50 Ohms;
- h. Connectors: N Female.

6.3.4. Power Supply

- a. All UHF active repeater shall have AC, from Essential Panel, and DC input power from a battery bank, powered from dedicated circuit AC and DC breakers;
- b. In case of AC fault, the DC power shall assume immediately without any interruption.

6.3.5. Licenses to Integrate with PETROBRAS SmartPTT System

- a. 05 (five) IP Site Connect Operation License (MOTOTRBO license);
- b. 05 (five) DGR data network interface SVC (MOTOTRBO license);
- c. 05 (five) DGR voice network interface SVC (MOTOTRBO license);
- d. 01 (One) Master in SmartPTT PLUS (IP site connect master; SmartPTT license);
- e. 05 (five) User Dispatch Console Licenses (SmartPTT license);
- f. 02 (two) SmartPTT Radioserver licenses (for local and remote recording; SmartPTT license).


6.3.5.1. MOTOTRBO license are applied to repeater radios whereas SmartPTT license is applied to servers and dispatch consoles that supports the service).

6.4 Digital Voice/Audio Recording System

6.4.1. It shall be supplied a dedicated server to record onboard all UHF channels simultaneously.

6.4.2. The server shall be a 19 inches standard rack server, defined by system vendor with the following minimum features:

- a. Operating system (O.S.): Windows® 16 Server Core 64-bit
- b. Processor: Intel® Core i7 quad-core or better
- c. Memory: 16 GB of RAM or better
- d. Hard disk drive: 7200 rpm SATA drive; (02) disk of 100GB (one for O.S. e another for SmartPTT Radioserver software)
- e. USB ports: One USB port per USB input device (mouse, keyboard)
- f. Network adapter: 10/100/1000 Gbps Ethernet adapter and management interface
- g. Power: 02 (two) AC power supply hot-plug, 220V, 50 ~ 60Hz


	TECHNICAL SPECIFICATION	Nr:	I-ET-3010.00-5515-762-PPT-003	REV.	B	
	AREA:	-			SHEET:	14 of 27
	TITLE:	HULL UHF ACTIVE REPEATER SYSTEM			INTERNAL	OI/CS

6.5 Battery Charger and Battery Bank

6.5.1. Battery Charger

6.5.1.1. It shall be supplied a battery charger for batteries bank stationary type, Free Vented Lead Acid (FVLA), with a sufficient capacity to feed all UHF active repeaters operating simultaneously as described below:

- a. Rectifiers toggled in high frequency.
- b. Input voltage of two phase: 220 VAC (180 to 275 VAC), with frequency strip 45 to 66Hz;
- c. Nominal output voltage for consumer: +24 VCC, with negative pole grounded, in accordance with UHF Active Repeater supply necessity;
- d. (+24) VCC, with (-) covered with ground;
- e. Power maximum: Dimensioned to 120% of nominal load;
- f. Output current will be defined during the detailed design;
- g. Units of rectification shall operate with the current equalized;
- h. Modular system with rectification units (URs) with 25 Amperes each one (maximum), in agreement with the need and it shall allow future enlargements so that, in case of failure of one UR module, the other ones shall keep all equipment working;
- i. Ventilation for convection forced (ventilated);
- j. The electrostatic discharge shall comply with the IEC-1000-4-2 standard;
- k. EMC shall comply with CISPR22 or EN 55022 standards;
- l. Tension outbreak shall comply with IEC-1000-4-5 standard;
- m. Static regulation: + / - 0,1%;
- n. Ripple psfometric: <2 mV rms
- o. Power factor: Greater than 0,89 at 50% load or more;
- p. Acoustic noise: <60 dBa;
- q. Automatic shutdown of the batteries bank for minimum tension in discharge;
- r. IP Interface for SMNP remote supervision system;
- s. Operation temperature: 0-50°C / Relative Humidity: 10% to 95%;
- t. The sensors shall be triggered among other the following events: interruption of the batteries and fuse, ventilation lack, flotation abnormal, high / low input / output voltage, discharged battery, high temperature;
- u. RELAY (magnetic switch or another adequate device) to disconnect the batteries when their final discharge voltage is reached, that shall be dimensioned for the rated current of the Direct Current Power Supply;
- v. It shall have voltage and current display on front of Equipment;

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.00-5515-762-PPT-003	REV. B
	AREA:	-	SHEET: 15 of 27
	TITLE:	HULL UHF ACTIVE REPEATER SYSTEM	
			O/CS

- w. It shall have protection in the AC input with fuses and suppressors and in the DC output with fuse and high temperature;
- x. It shall have independent circuit breaker for each UHF active repeater;
- y. It shall be provided an interface between UHF Active Repeater DC Battery Charger and CSS-HFGS according to I-ET-3010.00-5520-861-P4X-001 - CONTROL AND SAFETY SYSTEM - CSS;
- z. It shall be supplied and installed 01 (one) battery fuse box close to battery charger for each battery bank.

6.5.1.2. The Battery Charger shall be permitted a remote control and monitor, through:

- a. Dry contacts;
- b. SNMP - Internet Protocol (IP);
- c. Supervisory Control and Data Acquisition (SCADA).

6.5.1.3. The Battery Charger shall be permitted, also, a local control and monitor, through:

- a. Local desktop;
- b. Human Machine Interface (HMI).

6.5.1.4. The Battery Charger shall have interface with the following systems:


- a. Fire and Gas Panel (FGS): Automatically activate fire and gas emergency alarms;
- b. Structured Cabling and Optical Data Network (LAN) or HULL Structured Cabling Network System;

6.5.1.5. The Battery Charger shall inhibit the Battery Bank charging in case of hazardous atmosphere detected in the Battery Bank room.

6.5.2. Battery Bank

6.5.2.1. It shall be supplied batteries bank stationary type, Free Vented Lead Acid (FVLA), with a sufficient capacity to feed all UHF active repeater system as described below:

- a. Voltage shall be of +24 Volts;
- b. Nominal capacity: It will be defined during the detailed design;
- c. Autonomy: 30 min at full load;

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.00-5515-762-PPT-003	REV. B
	AREA:	-	SHEET: 16 of 27
	TITLE:	HULL UHF ACTIVE REPEATER SYSTEM	INTERNAL
			OI/CS

- d. As the batteries will be exposed to saline atmosphere, the poles shall be protected to avoid the corrosion and they shall be identified;
- e. The container shall be made of resistant plastic;
- f. The batteries shall be in accordance with ANATEL, ABNT and IEC standards applicable for telecommunications applications;
- g. The battery bank shall be installed in appropriate area defined during the detailed design and in accordance with IMO, IEC and ABNT standards;
- h. For installation of the bank of batteries, it shall be used racks with the characteristics appropriate for hazardous environments;
- i. The arrangement of battery bank elements shall allow properly maintenance and allow properly inspection of all battery's electrolytes.
- j. Each battery charger and battery bank shall reserve at least, 20 % of its capacity for future installations.
- k. It shall be considered an aging rate of 25% for batteries cells.
- l. A power factor of 80% for loads shall be take into account.

6.6 Antennas

6.6.1. CONTRACTOR shall supply antennas with the following characteristics:


- a. Frequency range: 450-470MHz;
- b. Fiberglass material or fiberglass radome;
- c. Vertical type;
- d. Minimum gain: 2.1dBi;
- e. RF cable;
- f. RF impedance equal to 50 Ohm;
- g. Connector standard: N Female;
- h. VSWR < 1,5;1
- i. Environment: indoor or outdoor.

6.7 Interconnection Box – Topsides Modules Network

6.7.1. The network installed in Topside and Modules shall be fed with UHF signal, from the UHF Active Repeater Rack, through an adequate interconnection box located in the external area.

6.7.2. CONTRACTOR shall perform the detailed design of this interconnection box considering the following items:

- a. 01 (one) incoming cable from Active Repeater System rack;

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.00-5515-762-PPT-003	REV. B
	AREA: -	SHEET: 17 of 27	
	TITLE:	HULL UHF ACTIVE REPEATER SYSTEM	INTERNAL
		OI/CS	

- b. 04 (four) holes for outgoing cables to Topsides Modules, in future;
- c. The 04 (four) holes above shall be closed for tap, stopping plug or stopper plug;
- d. It shall be dimensioned to inside installer a power split or directional coupler (1:4) accessory, if necessary;
- e. It shall be made in material adequate for external, hazardous and classified area.

6.8 Construction requirements

6.8.1. In outdoor areas, exposed a marine atmosphere, CONTRACTOR shall beware to mitigate the galvanic corrosion of equipment, antennas, panels, boxes, coaxial cables fixing accessories. For reference only, follow an example at the Figure 2.



Figure 2: Example of installation to avoid galvanic corrosion.

6.8.2. CONTRACTOR shall utilize tubing term-contractile materials (adhesive lined heat shrink tube) as a sealant forms for ending, cable splices or bundling of cables. It shall create a barrier for against water, moisture, dirty and other environmental contaminants. An example is shown in Figure 3.

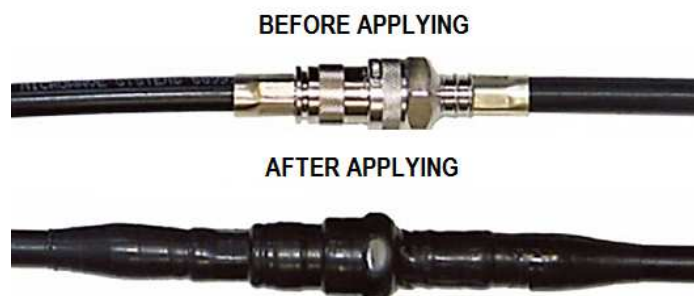


Figure 3 – Term-contractile material to protect the connection.

6.8.3. In order to avoid extra efforts on the connection of the RF cable to the antenna, the use of a flexible RF tail will be mandatory to make this connection, as shown in Figures 4 and 5.



Figure 4: RF flexible tail



Figure 5: Connection between RF cable and RF flexible tail

6.8.4. For the places where the radiating cable of the UHF active repeater is subject to an accident (for example: a cable disruption caused by an explosion or fire), the cable tray project of the radiating cable shall follow one of alternatives below:

- a. Alternative direction that avoid/minimize the possibility of the accident;
- b. Protection of the cable;
- c. Redundancy of the cable;
- d. For each 02 (two) plastic clamp shall be used to 01 (one) metallic clamp.

6.8.5. CONTRACTOR shall install all coaxial cables in cable trays or cable ladder, except for radiant cables. Radiant cables shall be installed external of cable tray, using appropriated accessories, as illustrated at the follow table.

6.8.5.1. CONTRACTOR shall assess radiating cables routes above rooms, cabins and offices and detail design to guarantee UHF coverage and also support WLAN 2,4GHz passive propagation between closed spaces.

6.8.6. For 7/8" leaked cables, supports shall be installed every 1,0 meter. For other cables, it shall be done according to manufacturer.




TECHNICAL SPECIFICATION	Nr: I-ET-3010.00-5515-762-PPT-003	REV. B
AREA: -	SHEET: 19 of 27	
TITLE: HULL UHF ACTIVE REPEATER SYSTEM		INTERNAL
		O/CS



Table 1: Examples of accessories to RF cables installation.

7. SCOPE OF SUPPLY

- 7.1 CONTRACTOR shall supply, install, test and commissioning the HULL UHF ACTIVE REPEATER SYSTEM and give the necessary training to PETROBRAS personnel, within the scope of the Contract and in accordance with this Technical Specification.
- 7.2 The HULL UHF ACTIVE REPEATER SYSTEM shall be composed by:
- a. 01 (one) Rack for accommodation of Equipment;
 - b. 05 (five) UHF Active Repeaters, Digital Mobile Radio (DMR) technology;
 - c. Circulator, coupler, duplexer and combiner;
 - d. Leaked feeder/radiant cables, coaxial cables, directional couplers, splitters, antennas and others devices/accessories needed for compose the UHF Network in the Hull of Unit;
 - e. 01 (one) battery charger and battery bank exclusive for UHF Active Repeater System;
 - f. 01 (one) programming kit;
 - g. 01 (one) interconnection box for external area to interconnect all coaxial cables from TOPSIDE MODULES;
 - h. 01 (one) SmartPTT Radioserver
 - i. All Licenses for integration with PETROBRAS SmartPTT System as stated herein.
- 7.3 Programming Kit
- 7.3.1. 01 (one) kit shall be supplied with hardware and software for programming the Active Repeater.
- 7.4 CONTRACTOR shall supply the UHF Active Repeater Manufacture Site Survey software to commissioning and maintenance activities, like a:
- a. Motorola MOTOTRBO Site Survey;

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.00-5515-762-PPT-003	REV. B
	AREA:	SHEET:	
	TITLE:	20 of 27	
	HULL UHF ACTIVE REPEATER SYSTEM	INTERNAL	
		OI/CS	

- b. Repeater Diagnostics and Control (RDAC);
- c. QRadio Predict;
- d. Similar software, in accordance with UHF System provider/manufacture.

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 UHF 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 UHF Active Repeater System and submit the results to PETROBRAS approval, to properly locate the antennas and leaked cables.
- 8.5 The heat map shall consider power level range colors with minimum 05 (five) levels, from target power level of -75 dBm 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 UHF Active Repeater System, like a: energy power, equipment, panels, boxes and antennas support, cable trays and ladder.
- 8.8 CONTRACTOR shall consider the UHF Active Repeater Standard capable to repeat, simultaneously, 10 (ten) channels/frequencies (Tx1/Rx1 ... Tx10/Rx10).
- 8.9 CONTRACTOR shall ensure the power level at portable radios, greater than -75 dBm, at anywhere in the Hull and Accommodation.
- 8.10 The calculation report shall consider the portable radio power transmission of 1 watt or 30 dBm.

8.11 SYSTEM PARAMETER LIST

- 8.11.1. Following the typical parameters that shall be considered for UHF calculation report:



PETROBRAS

TECHNICAL SPECIFICATION

Nr: I-ET-3010.00-5515-762-PPT-003

REV. B

AREA: -

SHEET: 21 of 27

TITLE: HULL UHF ACTIVE REPEATER SYSTEM

INTERNAL

OI/CS

Equipment Description	Value	Unit
Frequency	470	Mhz
Repeater TX Power	40	watts
Handheld Radio TX Power	1	watts
TX Combiner Loss for Repeaters	11	dB
Duplexer insertion Loss	2.5	dB
Directional Coupler Coupling Loss (15 dB)	15	dB
Directional Coupler Insertion Loss (15 dB)	0,14	dB
Directional Coupler Coupling Loss (10 dB)	10	dB
Directional Coupler Insertion Loss (10 dB)	0,454	dB
Directional Coupler Coupling Loss (6 dB)	6	dB
Directional Coupler Insertion Loss (6 dB)	1,26	dB
Splitter Loss (2 way)	3,4	dB
Splitter Loss (3 way)	5,2	dB
Splitter Loss (4 way)	6,5	dB
Cable connector loss	0.1	dB
Leaky cable 1/2"	5.70	dB/100m
Leaky cable 7/8"	3.05	dB/100m
Feeder cable 1/2" (Low loss)	4.98	dB/100m
Feeder cable 7/8" (Low loss)	2.70	dB/100m
Coupling loss C95% (IEC-96) for Leaky cable 1/2"	76	dB
Coupling loss C95% (IEC-96) for Leaky cable 7/8"	78	dB
Free Space Path distance (maximum distance found in project)	55	m
Provision for Loss thru' Environmental external metal structures (Antenna)	3	dB
Rayleigh Fading	6	dB
Provision for Loss thru' Environmental Loss (leaky cable only)	0	dB
Portable Radio Antenna Gain	-4	dB
Indoor Antenna Gain	2.1	dB
Outdoor Antenna Gain	2.1	dB
RX Multicoupler LNA Gain	10	dB
Downlink sensitivity at 12 dB SINAD	0.25	µV
Uplink sensitivity at 12 dB SINAD	0.3	µV

Table 2: Typical parameters for UHF calculation report.

- 8.11.2. The calculation report shall present an one line diagram including all antennas foreseen in the UHF active repeater network.
- 8.11.3. The one line diagram shall have the minimum information as, cable length, cable type, cable loss, coupler type.
- 8.11.4. The figure 5 below shows this representation:

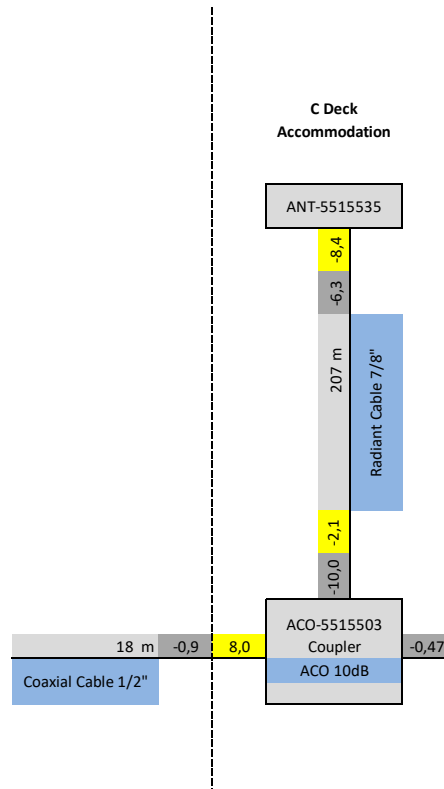



Figure 5: Example of information in the one line diagram in calculation report.

- 8.11.5. Follow examples of typical tables (table 3 and table 4) issued in the calculation report. One for each antenna including the system uplink and system downlink:


	TECHNICAL SPECIFICATION	Nr:	I-ET-3010.00-5515-762-PPT-003	REV.	B	
	AREA:	-			SHEET:	23 of 27
	TITLE:	HULL UHF ACTIVE REPEATER SYSTEM			INTERNAL	
				O/CS		

System Downlink coverage - Nominal mode

"C" Deck (ANT - 5515535)

Parameter	Name	QTY	Value	Unit	Result	Unit	Remark & Tag Number
Frequency	f		470	MHz			
Repeater TX Power	Pt		40	W	46,02	dBm	
Couplers, Splitter and Connectors loss							
TX Combiner Loss for Repeaters	CBX	1	11	dB	11	dB	
Duplexer insertion Loss	DPX	1	2,5	dB	2,5	dB	
Directional Coupler Coupling Loss (15 dB)	DC15		15	dB	0,0	dB	
Directional Coupler Insertion Loss (15 dB)	DC15		0,14	dB	0,0	dB	
Directional Coupler Coupling Loss (10 dB)	DC10	2	10	dB	20,0	dB	ACO-5515501 and ACO-5515502 (Rack Internal)
Directional Coupler Insertion Loss (10 dB)	DC10		0,454	dB	0,0	dB	
Directional Coupler Coupling Loss (6 dB)	DC6	1	6	dB	6,0	dB	ACO-5515503
Directional Coupler Insertion Loss (6 dB)	DC6		1,26	dB	0,0	dB	
Splitter Loss (2 way)	ST2	1	3,4	dB	3,4	dB	DIV-5515501 (Rack Internal)
Splitter Loss (3 way)	ST3		5,2	dB	0,0	dB	
Splitter Loss (4 way)	ST4		6,5	dB	0,0	dB	
Jumper loss	J		0,1	dB	0,0	dB	
Cable connector loss	V Tye	10	0,014	dB	0,1	dB	
Feeder and Leaky Cable losses							
Cable type	RFC78						
Cable length	L1	m	207				
Attenuation coefficient	a1	dB/100m	3,05				
Longitudinal Loss (attenuation loss)	Arc1				6,3	dB	
Cable type	RFC12						
Cable length	L2	m					
Attenuation coefficient	a2	dB/100m	5,70				
Longitudinal Loss (attenuation loss)	Arc2				0,0	dB	
Cable type	LCF12						
Cable length	L3	m	20				
Attenuation coefficient	a3	dB/100m	4,98				
Longitudinal Loss (attenuation loss)	Arc3				1,0	dB	
Cable type	LCF78						
Cable length	L4	m					
Attenuation coefficient	a4	dB/100m	2,70				
Longitudinal Loss (attenuation loss)	Arc4				0,0	dB	
Total System Losses (P_{sys} loss)					50,35	dB	
Antenna Gain	Gt		2,1		2,1	dB	
Power at the Antenna Input (Pa)	Pt - P _{sysloss}				-4,33	dBm	
Power Radiated by Antenna (P _{rx})	Pa + Gt				-2,23	dBm	
Environmental Losses							
Free Space Path Loss			20	m	51,96	dB	
Provision for Loss thru' Environmental (external metal structures) & Rayleigh Fading	Ae		12	dB	12,0	dB	
Total loss Due to Environmental Conditions (P_{loss})					63,96	dB	
Portable Radio Antenna Gain	GR		-4	dB	-4	dB	
Minimum receiver voltage (Portable Handset)	U		0,25	μV			
Receiver sensitivity at 12 dB SINAD	Pr				-119,03	dBm	
Receiver Provision Margin (for sensitivity)	Ms				3,00	dB	
Power Received at Portable Radio (Prx)	P _{tx} - P _{loss} + GR				-70,19	dBm	
Contractual System Margin (above -75 dBm)					4,81	dB	PASSED - Positive Value
Total System Margin (for receiver minimal operational level)					45,84	dB	PASSED - Positive Value
Radiating cable losses							
Coupling loss (IEC 61196-4)	c95%		78	dB			
Total Coupling Loss = c95% + 20log(d/2)	RCF78				69,8	dB	
Provision for Loss thru' Environmental - external metal structures (leaky cable)	Aec		3	dB	3,0	dB	
Minimum receiver signal level from Radiating Cable (Portable Handset)			-75	dB	-75,0	dB	
Maximum operating distance	d		0,8	m			Maximun operating distance from leaky cable, where the Portable's received signal level is -75dBm (When operating only from Leak Cable)

Table 3: Example of typical table issued in the calculation report (downlink).

	TECHNICAL SPECIFICATION	Nr:	I-ET-3010.00-5515-762-PPT-003	REV.	B	
	AREA:	-			SHEET:	24 of 27
	TITLE:	HULL UHF ACTIVE REPEATER SYSTEM			INTERNAL O/CS	


**System Uplink coverage - Nominal mode
"C" Deck (ANT - 5515535)**

Parameter	Name	QTY	Value	Unit	Result	Unit	Remark & Tag Number
Frequency	f		470	MHz			
Handheld Radio TX power	Pt		1	W	30	dBm	
Portable Radio Antenna Gain	Gr		-4	dB	-4	dB	
Environmental Losses							
Free Space Path Loss			20	m	51,96	dB	
Provision for Loss thru' Environmental (external metal structures) & Rayleigh Fading	Ae		17	dB	17,00	dB	
Total loss Due to Environmental Conditions (Ploss)					68,96	dB	
Couplers, Splitter and Connectors loss							
Duplexer insertion Loss	DPX	1	2,5	dB	2,5	dB	
Directional Coupler Coupling Loss (15 dB)	DC15		15	dB	0,0	dB	
Directional Coupler Insertion Loss (15 dB)	DC15		0,14	dB	0,0	dB	
Directional Coupler Coupling Loss (10 dB)	DC10	2	10	dB	20,0	dB	ACO-5515501 and ACO-5515502 (Rack Internal)
Directional Coupler Insertion Loss (10 dB)	DC10		0,454	dB	0,0	dB	
Directional Coupler Coupling Loss (6 dB)	DC6	1	6	dB	6,0	dB	ACO-5515503
Directional Coupler Insertion Loss (6 dB)	DC6		1,26	dB	0,0	dB	
Splitter Loss (2 way)	ST2	1	3,4	dB	3,4	dB	DIV-5515501 (Rack Internal)
Splitter Loss (3 way)	ST3		5,2	dB	0,0	dB	
Splitter Loss (4 way)	ST4		6,5	dB	0,0	dB	
Jumper loss	J		0,1	dB	0,0	dB	
Cable connector loss	V Tye	10	0,014	dB	0,1	dB	
Feeder and Leaky Cable losses							
Cable type	RFC78						
Cable length	L1	m	207				
Attenuation coefficient	a1	dB/100m	3,05				
Longitudinal Loss (attenuation loss)	Arc1				6,3	dB	
Cable type	RFC12						
Cable length	L2	m					
Attenuation coefficient	a2	dB/100m	5,70				
Longitudinal Loss (attenuation loss)	Arc2				0,0	dB	
Cable type	LCF12						
Cable length	L3	m	20				
Attenuation coefficient	a3	dB/100m	4,98				
Longitudinal Loss (attenuation loss)	Arc3				1,0	dB	
Cable type	LCF78						
Cable length	L4	m					
Attenuation coefficient	a4	dB/100m	2,70				
Longitudinal Loss (attenuation loss)	Arc4				0,0	dB	
Total System Losses (Psys loss)					39,35	dB	
Antenna Gain - System	Gt		2,1	dB	2,1	dB	
RX Multicoupler LNA Gain	GLNA		10	dB	10	dB	
Minimum receiver voltage (Repeater in Rack)	U		0,35	µV			
Receiver sensitivity at 12 dB SINAD	Pr				-116,11	dBm	
Receiver Provision Margin (for sensitivity)	Ms				3,00	dB	
Power Received at Repeater System (Prx)	Pt - Ploss - Psys loss + GLNA + Gr + Gt				-70,21	dBm	
Contractual System Margin (above -75 dBm)	Prx - 75dBm				4,79	dB	PASSED - Positive Value
Total System Margin (for repeater minimal operational level)	Prx - Pr - Ms				42,90	dB	PASSED - Positive Value
Radiating cable Losses							
Coupling loss (IEC 61196-4)	c95%		78	dB			
Total Coupling Loss = c95% + 20log(d/2)	RCF78				68,7	dB	
Provision for Loss thru' Environmental - external metal structures (leaky cable)	Aec		3	dB	3,0	dB	
Minimum receiver signal level from Radiating Cable (Repeater Receiver)			-75	dB	-75,0	dB	
Maximum operating distance	d		0,7	m			Maximun operating distance from leaky cable, where the Repeater's received signal level is -75dBm (When operating only from Leak Cable)


Table 4: Example of typical table issued in the calculation report (uplink).

9. COMMISSIONING

9.1 CONTRACTOR shall be responsible to realize a technical commissioning activity, check, test and evaluate the operation of equipment, panels, installations, protections and RF covering, in order to permit or authorize their use under normal operating conditions.

	TECHNICAL SPECIFICATION	Nr:	I-ET-3010.00-5515-762-PPT-003	REV.	B	
	AREA:	-			SHEET:	25 of 27
	TITLE:	HULL UHF ACTIVE REPEATER SYSTEM			INTERNAL	
						OI/CS

- 9.2 A professional team certified by the UHF Active Repeater equipment manufacturer provided, shall perform the Installation 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 a user to login to the device remotely: This operation enables a user to remotely login to the device in the central equipment room to deploy services.
 - f. Check and record values of VSWR, return loss and distance to fail obtained from properly calibrated Anritsu Cell Master Tool or similar for each device installed.
 - g. A proper table with measured values of VSWR at each device (antenna, coupler, splitter, radio) shall be presented comparing them to manufacturer values.
 - h. A proper table with measured values of current and tension inside cabinet for individual devices, with all repeater radios active, shall be presented comparing them to manufacturer values.
- 9.4 Special attention shall be done during running the coaxial cabling whose activity shall be properly inserted in constructability schedule, so that they do not get smashed.
- 9.5 CONTRACTOR shall consider that the Acceptance Testing shall evaluate signal strength and voice intelligibility. In addition, it will run the testing at 10 (ten) points selected by PETROBRAS, per Deck.
- 9.6 For indoor environment, the tests described above shall be done under condition of all doors closed and the measurement point, as far from to antenna.
- 9.7 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 switching;

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.00-5515-762-PPT-003	REV. B
	AREA:	-	SHEET: 26 of 27
	TITLE:	HULL UHF ACTIVE REPEATER SYSTEM	
			O/CS

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

9.8 CONTRACTOR shall perform a technical test, witnessed by Petrobras, to check:

- a. Energy power supply;
- b. UHF frequency/Channels programming;
- c. RF power output levels at the antennas (DOWNLINK),
- d. RF power input level at the coupler (UPLINK),
- e. RF power input level at the repeater radios (UPLINK),
- f. RF power input level at the interface box (UPLINK),
- g. Power level at portable radios, greater than -75dBm, at anywhere in the Hull and Accommodation.
- h. Power level in UHF repeater radio reception greater than -75dBm from radios at anywhere in the FPSO's accommodation or hull.

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


9.10 CONTRACTOR shall utilize a RF intensity level Site Survey software and accessories, if necessary, like QRadio Predict or similar.

9.11 CONTRACTOR shall submit a Site Survey report for PETROBRAS analysis and approval.

9.12 As a matter of general acceptance, is shall be considererd: equipment UHF configured with final allowed frequencies and other parameters; service coverage attended all around the vessel, tested with mobile devices in the vessel for all frequencies; remote channel access from Petrobras corporate network.

10. LEGALIZATION REQUIREMENTS

10.1 CONTRACTOR shall provide to PETROBRAS all documents and forms required properly filled to legalize the UHF Active Repeater System to be installed in PETROBRAS FPSO Unit, subject of this technical specification, including the

	TECHNICAL SPECIFICATION	Nr: I-ET-3010.00-5515-762-PPT-003	REV. B
	AREA:	-	SHEET: 27 of 27
	TITLE:	HULL UHF ACTIVE REPEATER SYSTEM	INTERNAL
			O/CS

payment of the ART (technical responsibility term) to CREA and assigned report of non-ionizing radiation.

- 10.2 CONTRACTOR shall be responsible for the procedures in order to legalize the UHF Active Repeater System.
- 10.3 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.
- 10.4 CONTRACTOR shall issue these documents, at least, 200 days before the unit leaves the shipyard.