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	CLIENT: SRGE	SHEET: 1 of 22
	JOB: OPERATIONAL RADIO	
	AREA: -	
TIC	TITLE: TOPSIDES UHF ACTIVE REPEATER SYSTEM	INTERNAL OI/CS

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1. SUBJECT

- 1.1 The subject of this document is to establish the criteria and basic characteristics for the detailed project, supply and installation of the TOPSIDE UHF ACTIVE REPEATER SYSTEM that shall be installed in PETROBRAS FPSO Unit.
- 1.2 The TOPSIDE UHF ACTIVE REPEATER SYSTEM shall be composed by antennas, RF cables and accessories needed to install and guarantee the communication among UHF portable transceivers located on TOPSIDE Modules in the PETROBRAS's FPSO Unit, without any shadow area.
- 1.3 This system will be integrated with the coaxial cables network located on the HULL, to allow the complete coverage of UHF signals for all areas of the Unit, where is needed guarantee the communication of the UHF-SPM (Production and Maintenance Service).

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 Metrologia (National Institute of Metrology)
IMO	International Maritime Organization
IP	Internet Protocol
IP-XX	Ingress Protection Code
IS	Intrinsically Safe
ITU	International Telecommunication Union
LAN	Local Area Network

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LSZH	Low Smoke Zero Halogen
MODU	Mobile Offshore Drilling Unit
NOC	Network Operation Center
NORMAM	Normas da Autoridade Marítima (Maritime Authority Standards)
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.
- 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.

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- 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 Ministério do Trabalho (Brazilian Ministry of Labor) 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.
- 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.

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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 the PETROBRAS Corporative Network all the materials necessaries shall be based on the technology indicated in this Technical Specification.

4.2 For PETROBRAS Detailed Design requirements, Installation, Configuration, Tests training and Commissioning the CONTRACTOR shall be 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.

4.6 Coaxial RF lightning arrestor shall protect all RF cables, before the ingress in the Accommodation Module (interface box) or any Topsides enclosed modules.

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

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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 be approved by Classification Society and submitted 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 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.
- 4.12 All equipment shall be homologated by ANATEL (Brazilian National Telecommunications Agency) for their respective uses requested in this technical specification.
- 4.13 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.
- 4.14 CONTRACTOR shall present the “Homologation Certified” emitted by the Brazilian Telecommunication Authority “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.
- 4.16 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.
- 4.17 All equipment shall be able to digital technology in accordance with ANATEL Resolutions: Nº 558 and Nº 628 and compatible with Operational Radio System.
- 4.18 Equipment and materials shall be supplied packed suitable for long periods of storage and be protected against mechanical impact and adverse weather conditions.

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- 4.19 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.
- 4.20 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 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), and
 - g) RF power input level at the coupler (UPLINK).
- 4.21 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.
- 4.22 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 RF cables, antennas, directional couplers, splitters and others components that will be used in 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 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 around all UNIT for PETROBRAS final analysis and definite approval.
- 4.24 The RF Cables Network installed in Topside Modules shall be connected on the UHF Active Repeater Network Cable through an interconnection box located on an external area of Accommodation. The UHF power levels at interface box (interconnection box) shall have:
- a) DOWNLINK – Transmission (from Hull network to Topside network): 29 dBm
 - b) UPLINK – Reception (from Topside network to the Hull network): - 75 dBm
- 4.25 The supply of interface box between Hull and Topside (CDC) is not scope of this Technical Specification. It is scope of Hull CONTRACTOR.



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- 4.26 The connections to the Hull Active Repeater network are not scope of this Technical Specification. It is scope of Hull CONTRACTOR.
- 4.27 Bi-directional amplifiers (BDA) shall not be used.
- 4.28 All splitters or couplers installed above de ceiling shall have a ceiling access panel in order to guarantee the maintenance. These accesses shall be tagged with the with the respective equipment TAG.
- 4.29 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 system detailed design.

5. SYSTEM DEFINITIONS

- 5.1 The HULL UHF Active Repeater System shall be able to use 10 (ten) simultaneous communication channels and shall be used coaxial and radiating cables and antennas without any shadow area. The frequency plan will be defined by PETROBRAS during the detailed design.
- 5.2 Shadow areas are understood as an area where the communication between UHF radios is not possible because of low signal level.
- 5.3 CONTRACTOR shall guarantee the power downlink level greater than -75 dBm anywhere in the Topside Modules, including enclosed Modules.
- 5.4 It shall be guaranteed the uplink power level greater than -75 dBm in the hull – topside interface box (CDC) from anywhere in the Topside Modules.
- 5.5 The Figure 1 exemplifies the UHF Active Repeater System Interface block diagram:

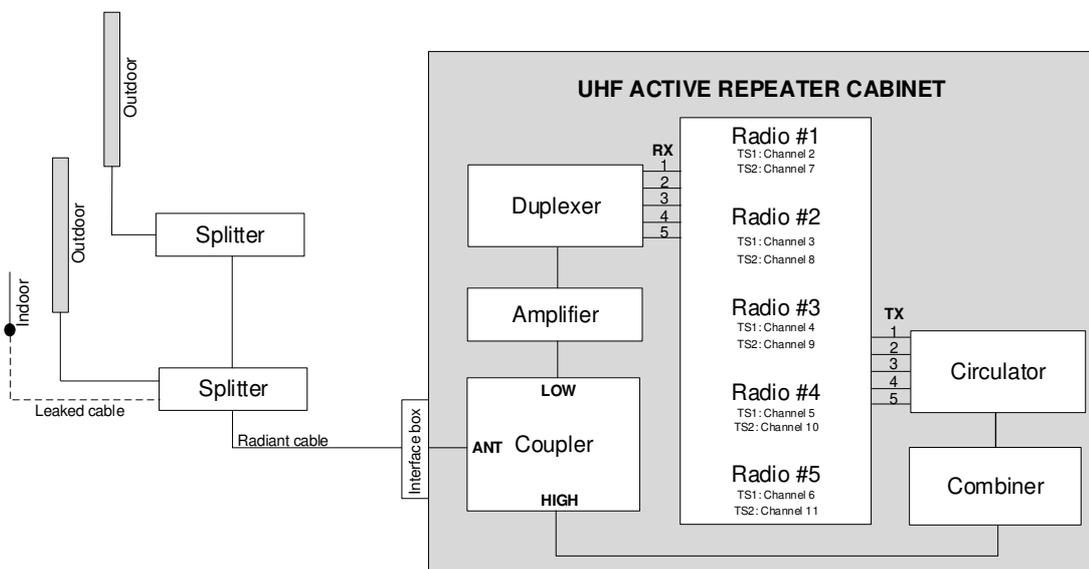


Figure 1 – Topside UHF System Block Diagram



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- 5.6 On 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 example in Figure 2.



Figure 2: Example of installation to avoid galvanic corrosion.

- 5.7 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. An example is shown in Figure 3.

BEFORE APPLYING



AFTER APPLYING



Figure 3 – Term-contractile material to protect the connection

- 5.8 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 below:



Figure 4: RF flexible tail



Figure 5: Connection between RF cable and RF flexible tail

- 5.9 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:
- Alternative direction that avoid/minimize the possibility of the accident;
 - Protection of the cable;
 - Redundancy of the cable
 - For each 02 (two) plastic clamp will be used to 01 (one) metallic clamp.
- 5.10 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 following table.
- 5.11 For 7/8" leaked cables, such supports shall be installed every 1,0 meter. For other cables, it shall be done according to manufacturer.



Table 1: Examples of accessories to RF cables installation.

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5.12 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 spaces and offices. The cables shall be in accordance with IEC standards.

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

6. TECHNICAL REQUIREMENTS

6.1 UHF Active Repeater Cable Network

6.1.1. CONTRACTOR shall design, supply and install a UHF cable network, integrated with the Hull UHF active repeater, for make possible and to guarantee the communications anywhere in the topside of the unit, from portable transceiver to portable transceiver eliminating the effects of signal obstructions in confined areas.

6.1.2. The coaxial cables shall be dimensioned to operate in wide band (up to 2.4 GHz), allowing the installation of new services. The cables shall be in accordance with IEC standards;

6.1.3. The coaxial cables shall be grounded according to manufacturer along their paths.

6.1.4. As PETROBRAS operationally uses UHF Active Repeater System during emergency situations, such system shall be considered as an emergency one.

6.1.5. CONTRACTOR shall design, supply and install all coaxial cables type Fire Resistant and LSZH/LS0H where applicable.

6.1.6. 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.

6.2 Antennas for UHF Active Repeater Network

6.2.1. CONTRACTOR shall supply antennas with the following characteristics:

a) Frequency range: 450-470MHz

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- b) Rugged industrial radome;
- c) Vertical type;
- d) Minimum gain: 2 dBi
- e) Connector standard N - Female;
- f) VSWR < 1,5:1
- g) RF impedance equal to 50 Ohms,
- h) Environment: indoor or outdoor
- i) ATEX and IECEX certifies

6.3 UHF Base Station Transceiver

6.3.1. Each UHF Base Station shall be composed by the following equipment:

- a) 01 (one) Fixed Transceiver;
- b) 01 (one) Microphone Unit;
- c) 01 (one) Antenna and RF cable;
- d) 01 (one) External Power Supply.

6.3.2. It shall be in accordance with Brazilian (ANATEL) and International Legislation (ITU-T) and this document.

6.3.3. It shall be compatible, technology and manufacture, with the Active Repeater System implemented on the Hull - Digital Mobile Radio (DMR) technology.

6.3.4. Microphone

- a) Hand microphone with PTT key and support for fixation at the Console or Desk.

6.3.5. Antenna

- a) Frequency range: 450-470MHz
- b) Fiberglass material;
- c) Vertical type;
- d) RF cable;
- e) RF impedance equal to 50 Ohms,
- f) Environment: outdoor

6.4 Interconnection Box – Topsides Modules Network

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6.4.1. The Topside RF cable network shall be fed by UHF signal from the Hull Interface Box, through an adequate interconnection box located in the accommodation external area.

6.4.2. CONTRACTOR shall consider for the TOPSIDE UHF ACTIVE REPEATER SYSTEM detailed design the interface box as following:

- a) 04 (four) holes for outgoing cables to Topsides Modules, in future;
- b) Internal space for one power split or directional coupler (1:4) accessory, if necessary;

7. SCOPE OF SUPPLY

7.1 CONTRACTOR shall supply, install, test and commission the TOPSIDES UHF ACTIVE REPEATER SYSTEM within the scope of the Contract and in accordance with this Technical Specification.

7.2 The TOPSIDES UHF ACTIVE REPEATER SYSTEM shall be composed by:

- a. 01 (one) UHF Base Station radio installed in the M17 - Electrical Automation Panel Room;
- b. 01 (one) UHF Base Station radio installed in the M15B – Operator’s Room;
- c. All internal areas in: M13 (Electrical equipment rooms); M15B (Operator’s room and laboratory) and M17 (Electrical Automation Panel Room) shall have internal antennas in order to guarantee the signal coverage.
- d. Total numbers of splitters, coupler and other accessories indicated by UHF calculation report;
- e. All leaked feeder/radiant cables, coaxial cables, directional couplers, antennas and others devices/accessories needed for compose the topsides UHF Network, indicated in the UHF calculation memory report;

7.3 CONTRACTOR shall supply the UHF Active Repeater Manufacture Site Survey software to commissioning and maintenance activities, as:

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



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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 use for developing the calculation memory report a 3D software for coverage simulation considering all antennas contribution.
- 8.3 CONTRACTOR shall ensure full UHF Radio cover between 02 (two) portables two-way communication in the enclosed Modules, Topside Areas and Modules.
- 8.4 CONTRACTOR shall consider the detailed design to provide all necessary infrastructure to UHF Active Repeater Network and UHF Base Stations, as: energy power, antennas support and cable trays.
- 8.5 CONTRACTOR shall consider the Hull UHF Active Repeater Standard will be capable to repeat, simultaneously, 10 (ten) channels/frequencies (Tx1/Rx1 ... Tx10/Rx10).
- 8.6 CONTRACTOR shall ensure the RX power level at portable radios, greater than -75 dBm, on anywhere in the Topsides Areas and enclosed Modules.
- 8.7 The calculation report shall consider the portable radio power transmission of 1 watt or 30 dBm.

8.8 SYSTEM PARAMETER LIST

8.8.1. Following the typical parameters that shall be considered for UHF calculation report.

Equipment Description	Value	Unit
Frequency	470	Mhz
Repeater TX Pwr	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

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Equipment Description	Value	Unit
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	30	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.

- 8.8.2. The calculation report shall presented as an one line diagram including all antennas foreseen in the UHF active repeater network.
- 8.8.3. The one line diagram shall have the minimum information as, cable length, cable type, cable loss, coupler type, as shown in Figure 6.

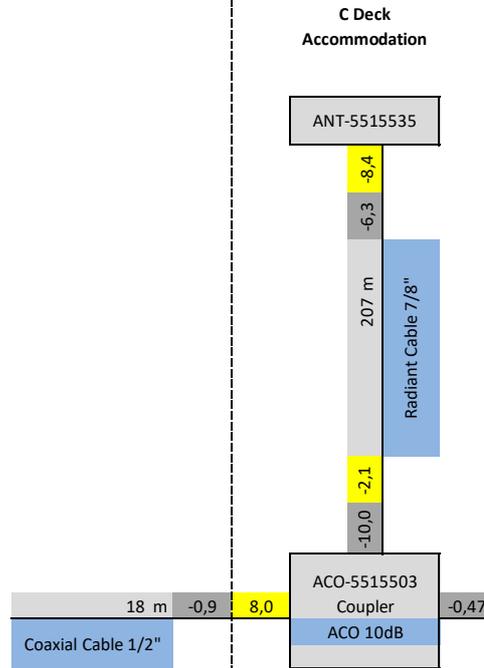


Figure 6: Example of information in the one line diagram in calculation report.

8.8.4. Following are the typical tables that shall be issued in the calculation report, one for each antenna including the uplink system and downlink system.



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INTERNAL

OI/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	3	10	dB	30,0	dB	ACO-5515501 and ACO-5515502 (Rack Internal) / ACO-5515503
Directional Coupler Insertion Loss (10 dB)	DC10		0,454	dB	0,0	dB	
Directional Coupler Coupling Loss (6 dB)	DC6		6	dB	0,0	dB	
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})						54,35	dB
Antenna Gain	Gt		2,1		2,1	dB	
Power at the Antenna Input (Pa)	Pt - P _{sysloss}				-8,33	dBm	
Power Radiated by Antenna (P _{tx})	Pa + Gt				-6,23	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 (P _{rx})	P _{tx} - P _{loss} + Gr				-74,19	dBm	
Contractual System Margin (above -75 dBm)						0,81	dB
Total System Margin (for receiver minimal operational level)						41,84	dB
Radiating cable Losses							
Coupling loss (IEC 61196-4)	c95%		78	dB			
Total Coupling Loss = c95% + 20log(d/2)	RCF12				65,8	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		0,5	m			Maximum 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).



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TOPSIDES UHF ACTIVE REPEATER SYSTEM

INTERNAL

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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	3	10	dB	30,0	dB	ACO-5515501 and ACO-5515502 (Rack Internal) / ACO-5515503
Directional Coupler Insertion Loss (10 dB)	DC10		0,454	dB	0,0	dB	
Directional Coupler Coupling Loss (6 dB)	DC6		6	dB	0,0	dB	
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)					43,35	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				-74,21	dBm	
Contractual System Margin (above -75 dBm)					0,79	dB	PASSED - Positive Value
Total System Margin (for repeater minimal operational level)					38,90	dB	PASSED - Positive Value
Radiating cable Losses							
Coupling loss (IEC 61196-4)	c95%		78	dB			
Total Coupling Loss = c95% + 20log(d/2)	RCF12				64,7	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	
Maximum operating distance	d		0,4	m			Maximum 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).

8.9 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.

8.10 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.

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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.
- 9.2 A professional team with the knowledge of the UHF Active Repeater equipment manufacture provider 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. Check the values of VSWR at each device, return loss and distance to fail obtained from properly calibrated Anritsu Cell Master Tool or similar for each device installed.
 - f. A proper table with measured values of VSWR at each device (antenna, coupler, splitter, radio) 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 30 (thirty) points selected by PETROBRAS, per Area or Module.
- 9.6 For indoor environment, the tests above shall be performed under condition of all doors closed and the measurement point, as far from to antenna.
- 9.7 The PETROBRAS shall perform 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;

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- b. Antennas switching;
- 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 interface box (UPLINK),
- f. Power level at portable radios, greater than -75dBm, on anywhere in the Topside Modules.
- g. Power level in the Hull-Topside Interface Box (CDC) -75dBm from the radios at anywhere in the Topside Modules

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

9.10 **CONTRACTOR** shall utilize a 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 considered: 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 to legalize the UHF Active Repeater 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.

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- 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.