PETROBRAS	TECHNICAL SPECIFICATION	Nº:	I-ET-3010.00-5264-769-PPT-003
	CLIENT: SRGE		SHEET: 1 of 15
	JOB: TELECOMMUNICATION POWER		
	AREA: -		
TIC	TITLE: TOPSIDES TELECOM ENERGY SYSTEM		INTERNAL
			OI/CS

MICROSOFT WORD / V.2016 / I-ET-3010.00-5264-769-PPT-003_B.docx

INDEX OF REVISIONS

REV.	DESCRIPTION AND/OR REVISED SHEETS
0	ORIGINAL ISSUE
A	REVISED WHERE INDICATED
B	REVISED WHERE INDICATED

	REV. 0	REV. A	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE	APR/15/2022	OCT/25/2022	NOV/10/2022						
DESIGN	PROJ-US	PROJ-US	PROJ-US						
EXECUTION	Y3S7	Y3S7	Y3S7						
CHECK	CY22	CY22	CY22						
APPROVAL	X187	X187	X187						

INDEX

1. SUBJECT 3

2. ABBREVIATIONS 3

3. REFERENCE DOCUMENTS, CODES AND STANDARDS 4

4. GENERAL REQUIREMENTS 5

5. SYSTEM DEFINITIONS 6

6. TECHNICAL REQUIREMENTS 7

7. SCOPE OF SUPPLY 13

8. DIMENSIONING CRITERIA 14

9. COMMISSIONING 14

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 telecommunication Energy System that shall be installed in Topsides of PETROBRAS FPSO Unit and its interface with Hull.

1.2 The Telecommunication Energy System shall provide energy supply for some Telecommunication Systems in accordance with Brazilians and Internationals applicable standards and PETROBRAS requirements.

2. ABBREVIATIONS

ABNT	Brazilian Association of Technical Standards
AC	Alternating Current
ANATEL	Brazilian Telecommunication Authority
ANSI	American National Standards Institute
ART	Technical Responsibility Note
ASTM	American Society for Testing and Materials,
AWG	American Wire Gauge
DC	Direct Current
EIA	Electronic Industries Alliance
FGS	Fire and Gas Panel
FVLA	Free Vented Lead Acid
HMI	Human Machine Interface
IEC	International Electrotechnical Commission
IEEE	Institute of Electric and Electronic Engineers
INMETRO	National Institute of Metrology
IMO	International Maritime Organization
IP	Internet Protocol
IS	Intrinsic Safe
ITU	International Telecommunication Union
LAN	Local Area Network
LST	Telephone Signaling Lamp
LSZH	Low Smoke Zero Halogen
MCCB	Moulded-Case Circuit Breaker
MODU	Mobile Offshore Drilling Unit
SCADA	Supervisory Control and Data Acquisition
SNMP	Simple Network Management Protocol
TIA	Telecommunications Industry Association
SOLAS	Safety Of Life At Sea
VAC	Volts Alternating Current
VDC	Volts Direct Current

3. REFERENCE DOCUMENTS, CODES AND STANDARDS

3.1 The detailed design shall be made, at least, in accordance with requirements of those International and National Standards listed below:

a. ABNT NBR 6814 – Fios e cabos elétricos - Ensaio de resistência elétrica;

b. ABNT NBR 14197 – Acumulador chumbo – ácido estacionário ventilado – Especificação;

c. ABNT NBR 14198 – Acumulador chumbo – ácido estacionário ventilado – Terminologia;

d. ABNT NBR 14199 – Acumulador chumbo – ácido estacionário ventilado – Ensaios;

e. IEC 61892 – Mobile and fixed offshore units – Electrical installations – All Parts;

f. IEC 60079 – Explosive Atmospheres – All Parts;

g. IEC 60092 – Electrical installations in ships – All Parts;

h. IEC 60228 – Conductors of insulated cables;

i. IEC 60331 – Fire-resisting characteristics of electric cables;

j. IEC 60332 – Flame-retardant characteristics of electric cables;

k. IEC 60947-2 – Low-voltage switchgear and control gear - Part 2: Circuit-breakers;

l. IEC 60950 – Information technology equipment – Safety;

m. IEC 62444 – Cable glands for electrical installations;

n. IEC 60529 – Degrees of Protection Provided by Enclosures (IP Code);

o. IEEE Std 485™-2010 – Sizing Lead-Acid Batteries for Stationary Applications;

p. NFPA 70 – National Electrical Code;

q. NFPA 72 – National Fire Alarm and Signaling Code;

r. NFPA 76 - Standard for the Fire Protection of Telecommunications Facilities;

s. OSHA Rules - Occupational Safety and Health Administration;

t. Resolução Anatel 597 - Norma para Certificação e Homologação de Acumuladores Chumbo-Ácido Estacionários Ventilados;

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 Regulamentadoras

a. NR-10: SEGURANÇA EM INSTALAÇÕES E SERVIÇOS EM ELETRICIDADE;

b. NR-37: SEGURANÇA E SAÚDE EM PLATAFORMAS DE PETRÓLEO;

c. It shall be followed all others NR's – Normas Regulamentadoras (Regulatory Standards) from Ministério do Trabalho (Brazilian Ministry of Labor) applicable to this Technical Specification.

3.2.3. 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 The telecommunications DC Energy System shall be dimensioned in accordance with standards, requirements and determinations from:

a. ANATEL / TELEBRAS (Brazilian Telecommunications Management);

b. International Convention for the Safety of Life at Sea (SOLAS);

c. Mobile Offshore Drilling Unit (IMO MODU CODE);

d. DR-ENGP-M-I-1.3-R.4- SAFETY ENGINEERING.

4.2 CONTRACTOR shall present the "Certificate of Technical Qualifying" (AQT) or the "Certificate of Grant" for DC Energy System, issued by Brazilian Telecommunication Government Agencies: ANATEL or TELEBRAS, according to the legislation in Brazil, to guarantee the quality of its products.

4.3 Electrical installations, equipment and materials shall comply with the requirements of IEC 60079, IEC 61892-7 and Classification Society.

4.4 All equipment, installations and materials shall be of type approved and certified by international recognized laboratory and shall be in accordance with INMETRO Portaria n° 115, March 21st 2022 and its annexes.

4.5 CONTRACTOR shall elaborate Calculation Report for DC Energy System, in accordance with Standards herein listed.

4.6 CONTRACTOR shall provide all necessary materials to install all equipment, accessories, cables and infrastructure that compose the DC Energy System.

4.7 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.

4.8 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.

4.9 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.

4.10 For telecommunications infrastructure materials, accessories, cable trays cable ladder, the Detailed Design shall comply with the Technical Specification: I-ET-3010.00-5140-700-P4X-002 – SPECIFICATION FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.

4.11 Safety grounding of telecommunication panels enclosure shall comply with the Technical Specification I-ET-3010.00-5140-700-P4X-001 - SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS."

4.12 All main AC and DC electrical panels shall follow I-ET-3010.00-5140-741-P4X-004 - SPECIFICATION FOR LOW-VOLTAGE GENERIC ELECTRICAL PANELS FOR OFFSHORE UNITS mainly regarding to mechanical interlock through “KIRK” blocking and ESD signals reception.

4.13 Basic design for the telecommunications energy system is presented in Hull and Topsides telecommunications energy system one line diagrams.

4.14 Equipment and accessories shall attend the ingress protection degree, protection type, area classification established by IEC / ABNT.

4.15 CONTRACTOR shall only supply equipment, cables and its approved and certificated by Classifying Society and in technical accordance with the International and National standardization organism: ABNT, IEC and INMETRO.

4.16 Equipment and materials shall be supplied packed suitably for long periods of storage being protected against mechanical impact and adverse weather conditions.

4.17 Safety grounding of telecommunication panels enclosure shall be according to I-ET-3010.00-5140-700-P4X-001 - SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS." Grounding by simply supporting the casing on the steel structure of the FPSO shall not be deemed adequate.

4.18 Equipment and accessories shall be specified, built and assembled using non-combustible, non-corrosive and mechanically rigid materials.

4.19 When designing an enclosure, its size and shape should be chosen taking into account the devices it will house and what else may be added in future, in order to enable easy servicing even after future expansion.

4.20 All grounding bus bars shall be of tin-plated copper and painted with green strips.

4.21 All connections between the grounding network and equipment or boxes shall be done by means of bolted terminals.

4.22 CSS-HFGS shall send signals in order to inhibit the (-)48 VDC battery charger in case of hydrogen detection and ventilation failure in the batteries room.

5. SYSTEM DEFINITIONS

5.1 Emergency generator shall supply essential loads in a case of main supply fails.

5.2 Equipment installed in cabinets shall have 02 (two) different sources of energy: essential + DC or from both UPS bus bar through ATS device.

5.3 Each electrical panel shall have current and voltage meter devices for online real measurements.

5.4 All Telecom loads in Topsides will be powered from AEPR electrical panels.

5.5 Electrical panel source

a. Equipment with 02 (two) AC sources at its chassis shall be powered by UPS-A and UPS-B.

b. Equipment with AC and DC sources at its chassis shall be powered by Essential and -48VDC.

c. Equipment with only 01 (one) AC source at its chassis shall be powered by UPS-A and UPS-B by means of an ATS.

d. Additional information shall be found in ENERGY SYSTEM ONE LINE DIAGRAM applied for Telecommunication.

6. TECHNICAL REQUIREMENTS

6.1 The 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.

6.2 Brackets, bolts, nuts, washers and any other mechanical fixing elements shall be made in stainless steel.

6.3 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.

6.4 In case of equipment and accessories have their external bodies built in aluminum alloy, 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) and shall be submitted to PETROBRAS approval.

6.5 Equipment and materials shall be supplied and installed with all threads, hinges, bolts, cover plugs, cable glands and flanges lubricated with anti-seize (loctite) or similar grease.

6.6 Equipment and materials shall be supplied with cable passage holes sealed with plastic plugs in the holes to be used and definitive plugs (made of the same material as the equipment and accessories) in the reserve holes.

6.7 Detailed engineering design shall be render feasible through strategic installation of components, so as to minimize the number of connections and thus optimize costs of materials and/or work to be done.

6.8 DC Energy System shall be duplicated and be composed by System A (#1) installed in Telecom Upper Room at Accommodation Module and System B (#2) installed in Telecom Lower Room at Accommodation Module.

6.9 Each DC Energy System shall be dimensioned to feed all (-)48 VDC charges installed in Telecom Upper Room and (-)48 VDC charges installed in Telecom Lower Room.

6.10 In normal conditions each battery charger shall be responsible to power all (-)48 VDC loads installed in same room as the battery charger.

6.11 In case of failure of one battery charger or during its routine maintenance the other battery charger shall be able to power all (-)48 VDC loads of both DC panels installed in each Telecommunication Room. It is assumed that each battery bank connected to each DC Electrical Panel in each Telecom Room keeps connected to DC panel even if its respective battery charger fails or is under maintenance. So, each battery bank shall be calculated for the loads connected to its respective DC panel.

6.12 The loads maneuver between battery banks shall be done in the main DC electrical panels.

6.13 Equipment, cables, boxes, materials and accessories for installation in the industrial areas (outdoor or indoor) of the FPSO PETROBRAS Unit, shall be specified and assembled taking into account the adverse operating conditions on FPSO such as:

a. Atmosphere with high content of humidity, salts hydrocarbons and other corrosive factors;

b. Environment subject to the presence of explosive gases shall be in accordance with Hazardous area classification;

c. Exposure to weather conditions (sun and rain) and maritime atmosphere;

d. Air temperature: From -10ºC up to +50ºC;

e. Air Humidity: 95%.

6.14 APER shall have a 220 VAC Telecom UPS panel from Topsides UPS and a DC electrical switchboard from (-)48 VDC Telecom Interface box (Hull).

6.15 AEPR shall also have normal panel for MODA and RRMS according to these systems technical specifications.

6.16 CONTRACTOR shall install and connect one electrical cable from 220 VAC Telecom UPS of AEPR to each crane electrical junction box or straight to slip ring inside crane.

6.17 CONTRACTOR shall install and connect one electrical cable from 220 VAC Telecom UPS of AEPR to electrical junction box to be used for VHF base station radio in Pull in winch.

6.18 CONTRACTOR shall interconnect (-)48 VDC Telecom Interface box to Topside DC switchboard panel in AEPR Telecom cabinet.

6.19 Each Telecommunication cabinet shall be equipped with proper grounding cabling and devices from Unit to properly ground equipment inside cabinets, racks and panels.

6.20 SELLER shall provide facilities so that specific loads powered from Electrical Panels to be installed can be interconnected to the Energy Shutdown (ESD) system.

6.21 DC Electrical Panel

6.21.1. General guidance:

a. The DC electrical panel shall be defined in accordance with the operating voltages and group of equipment to which they will be interconnected;

b. The switchboards size shall be the sufficient to contain its own components and to allow the suitable arrangement for external connection cables;

c. DC electrical panel shall be wall-mounted or installed inside rack as it shall be a circuit from DC panel of Telecom Lower Room;

d. DC electrical panel shall have one thermo-magnetic circuit breaker for incoming circuit, for general protection, equipped with shunt-trip coil for remote command;

e. DC electrical panel internal bus-bar shall be of electrolytic copper;

f. The electrical panel shall be dimensioned to withstand the level of the short-circuit current obtained in the electrical studies;

g. All DC electrical panel shall have grounding terminals for 25 mm² or greater cables;

h. All of the DC electrical panel shall have additional thermo-magnetic circuit breakers or fuses, of which the quantity and rated current, as well as its position spare cable, shall be defined during detail design. CONTRACTOR shall consider, at least, quantity 35% of circuit breakers or fuses in additional to spare or expansion;

i. It shall be provided an interface between DC electrical panels and CSS-HFGS according with I-ET-3010.00-5520-861-P4X-001 - CONTROL AND SAFETY SYSTEM – CSS in order to permit the selective charge disconnection in case of gas detect in antenna area installation.

6.22 AC Electrical Panel

a. All AC electrical panels required for telecommunications energy system are described in Hull and Topsides telecommunications energy system one line diagrams.

b. All AC electrical panels required for telecommunications energy system shall be in accordance with I-ET-3010.00-5140-700-P4X-002 - SPECIFICATION FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.

c. All AC essential and emergency (UPS) electrical panel shall have, at least, the quantity 35% of circuit breakers in additional to spare or expansion.

d. It shall be provided 01 (one) AC electrical interface panel to power each BLT in Topsides areas according to TOPSIDES TELECOMMUNICATIONS ENERGY SYSTEM ONE LINE DIAGRAM. Such electrical panel shall be connected to both UPS bus bars through an ATS device or similar, so that a failure in one bus bar does not affect the service. Such panel shall have 01 (one) circuit breaker for each BLTs plus 20% as spare fed by such automatic transfer switch device.

e. All circuit breakers inside electrical panel shall be MCCB type according to Electrical Discipline requirements.

f. AC panels (from UPS or Essential) shall have their loads properly balanced among all 03 (three) phases available inside the panel.

g. AC panels shall be internally organized considering vertical bus bars for entrance power connected to its respective circuit breakers and interlocking bus device (tie circuit-breaker); vertical supports for load circuit breakers connected to entrance bus bar by cooper bars (nor flexible core wire) and protected by transparent polycarbonate cover or similar; a horizontal grounding bar; a horizontal bar for internal services; internal service light; cable organizing covered. Next figure exemplifies the internal arrangement. Anything different shall be approved by PETROBRAS.

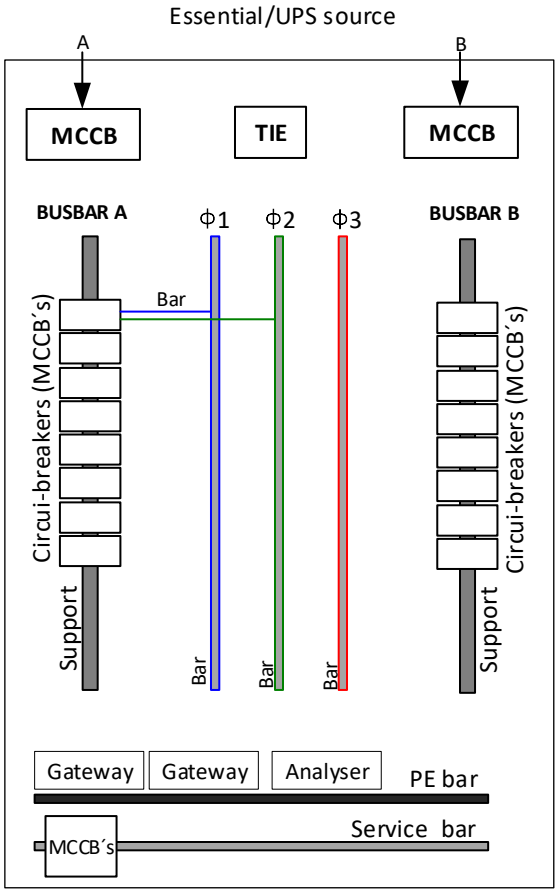

Figure 1: typical internal AC panel arrangement

6.23 Interlocks - Parallel Operations

a. This operation shall allow the operator to change the configuration of panel, from “II” (the incoming circuit breakers closed and the tie circuit breaker opened) to “L” (one incoming circuit breaker plus the tie circuit-breaker closed and the other incoming circuit-breaker opened) and return it to “II”, if desired;

b. Parallel operation of upstream transformers, with the panel in “U” configuration (two incoming circuit breaker plus the tie circuit breaker closed), shall only be

possible momentarily, when the tie circuit-breaker of the DC electrical panel is closed;

c. The “U” operation shall only be allowed for the time required to change the configuration from one to the other;

d. The panels shall have selector switches to select the circuit breaker that will open (one of the incomings or the tie circuit breaker), after the load transference (closing of the third circuit breaker).

e. The panel shall have an external light signaling indicating the current way of operation: if bus bars A and B are connected or not.

6.24 DC Distribution Panel for 19” rack

6.24.1. The circuit breaker panels shall provide distribution and overload protection up to 20 circuits with circuit breakers. However, the final circuit breaker quantity shall define by CONTRACTOR on the detail design.

6.24.2. The circuit breaker panels shall provide dual-bus (A/B) distribution and alarm capabilities.

6.24.3. The A and B sections of the dual-bus panel are fully isolated.

6.24.4. The circuit breaker and power fail shall be indicated on local visual alarm and relay contacts for each bus.

6.24.5. Examples of DC Distribution panels for 19” racks are shown at Figure 1 and Figure 2.

Figure 1: Example of DC switchboard

Figure 2: Example of DC Switchboard

6.25 Cables

6.25.1. Current criteria

a. Each cable shall be designed to a current equal or minor than 60% (sixty percent) of the rated value specified by the cable manufacturer, considering the 45ºC (forty-five Celsius degrees) environment temperature.

b. Cabling gauges represented on electrical one line diagram is for reference. The final and correct cabling gauges shall be calculated by CONTRACTOR.

6.26 MANAGEMENT REQUIREMENTS

6.26.1. Connection to PI interface

6.26.1.1. Electrical panel PN-5264001 of M-17 shall have a digital device meter to measure current, voltage and power (real/apparent).

6.26.1.2. Such digital device shall the minimum features:

a. Visual display screen outside the panel

b. Internal clock with date and time for event logging

c. Availability for Modbus-RTA RS485 networking

d. Password for programming lock

e. List of configurable alarms

f. Interfaces for connection in three-phase and two-phase systems, according to the panel

g. Inlet voltage and current values indication

h. Inlet voltage and current failure status/alarms

6.26.1.3. CONTRACTOR shall provide OPC-UA drivers compatible with Osisoft's PI OPC-UA Connector for the digital device interface in order to provide data for reading. In other words, data from digital device interface shall be readable from PI interface.

6.26.1.4. As a matter of information, this connection with PI system is meant for monitoring only, i.e., no commands are allowed from this LAN connection to Electrical Panel.

6.26.1.5. So that the digital interface meter can be directly connected to DMZ Switch, through FTB cable, in a TCP/IP connection (as per interface velocity and type port of DMZ switch), it shall also be provided, installed and commissioned 02 (two) gateways, working in master-slave mode, which shall have at least 02 (two) ethernet ports and 08 (eight) Modbus ports.

6.26.1.6. The Modbus gateways place of installation shall be defined by CONTRACTOR, whose required cabling shall be provided accordingly design.

6.26.1.7. The gateway shall have the same features of model EKI-1228/CI/I-DR from Advantech vendor, but another model can be acceptable, once approved by PETROBRAS. In case of gateway to be powered by DC energy, it shall be provided AC/DC power converter for each gateway.

6.26.1.8. All required cables and interfaces to interconnect digital interface meter to Modbus gateways shall be provided.

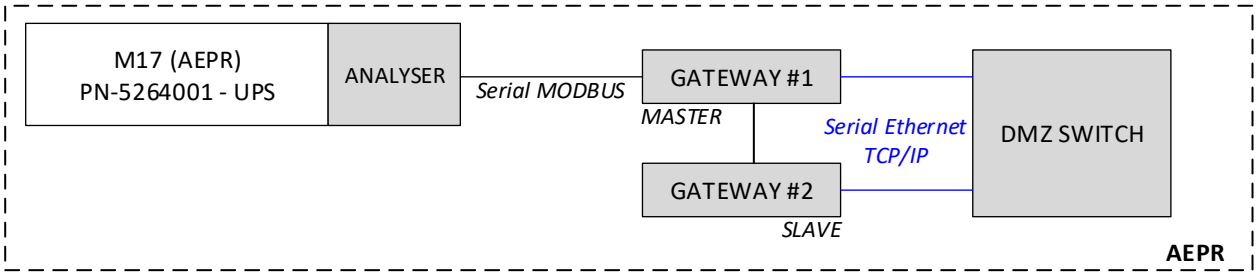

Figure 4: schematic interconnections

6.27 Automatic Transfer Switch

6.27.1. The ATS device shall have the following features for installation inside cabinets:

a. The ATS device shall provide reliable, redundant power to single-corded equipment loads. The ATS device shall have two input power cords supplying power to the connected loads.

b. The ATS device shall have has built-in network connectivity, which allows for remote management via Web, Telnet, SNMP and SSH.

c. Input: 02 (two) inputs for two separate power sources (A, B).

d. Outputs: 08 (eight) outputs (minimum) to power equipment.

e. Transfer time: 10ms maximum.

f. Visual singling operation mode indication by frontal LEDs.

g. 19” standard for rack installation.

6.27.2. The ATS device shall have the following features for installation inside electrical panels:

a. The ATS device shall provide reliable, redundant power to single-corded equipment loads. The ATS device shall have 02 (two) input power cords supplying power to the connected loads.

b. Input: 02 (two) inputs for two separate power sources (A, B).

c. Outputs: assembled to be connected to terminal born and circuit breakers that will power the device.

d. Transfer time: 10ms maximum.

e. In case of failure, it shall bypass to just one source.

f. It shall be according to classification area to be installed.

7. SCOPE OF SUPPLY

7.1 CONTRACTOR shall be responsible to supply, install, test and commission the Energy System for Telecommunications Systems in PETROBRAS FPSO Unit, within the scope of the Contract and in accordance with this Technical Specification that shall be composed, at least, by:

a. 01 (one) 220 VAC UPS Telecom Panel
b. 01 (one) AC electrical panel (for BLT)
c. DC distribution switchboard for 19” rack (01 for each telecom rack)
d. AC distribution switchboard for 19” rack (01 for each telecom rack)
e. Accessories;
f. Cables;
g. 04 (four) ATS 19 inches device for cabinets;
h. 01 (one) ATS device for electrical panel.
i. 01 (one) digital meter for electrical panel;
j. 02 (two) Modbus gateways for electrical panel.

7.2 220 VAC UPS Telecom Panel shall be dimensioned to attend its specifics AC telecom demands and follow the I-ET-3010.00-5140-700-P4X-002 - SPECIFICATION FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS and I-ET-3010.00-5140-741-P4X-004 - SPECIFICATION FOR LOW-VOLTAGE GENERIC ELECTRICAL PANELS FOR OFFSHORE UNITS.

8. DIMENSIONING CRITERIA

8.1 It can be considered power factor of 0,85.

8.2 As preliminary input, to be confirmed during Detail Design, the following medium Load Factor (Use Factor) is expected:

a. UPS 56%
b. Essential 47%
c. Normal 55%
d. DC 40%

8.3 CONTRACTOR shall be responsible to issue a calculation report in order to dimension the final capacity of each electrical panel.

9. COMMISSIONING

9.1 CONTRACTOR shall, as a technical commissioning activity, check, test and evaluate the operation of machines, equipment, panels, installations, protections and redundancies, in their components or in the set, in order to permit or authorize their use under normal operating conditions.

9.2 The following verifications shall be checked as scope of commissioning activities in accordance with Contract and this Technical Specification.

a. Annotation of the plate data;
b. Continuity and interconnection;

c. Analysis of the philosophy of protection and measurement;
d. Wiring insulation;
e. Fuse check;
f. Checking of signal lights, control keys;
g. Analysis of the heating system;
h. Current application in the TC circuit;
i. Application of voltage in the TP circuit;
j. Analysis of results;
k. Final Inspection with issued report.

9.3 CONTRACTOR shall provide all items needed to carry out the commissioning activities of the Energy System.

9.4 CONTRACTOR shall follow all verifications that are scope of commissioning activities in accordance with Contract documents and this Technical Specification.

9.5 CONTRACTOR shall be responsible to preserve the power battery banks, make all tests and issue and report prior to commissioning.

9.6 Each AC and DC panel shall have their inputs current measured and recorded during a full load test.

9.7 As a matter of general acceptance, it is expected: switchover from AC to DC and vice versa; DC switchboard and AC panels properly identified and sized as per actual loads and spare ones required.