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SRGE	TITLE: SPECIFICATION FOR LOW-VOLTAGE GENERIC ELECTRICAL PANELS FOR OFFSHORE UNITS		INTERNAL
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SPECIFICATION FOR LOW-VOLTAGE GENERIC ELECTRICAL PANELS FOR OFFSHORE UNITS

INTERNAL

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1 OBJECTIVE

- 1.1 This specification establishes the minimum technical requirements for design, manufacture, and supply of Low-Voltage Generic Panels for PETROBRAS Offshore Units.
- 1.2 Classification Society requirements shall prevail over requirements of this document.

2 REFERENCE STANDARDS AND DOCUMENT LIST

2.1 GENERAL

At the design development and for equipment specification, IEC standards shall be used, all on their latest revisions. Exceptionally, where it is clearly justifiable, ANSI, IEEE and others, internationally recognized standards, may be used. Their use shall be restricted to specific cases and shall be approved by PETROBRAS.

2.2 CODES, STANDARDS AND RECOMMENDED PRACTICES

2.2.1 IEC – INTERNATIONAL ELECTROTECHNICAL COMMISSION

IEC 60445	Basic and Safety Principles for Man-Machine Interface, Marking and Identification - Identification of Equipment Terminals, Conductor Terminations and Conductors
IEC 60364-4-41	Low-Voltage Electrical Installations - Part 4-41: Protection for Safety - Protection Against Electric Shock
IEC 60947-2	Low-Voltage Switchgear and Controlgear - Part 2: Circuit-Breakers
IEC 60947-3	Low-voltage switchgear and Controlgear - Part 3: Switches, disconnectors, switch-disconnectors and fuse-combination units
IEC 61000	Electromagnetic Compatibility (EMC) - All parts
IEC 61439	Low-Voltage Switchgear and Controlgear Assemblies - All Parts
IEC 61892	Mobile and Fixed Offshore Units - Electrical Installations - All parts

Note: When all parts are informed, all applicable parts shall be used as reference. If a specific part in mentioned in text, it will be listed following the general code reference.

2.3 REFERENCE DOCUMENTS

- [1] I-ET-3010.00-5140-700-P4X-001 - SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS
- [2] I-ET-3010.00-5140-700-P4X-002 - SPECIFICATION FOR ELECTRICAL MATERIAL FOR OFFSHORE UNITS
- [3] I-ET-3010.00-5140-700-P4X-005 - REQUIREMENTS FOR HUMAN ENGINEERING DESIGN FOR ELECTRICAL SYSTEMS OF OFFSHORE UNITS
- [4] I-ET-3010.00-5140-700-P4X-007 - SPECIFICATION FOR GENERIC ELECTRICAL EQUIPMENT FOR OFFSHORE UNITS

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- [5] I-ET-3010.00-5140-700-P4X-009 - GENERAL REQUIREMENTS FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS
- [6] I-ET-3010.00-5140-741-P4X-001 - LOW-VOLTAGE MOTOR CONTROL CENTER AND SWITCHGEAR FOR OFFSHORE UNITS
- [7] I-ET-3010.00-5140-773-P4X-003 – SPECIFICATION FOR A.C. UPS FOR OFFSHORE UNITS
- [8] I-DE-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION ARCHITECTURE DIAGRAM
- [9] I-ET-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION ARCHITECTURE
- [10] ELECTRICAL SYSTEM DESCRIPTIVE MEMORANDUM
- [11] I-LI-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION INTERFACE SIGNALS LIST
- [12] I-ET-3010.00-5520-888-P4X-001 - AUTOMATION PANELS
- [13] I-LI-3010.00-5140-700-P4X-001 - ELECTRICAL EQUIPMENT DATA SHEET MODELS
- [14] I-ET-3010.00-5140-773-P4X-001 - SPECIFICATION FOR D.C. UPS FOR OFFSHORE UNITS

Note: Documents without code in the list are documents with variations according to project characteristics. Verify in project documentation list the reference for codes of these documents.

3 EQUIPMENT

3.1 GENERAL CONDITIONS

All General Equipment Conditions (Environmental Conditions, Heat Dissipation Characteristics, Motion and Inclination Limits Requirements, Vibration Limits Requirements, Hazardous Areas Requirements, Construction Requirements, Warning Labels for Electrical Equipment, Voltage Requirements, Frequency Requirements and EMC and RFI Requirements) not covered by this Specification, are defined, when applicable, in I-ET-3010.00-5140-700-P4X-009 - GENERAL REQUIREMENTS FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.

3.2 GENERAL REQUIREMENTS

3.2.1 The following requirements refer to:

- A.C Main distribution. panels up to 240V.
- A.C. Secondary distribution panels up to 240V.
- A.C. and D.C lighting. panels up to 240V.
- A.C. and D.C. UPS Secondary Distribution Panels.
- Generic DC UPS Distribution Panels.
- Low-voltage panels (not MCC or Switchgear) and power transformers forced ventilation control panels up to 690VAC.
- Generic heating systems panels in 690/480 VAC, and all other 690/480 VAC generic panels that are not covered by I-ET-3010.00-5140-741-P4X-001 - LOW-VOLTAGE MOTOR CONTROL CENTER AND SWITCHGEAR FOR OFFSHORE UNITS.
- Control panels, accommodation panels, distribution boards, signalling panels and other similar controlgears.
- Heat tracing panels.


3.2.2 Medium-voltage switchgears and medium-voltage MCCs requirements are defined in specific Technical Specification and respective Datasheet.

3.2.3 Low-voltage switchgears and low-voltage MCCs requirements are defined in specific Technical Specification and respective Datasheet.

3.2.4 Thyristorized panels requirements are defined in specific Technical Specification and respective Datasheet.

3.2.5 A&C (Automation and Control System) Panel's requirements are defined in specific Technical Specification – see I-ET-3010.00-5520-888-P4X-001 - AUTOMATION PANELS.

3.2.6 Manufacturer shall consider cable sizes for necessary internal space considering panel cable incoming, cable outgoing and future cable provisions for spare outgoing, assuring that internal cable channels will not be damaged. If cable channels are not sufficient for all cable incoming and cable outgoing, specific arrangement shall be informed to PETROBRAS for approval.

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3.2.7	All panels shall comply with the requirements of the I-ET-3010.00-5140-700-P4X-005 - REQUIREMENTS FOR HUMAN ENGINEERING DESIGN FOR ELECTRICAL SYSTEMS OF OFFSHORE UNITS.		
3.2.8	All panels shall be designed to conditions (including voltage and frequency variations) defined in I-ET-3010.00-5140-700-P4X-009 - GENERAL REQUIREMENTS FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.		
3.2.9	For A.C. UPS Main Distribution Panels shall follow the requirements of I-ET-3010.00-5140-773-P4X-003 – SPECIFICATION FOR A.C. UPS FOR OFFSHORE UNITS.		
3.2.10	For D.C. UPS Main Distribution Panels shall follow the requirements of I-ET-3010.00-5140-773-P4X-001 - SPECIFICATION FOR D.C. UPS FOR OFFSHORE UNITS.		
3.3 SCOPE OF SUPPLY			
3.3.1	Manufacturer shall supply the panels and all accessories and tools to operate, change spare parts and adjustments, recommended by its own experience. Components requiring periodic replacement shall be listed in the spare parts list with the recommended replacement frequency.		
3.3.2	Manufacturer shall provide the necessary spare parts for the commissioning and pre operation periods.		
3.4 CONSTRUCTIVE CHARACTERISTICS			
3.4.1	GENERAL All panels shall be designed, manufactured, and tested according to reference Standards presented in item 2.		
3.4.2	INSULATION LEVELS The rated voltage (U_n), the rated operational voltage (U_e), the rated insulation voltage (U_i) and the rated impulse withstand voltage (U_{imp}) shall comply with the requirements of IEC 61439-1.		
3.4.3	STRUCTURE		
3.4.3.1	All panels shall be provided with lifting eyelets.		
3.4.3.2	Panels shall be able to operate on structures subject to vibrations up to the limits stated in IEC 61892.		
3.4.3.3	It shall be provided at least 20% of spare complete outgoing circuits, including the terminal blocks.		
3.4.3.4	Panels shall be floor-mounted or wall-mounted, self-supported, fitted with means of access for maintenance from front sections, unless otherwise stated in design documentation.		
3.4.3.5	Suitable sheet or removable covers shall be provided to avoid contact with energized parts in the interior of the panels, during operation of circuit-breakers.		

- 3.4.3.6 On panels with circuit-breakers, the assembly, hardware, busbars, fittings, etc., shall be built in order to allow the interchange, respectively, with all circuit-breakers of the same characteristics.
- 3.4.3.7 The whole structure, including doors, shall withstand the thermal (for a minimum period of one second) and dynamic effects due to short-circuit currents calculated.
- 3.4.3.8 Vertical sections shall have hinged front door. Doors shall be bonded to the panel structure through flexible copper cable. Hinged doors shall have an open position lock device.
- 3.4.3.9 When rear access is required, screwed rear doors shall be fitted with handles to ease their remove and installation.
- 3.4.3.10 Sensible equipment panels and control panels shall be installed in structures free of vibration. It shall be avoided installation of these types of panels in the structure base, or skid of the controlled equipment.
- 3.4.3.11 For floating units, the floor-mounted panels shall be provided with an insulating handrail in the fixed frontal side.

3.4.3.12 The following criteria shall be applied:

Table 1 – Low-voltage Generic Panels Material

AREA	MATERIAL
Internal Areas	Steel Sheets AISI 316L, or Painted Carbon Steel, or Painted Galvanized Steel, or Aluminium alloys defined in I-ET-3010.00-5140-700-P4X-002 - SPECIFICATION FOR ELECTRICAL MATERIAL FOR OFFSHORE UNITS.
External Areas	Steel Sheets AISI 316L, or Aluminium alloys defined in I-ET-3010.00-5140-700-P4X-002 - SPECIFICATION FOR ELECTRICAL MATERIAL FOR OFFSHORE UNITS.

3.4.3.13 Panels for external non-hazardous areas shall be wall-mounted type.

3.4.4 THERMAL INSPECTION FACILITIES

The panels shall be constructed so that thermal inspection by optical infrared thermographic devices could be safely performed with the circuits energized.

3.4.5 BUSBAR

3.4.5.1 Panel shall have busbars of electrolytic copper in A.C. systems, identified with coloured strips as follows:

- Phase: red, white, and black (R – S – T, respectively).
- Neutral: light blue according to IEC 60445.
- Ground: bi-colour combination green-and-yellow according to IEC 60445.

3.4.5.2 Panel shall have busbars of electrolytic copper in D.C. systems, identified with coloured strips as follows:

- Positive pole: red.
- Negative pole: black.

- 3.4.5.3 The panels' busbars shall be sized to conduct the rated current related to the rated power under steady state condition, with the temperature rise limited to the values specified on standards.
- 3.4.5.4 Busbar shall be dimensioned to support the mechanical and thermal stresses due to short-circuit currents. The space between supports shall not exceed the insulators minimum clearance and creepage distances guaranteed by the respective manufacturers.
- 3.4.5.5 If parallel bars are used for a same phase, shims shall be used, suitably spaced along these bars' longitudinal axis.
- 3.4.5.6 Bars at junction points shall be silver-coated according to ASTM B700 with minimum thickness of 2.5µm and placed in such manner to guarantee a perfect alignment and high-pressure contact.
- Note: Both sides of contact bus bar shall be silver coated.
- 3.4.5.7 The insulation of bars, supports and junction pieces, shall be of non-hygroscopic and non-fire propagating material. Fiberglass or Celeron shall not be accepted.
- 3.4.5.8 The strength applied on supports shall not exceed the minimum rupture load of insulators, guaranteed by respective manufacturers.
- 3.4.6 GROUNDING BUSBARS**
- 3.4.6.1 All panels shall be supplied with internal grounding busbars.
- 3.4.6.2 Floor-mounted panels shall have the grounding bar installed in the lower part and supplied with non-welded type connectors, suitable for bare stranded copper cable with cross-sectional area according to I-ET-3010.00-5140-700-P4X-001 - SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS.
- 3.4.6.3 Wall-mounted panels shall have an external terminal with non-welded type connector, suitable for connection to bare stranded copper cable, with cross-sectional area according to I-ET-3010.00-5140-700-P4X-001 - SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS, installed in one of the lateral sides of the panels. The grounding busbar shall be internally connected to this terminal.
- 3.4.6.4 In solidly grounded neutral systems, the neutral busbar, when required, shall be internally connected to the grounding busbar.
- 3.4.6.5 All panel metallic parts, which are not intended for current conduction, shall be interconnected to the grounding bar, including movable parts.
- 3.4.6.6 All panels with signal circuits shall have dedicated PE, IE and IS grounding bars, when required, as defined in I-ET-3010.00-5140-700-P4X-001 - SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS.
- 3.4.6.7 Panels with electronic components shall have an "Electronic Reference Bar" (IE), duly identified, complying with requirements of IEC 61000-5-2, for connection of electronic reference grounding terminals of instruments, sensors, and intelligent devices.
- 3.4.7 WIRING AND CONDUCTORS**
- 3.4.7.1 All internal conductors shall comply with requirements of I-ET-3010.00-5140-700-P4X-002 - SPECIFICATION FOR ELECTRICAL MATERIAL FOR OFFSHORE UNITS.
- 3.4.7.2 The minimum conductor cross section inside panels shall be:

- 1 mm² for discrete signals cables.
- 0.5 mm² for analogue signal cables.
- 2.5 mm² for power and VT (Voltage Transformer) circuits.
- 4 mm² for CT (Current Transformer) circuits.

3.4.7.3 Equipment assembled on the doors shall be connected with extra flexible conductors.

3.4.7.4 For panels installed outdoors, all cables entrances shall be through panels' bottom side.

3.4.7.5 For cable entrance, the manufacturer shall provide removable aluminium or non-magnetizing material plates for installation of cable glands or MCT for floor mounted panels. The use of any type of sealing mass for cable entrance is forbidden.

3.4.7.6 Panel shall be delivered with all connections for instruments, transformers, controls and wiring between the units and sections installed. The interconnection wiring between sections needing to be separated for transportation shall end on terminal blocks, in order that jumpers shall complete the interconnection, when the sections are assembled.

3.4.7.7 The cables shall be grouped in lugs strips, properly identified at the ends. The panel shall be provided with all connections between installed components done.

3.4.8 PAINTING

3.4.8.1 The painting of electrical panels shall be according to I-ET-3010.00-5140-700-P4X-009 - GENERAL REQUIREMENTS FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.

3.4.9 IDENTIFICATION NAMEPLATE AND INFORMATION LABELS

3.4.9.1 All drawers, compartments, columns, and internal components shall be identified by means of black acrylic labels engraved with white letter.

Note: for small internal components (i.e.: small circuit-breakers, contactors, auxiliary relays) where acrylic labels are not feasible due to constrict sizes and small spaces, adhesive labels are allowed.

3.4.9.2 All panels shall have a label identifying the grounding system for the power and control systems.

3.4.9.3 All panels' incoming functional units shall have a label identifying the panel TAG of the feeding circuit.


3.4.9.4 All panels fed by uninterrupted power systems shall have a label informing expected autonomy in hours and minutes.

3.4.9.5 All functional units in panels that are in isolated ground system shall have a label informing if they will or not be shut down in case of fault to ground.

3.4.9.6 Warning labels for electrical equipment shall follow requirements informed in I-ET-3010.00-5140-700-P4X-009 - GENERAL REQUIREMENTS FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.

3.4.10 CIRCUIT-BREAKERS

3.4.10.1 Circuit-breakers shall be manufactured and tested according to recommendations of IEC 60947-2 and IEC 61439-2.

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<p>3.4.10.2 Power circuit-breakers shall have test certificate, furnished by a recognized laboratory in accordance with standards IEC 61439-2 and IEC 60947-2.</p> <p>3.4.10.3 The control circuits auxiliary contacts and changeover switches shall be connected to the fixed part by plugs.</p> <p>3.4.10.4 The rated ultimate short-circuit breaking capacity (Icu), the rated service short-circuit breaking capacity (Ics), the rated short time withstand current (Icw) and the rated short-circuit making capacity (Icm) shall be higher than the maximum short-circuit current indicated in the short-circuit calculation reports.</p> <p>3.4.10.5 Circuit-breakers shall be provided with the interlocking and parallel operation mentioned in one-line diagram and in this specification.</p> <p>Note: A label with reference to interlocking and parallel operation allowed and not allowed document and a resume of main circuit-breaker interlocking and parallel operation, allowed and not allowed, shall be provided.</p> <p>3.4.10.6 For circuit-breakers with RCD see I-ET-3010.00-5140-700-P4X-001 - SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS.</p> <p>3.4.10.7 It shall be possible to block the circuit-breaker in open position with padlock for panel incoming and primary outgoing circuit-breakers.</p> <p>3.4.10.8 Circuit-breakers for D.C. panels shall protect both circuit poles.</p> <p>3.4.10.9 Incoming panel circuit-breakers shall be located near panel cable entrances.</p> <p>3.4.11 INSTRUMENT TRANSFORMERS</p> <p>For instrument transformers see I-ET-3010.00-5140-700-P4X-007 - SPECIFICATION FOR GENERIC ELECTRICAL EQUIPMENT FOR OFFSHORE UNITS.</p> <p>3.4.12 INTELLIGENT RELAYS</p> <p>For intelligent relays requirements, see I-ET-3010.00-5140-700-P4X-007 - SPECIFICATION FOR GENERIC ELECTRICAL EQUIPMENT FOR OFFSHORE UNITS.</p> <p>3.4.13 AUXILIARY RELAYS</p> <p>For auxiliary relays requirements, see I-ET-3010.00-5140-700-P4X-007 - SPECIFICATION FOR GENERIC ELECTRICAL EQUIPMENT FOR OFFSHORE UNITS.</p> <p>3.4.14 INSTRUMENTS</p> <p>3.4.14.1 All instruments shall comply with requirements of I-ET-3010.00-5140-700-P4X-005 - REQUIREMENTS FOR HUMAN ENGINEERING DESIGN FOR ELECTRICAL SYSTEMS OF OFFSHORE UNITS.</p> <p>3.4.14.2 All discrete input/output signals for instrumentation shall be voltage free (dry-contacts).</p> <p>3.4.14.3 All indicating instruments shall have external zero adjustment, accuracy of 1.5%, white scale, black markings.</p> <p>3.4.14.4 They shall be immune to electromagnetic interference and radio interference according to IEC 61000.</p>						

3.4.14.5 The active energy meters shall have a maximum demand indicator ranging for the last 15 (fifteen) minutes.

3.4.14.6 Preference shall be given to discrete measuring devices, having the capacity of data gathering and data availability through digital communication port.

3.4.14.7 These meters shall be able to indicate a reverse power up to 15% of the rated power.

3.4.15 HEATING RESISTORS

3.4.15.1 Panels shall be provided with heating resistors, (one for each vertical section or compartment), in 220VAC (two phases, grounded isolated). The resistors shall be automatically controlled by means of a thermostat with scale up to 60°C maximum. A circuit-breaker shall be provided on each resistor circuit.

3.4.15.2 Panels shall be provided with external (220VAC, two phases, grounded isolated) outlet to energize the heating circuits during the storage period.

3.4.15.3 Space heaters shall be protected against accidental contacts. The wiring next to them (about 300mm) shall have proper insulation to avoid damages due to overtemperature.

3.4.16 LIGHTING

Unless otherwise defined in project documentation or panel datasheet, the following panels shall be provided with internal (220Volts, two phases) outlet to energize the internal lighting circuits:

- A.C. and D.C. Main distribution panels up to 240V;

-Distribution Panels fed by Generic DC UPS;

- A.C. and D.C. UPS Secondary Distribution Panels;

- Heat Tracing panels;

-Control panels.

3.4.17 SIGNALLING

According to the respective One-Line Diagram, each compartment shall have high luminosity signalling LEDs, with colours according to I-ET-3010.00-5140-700-P4X-005 - REQUIREMENTS FOR HUMAN ENGINEERING DESIGN FOR ELECTRICAL SYSTEMS OF OFFSHORE UNITS.

3.4.18 TERMINALS FOR POWER CIRCUITS

All necessary terminals for connection with external power cables shall be supplied with the Panel.

3.4.19 FACILITIES FOR TEMPORARY GROUNDING

Facilities shall be provided to allow temporary grounding by means of ground cables, through screwed connectors, separately, to the panel frame to the terminal block box and to the enclosure.

3.4.20 CHANNELS

Channels shall be made of non-fire propagating material.

3.4.21 TESTS

Manufacturer shall carry out all tests indicated in Table 2 and all tests foreseen in standards listed in item 2.

Table 2 - Reference Test Requirements for Panels

Test Description
Visual inspection, with verification of construction in general, surfaces, structures and supports finishing and dimensions.
Mechanical tests, with verification of suitable operation of mechanical parts, such as circuit-breakers connection devices, interlock mechanisms, doors, etc.
Withstand voltage test, at 60 Hz, dry, on the main insulation components.
Verification of wiring continuity according to the last approved wiring diagrams.
Wiring insulation test.
Complete operational test, with verification of measuring instruments and relays regarding calibration and operation. After assembled, all components of control circuits and auxiliaries shall be energized with the respective rated voltages to verify the perfect operation of all concerned components (relays, measuring instruments, signalling lamps, heating resistors, etc). Instrument transformer polarities shall be verified.
Verification of painting procedures for internal and external surfaces.
Verification of nameplates arrangement, internally and externally.
Verification of the instruments and components assembled on panel.
Test of electric insulation for 1 (one) minute, between conductors and grounding, which shall have a value above of 100 Megaohms.
Note: Short-Circuit test supportability test certificate shall be issued for 220VAC low-voltage panels with short-circuit current rating ≥ 10 kA, as required by IEC 61439-1.

3.5 A.C. MAIN DISTRIBUTION PANELS UP TO 240V

3.5.1 GENERAL

This item refers to main distribution panels up to 240V, connected to secondary winding of 690/480-220/127V or 690/480-220V transformers.

3.5.2 STRUCTURE

Panels shall be built according to I-ET-3010.00-5140-700-P4X-009 - GENERAL REQUIREMENTS FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS and 3.4.

3.5.3 INCOMING AND OUTGOING CIRCUITS CHARACTERISTICS

3.5.3.1 When panel has two incoming circuit-breakers and one tie circuit-breaker, it shall be provided, mechanically interlocked through "KIRK" blocking, to avoid transformers parallel operation.

3.5.3.2 All outgoing feeders shall be protected with moulded-case circuit-breakers. All outgoing circuit-breakers of normal 220VAC Main Distribution Panels and outgoing circuit-breakers for HVAC essential loads panels shall have shunt-trip coils, to allow selective safety shutdown from A&C. The shutdown of the panels shall be selective, according to the supplied location (e.g.: modules). Other circuit-breakers for essential and emergency distribution panels shall not have shunt trip coils.

3.5.3.3 All ESD signals triggered by fire or gas detection shall trip outgoing circuit-breakers of normal distribution panels to avoid necessity of individual control of these circuit in each load.

3.5.3.4 All panels expected to receive ESD or other wet signals from A&C or Package Control Panels shall have interposing relays with enough quantity to convert discrete 24 VDC signal in discrete voltage-free signal.

3.5.3.5 There shall be an identification label, next to each circuit-breaker, with identification of the circuit and of the load fed by the circuit-breaker.

3.5.3.6 Unless otherwise stated in Data Sheet, there shall be at least 3 (three) spare circuit-breakers installed in each busbar.

3.5.4 **CIRCUIT-BREAKERS**

3.5.4.1 Circuit-breakers shall be manufactured according to recommendations of standards mentioned on item 2 of this specification and suitable to interrupt the circuits to which they are connected.

3.5.4.2 They shall be moulded-case type, not being permitted the use of single-pole circuit-breakers mechanically coupled.

3.5.4.3 Each circuit-breaker shall have on each phase, direct action short-time, long-time and instantaneous tripping devices (STD/LTD and INST).

3.5.4.4 Circuit-breakers shall be provided with devices to neutralize the environmental temperature variation effect over their tripping devices.

3.5.4.5 The opening mechanism shall be "trip-free" type.

3.5.5 **BUSBAR**

3.5.5.1 Panels shall have five electrolytic copper busbars (three phases plus neutral plus grounding) dimensioned for rated current and to withstand the thermal and mechanical stresses due to short-circuit current.

3.5.5.2 Panels for isolated neutral systems shall not have neutral busbar.

3.5.6 **INTELLIGENT RELAYS (IRs)**

Panels shall have intelligent relays (IRs) according to I-ET-3010.00-5140-700-P4X-007 - SPECIFICATION FOR GENERIC ELECTRICAL EQUIPMENT FOR OFFSHORE UNITS.

3.5.7 **GROUND FAULT DETECTION**

3.5.7.1 One insulation monitoring device shall be installed in each busbar of A.C. Main Distribution Panels up to 240V with isolated neutral.

3.5.7.2 The insulation monitoring devices shall indicate the measured insulation ohmic value between phases and between phases and ground.

3.5.7.3 For panels with possibility to operate in "L" configuration with interconnection circuit-breakers closed, it shall be provided a logic to disable one of insulation monitoring devices in this condition. It shall also be provided a logic to enable both of insulation monitoring devices during the return to "ii" configuration.

3.5.7.4 It shall be furnished individual earth fault indicators for:

3.5.7.4.1 Distribution panels, for loads located in Zone 1 or loads where the feeding cable crosses Zone 1.

3.5.7.4.2 Heat tracing panels according to IEC-60079-14.

3.5.7.5 For the other cases, not in above conditions of 3.5.7.4, loads shall be grouped in one individual earth fault indicator.

3.5.7.6 One portable ground fault detector shall be supplied by BIDDER to detect faults through specific portable current-clamp meter, proper for D.C. and A.C. systems. This device shall be capable to detect all faults when until three different sensors are simultaneously activated by faulted circuits.

3.5.7.7 The outgoing cables for all circuits shall be installed in a way to enable easy access to clamp them with a portable ground fault detector, with the circuit energized. The shields shall be installed according to the detector requirements.

3.5.7.8 The insulation monitoring devices shall send a discrete alarm signal to an IED (IR) inside the panel, through a voltage free contact (1A @ 220VAC PF 0.4).

3.5.7.9 Each bar or semi-bar of the panel shall be supplied with devices to indicate defective phase by means of three lamps connected between phases and ground through a NO (normally open) push-button.

Note: In case of use of ground fault location devices, it is forbidden the use of voltage transformers connected YNyn (two neutral grounded).

3.5.7.10 To indicate that the ground fault detection device is turn off, an alarm shall be sent to IED (IR) installed inside the panel through a voltage free contact (1A @ 220VAC PF 0.4).

3.5.8 INTERFACE SIGNALS

3.5.8.1 Panels shall include an IED (IR) to obtain all signals from internal components as required by I-LI-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION INTERFACE SIGNALS LIST.

3.5.8.2 The IED (IR) shall communicate with protocols according to I-DE-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION ARCHITECTURE DIAGRAM and I-ET-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION ARCHITECTURE.

3.6 A.C. AND D.C. SECONDARY DISTRIBUTION, GENERIC D.C. UPS, AND A.C. AND D.C. LIGHTING PANELS UP TO 240V

3.6.1 GENERAL

3.6.1.1 Requirements contained on this item apply to following panels:

a) A.C. and D.C Lighting panels

I) for accommodation.

II) for external non-hazardous areas.

III) for hazardous areas.

b) Generic D.C. UPS panels:

I) Main distribution 125VDC panels for navigation aid lighting system.

II) Main distribution 125VDC panels for emergency auxiliary loads of gas compressors.

III) Main distribution 125VDC panels for emergency auxiliary loads of turbogenerators.

c) A.C. and D.C. UPS secondary distribution panels.

d) A.C. Secondary distribution panels up to 240V.

3.6.2 STRUCTURE

3.6.2.1 Panels shall be built according to I-ET-3010.00-5140-700-P4X-007 - SPECIFICATION FOR GENERIC ELECTRICAL EQUIPMENT FOR OFFSHORE UNITS and 3.4.

3.6.2.2 Lighting Panels may follow 3.6.2.1 or, for external areas, be made of non-metallic material, complying with requirements of Non-Metallic Materials Section of I-ET-3010.00-5140-700-P4X-002 - SPECIFICATION FOR ELECTRICAL MATERIAL FOR OFFSHORE UNITS.

3.6.3 BUSBAR

3.6.3.1 A.C. panels shall have five electrolytic copper busbars (three phases plus neutral plus grounding) dimensioned for rated current and to withstand the thermal and mechanical strength of the short-circuit current.

3.6.3.2 Panels for isolated neutral systems shall not have neutral busbar.

3.6.3.3 D.C. panels shall have three electrolytic copper busbars (two poles and grounding) dimensioned for rated current and to withstand the thermal and mechanical strength of the short-circuit current.

3.6.4 INTELLIGENT RELAYS (IRs)

3.6.4.1 Main distribution 125VDC panels for navigation aid lighting system, main distribution 125VDC panels for emergency auxiliary loads of gas compressors, main distribution 125VDC panels for emergency auxiliary loads of turbogenerators and secondary A.C. distribution panels used for heating resistors of panels and motors shall have intelligent relays (IRs). For IRs see I-ET-3010.00-5140-700-P4X-007 - SPECIFICATION FOR GENERIC ELECTRICAL EQUIPMENT FOR OFFSHORE UNITS.

3.6.5 GROUND FAULT DETECTION

3.6.5.1 One insulation monitoring device shall be installed in each busbar of the Generic DC UPS panels:

- Main distribution 125VDC panels for navigation aid lighting system.
- Main distribution 125VDC panels for emergency auxiliary loads of gas compressors.
- Main distribution 125VDC panels for emergency auxiliary loads of turbogenerators.

3.6.5.2 The insulation monitoring devices shall indicate the measured ohmic value between poles and between poles and ground.

3.6.5.3 It shall be furnished individual earth fault indicators for:

3.6.5.3.1 Distribution panels, for loads located in Zone 1 or loads where the feeding cable crosses Zone 1.

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3.6.5.3.2 Heat tracing panels according to IEC-60079-14.

3.6.5.4 For the other cases, not in above conditions of 3.6.5.3, loads shall be grouped in one individual earth fault indicators.

3.6.5.5 For space-heaters and lighting panels it shall be used a specific portable current-clamp meter.

3.6.5.6 One portable ground fault detector shall be supplied by BIDDER to detect faults through specific portable current-clamp meter, proper for D.C. and A.C. systems. This device shall be capable to detect all faults, even if three different circuits are faulted simultaneously.

3.6.5.7 The outgoing cables for all circuits shall be installed in a way to enable easy access to clamp them with a portable ground fault detector, with the circuit energized. The shields shall be installed according to the detector requirements.

3.6.5.8 The insulation monitoring devices shall send a discrete alarm signals to an IED (IR) inside the panel, through a voltage free contact (1A @ 220VAC PF 0.4 for AC panels and 1A @ 220VD.C. voltage for D.C. panels) in order to provide insulation fault signal and ground fault detection device turned off to Electrical System Automation through network.

3.6.5.9 To indicate that the ground fault detection device is turn off, an alarm shall be installed.

3.6.6 INCOMING FEEDERS

3.6.6.1 A load switch, minimum AC-22B, as defined in IEC 60947-3, shall be used in case of incoming feeder is already protected by a circuit-breaker in the upstream panel.

3.6.6.2 Circuit-breakers used at the incoming feeders shall coordinate with upstream and downstream circuit-breakers.

3.6.7 OUTGOING FEEDERS

3.6.7.1 Outgoing circuits shall be protected by thermomagnetic moulded-case circuit-breakers, suitable to interrupt short-circuit and overload currents. For lighting panels, miniature type circuit-breakers shall be used.

3.6.7.2 The outgoings shall be connected through non-welded type connectors appropriated to the cross-section of the specified cables.

3.6.7.3 In case of bipolar circuits, it shall not be allowed the use of single pole circuit-breakers, mechanically coupled.

3.6.7.4 Unless otherwise stated in Data Sheet, there shall be at least 4 (four) spare circuit-breakers installed in these panels.

3.6.7.5 Panel shall be supplied with enough space for future inclusion of new circuits.

3.6.7.6 There shall be an identification label, next to each circuit-breaker, with identification of the circuit and of the load fed by the circuit-breaker.

3.6.7.7 The bipolar circuit-breakers shall be identified, using the respective numbers of each bar.

3.6.7.8 Circuit-breakers for D.C. panels shall protect both circuit poles.

3.6.7.9 Navigation aid lighting panel systems, feeding navigation aid lights located in high positions and subject to lighting discharges effects in 125 VDC, shall have surge arresters at outgoing circuits for lightning discharges secondary effect protection. In this case, it shall be adopted a hybrid protection composed by spark-gap and varistor or transient-voltage-suppression diode.

Note: These surge arresters shall comply with I-ET-3010.00-5140-700-P4X-007 - SPECIFICATION FOR GENERIC ELECTRICAL EQUIPMENT FOR OFFSHORE UNITS.

3.6.7.10 Aircraft obstruction lights panel systems subject to lighting discharges effects in 120 VAC or other AC voltage, shall have surge arresters at outgoing circuits for lightning discharges secondary effect protection. In this case, it shall be adopted a hybrid protection composed by spark-gap and varistor or transient-voltage-suppression diode; Additionally, this outgoing circuit shall have insulation 1:1 transformer grounded at secondary side at outgoing circuits for lighting discharges secondary effect protection.

Note: These surge arresters shall comply with I-ET-3010.00-5140-700-P4X-007 - SPECIFICATION FOR GENERIC ELECTRICAL EQUIPMENT FOR OFFSHORE UNITS.

3.6.7.11 For emergency lightning panels outgoing circuits, it shall be provided a remote alarming of tripped circuit to a supervisory monitoring system, as required in IEC 61892-2.

3.6.7.12 For emergency lightning panels outgoing circuits, it shall be provided circuit-breakers with adequate protection curve according to Electrical Studies in order to avoid shutdown when all loads are simultaneously turned-on.

3.6.7.13 The emergency lighting fixtures internal to accommodation cabins shall not be turned on continuously to not impair staff resting. Emergency lighting panels for accommodation module shall have contactors to start automatically the emergency lighting fixtures internal to cabins in case of ESD-3T, or failure in essential lighting in accommodation, or failure in normal lighting in accommodation or in case of lighting testing. There shall be test pushbuttons in order to enable testing.

3.7 ELECTRICAL CONTROL PANELS

3.7.1 Unless otherwise stated, electrical control panels installed in exposed and in safe areas shall be wall-mounted and shall be according to I-ET-3010.00-5140-700-P4X-009 - GENERAL REQUIREMENTS FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.

3.7.2 Electrical control panels installed in hazardous areas shall have type of protection Ex according with I-ET-3010.00-5140-700-P4X-009 - GENERAL REQUIREMENTS FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.

3.7.3 The use of panels with type of protection Ex p shall be submitted to PETROBRAS approval. These panels, when approved, shall be made with stainless steel AISI-316L sheets, provided with regulation valve, pressure indicator, low-pressure local alarm, and low-pressure contact for remote alarm.

3.8 BOXES OF INTERCONNECTION WITH RIG AND DIVING EQUIPMENT

3.8.1 These boxes shall be “Ex de” type, fabricated in non-metallic material (FRP).

3.8.2 They shall have insulation switch and socket-outlet mechanically interlocked with the switch.

4 MANUFACTURER DOCUMENTATION

4.1 DOCUMENTS TO PROPOSAL

The following documents and information shall be annexed to the proposal for the transformer and all related equipment and accessories:

- a) Documents list;
- b) Dimensional drawings including frontal view, upper view, estimated weight and thermal dissipation;
- c) Technical catalogues with information about all components;
- d) Manuals at least with: maintenance tools list, maintenance accessories list, MTTR (mean time to repair), drawings and weights of each part, lifting drawings;
- e) Spare parts list for two years of operation, including item, part number, quantity, description, MTBF and price for each part;
- f) Technical assistance prices and representative address;
- g) Data-sheet completely filled in with Manufacturer data with identification of the person responsible for the filling. This Data Sheet shall be submitted to PETROBRAS approval;
- h) List of applicable standards;
- i) Painting method;
- j) Inspection and test schedule, including acceptance criteria for each test;
- k) Other documents required in project documentation, including certificates.

Note: At least, two copies in English language and two copies in Brazilian Portuguese language shall be provided for all reference manuals. Manuals shall comply with content requirements of NR-12 as defined in I-ET-3010.00-5140-700-P4X-001 - SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS.

4.2 DOCUMENTS FOR APPROVAL

The following documents and information shall be submitted for PETROBRAS approval, after Packager definition, for the transformer and all related equipment and accessories:

- a) Documents list;
- b) Dimensional drawings including frontal and upper views, details, location of lifting eyelets and area for incoming cables, fixing base details;
- c) Weight and volume of each unit for transportation and total weight;
- d) Manufacturer shall inform on Datasheet the panel heat normal and maximum dissipation. Arrangement of equipment and components shall be defined in order that the components generating heat shall not damage or reduce the service capacity of the adjacent elements.
- e) Package and transportation instructions;
- f) Identification plates;
- g) Detailed description of the equipment, including all accessories;
- h) Procedures during emergency conditions;
- i) Warranty certificate and declaration of availability of spare parts for 10 (ten) years;

4.3 DOCUMENTS AFTER APPROVAL

Assembly, Installation, Operation and Maintenance manuals shall be furnished, after documentation approval, containing at least the following information (including all requirement of NR-12):

- a) Data-sheet full-filled “as built”;
- b) List of standards followed for design, fabrication and tests;
- c) Detailed description of panel and accessories;
- d) List of risks for operators during operation and maintenance;
- e) Storage, preservation and unpacking instructions in Portuguese language;
- f) Detailed lifting and handling procedures in Portuguese language;
- g) Installation and assembly instructions in Portuguese language;
- h) Operation instructions in Portuguese language;
- i) Maintenance instructions, including list of necessary equipment, accessories and tools in Portuguese language;
- j) Spare parts lists;
- k) “As built” technical catalogue for all components;
- l) Complete test report, including type, routine and special tests;
- m) Components list, including at least, item, description, draw, unit, quantity and part number;
- n) Constructive details about baseplate fixation screws such as quantity, size, type and position in baseplate.
- o) All interlocking and parallel operation allowed and not allowed shall be informed in a specific document issued during detailed design.

Documents provided by Panel Manufacturer shall be delivered in an electronic format (original version and PDF version), the original documents shall be editable and the PDF documents shall be searchable.

5 DATASHEET FORMS

- 5.1 All existing data sheet templates are available at I-LI-3010.00-5140-700-P4X-001 - ELECTRICAL EQUIPMENT DATA SHEET MODELS.
- 5.2 The Datasheets are models and do not refer to any equipment. The manufacturer shall fill in a Datasheet for each equipment.
- 5.3 For equipment without Datasheet model, Manufacturer shall fill in Datasheets according to its own standard and submit to PETROBRAS approval.

6 ANNEX I – ABBREVIATIONS AND ACRONYMS

A&C	Automation and Control System
A.C.	Alternated Current
CT	Current Transformer
D.C.	Direct Current

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ESD	Emergency Shutdown
ET	Technical Specification
FPSO	Floating, Production, Storage and Offloading Unit
FRP	Fiber Reinforced Plastic
Icm	Rated Short-Circuit Making Capacity
Ics	Rated Service Short-Circuit Breaking Capacity
Icu	Rated Ultimate Short-Circuit Breaking Capacity
Icw	Rated Short Time Withstand Current
IE	Instrument Earth
IEC	International Electrotechnical Commission
IED	Intelligent electronic device
IEEE	Institute of Electrotechnical and Electronic Engineers
IR	Intelligent Relay
IS	Intrinsically Safety
MCC	Motor Control Centre
PE	Protective Earth
PF	Power Factor
RCD	Residual Current Protective Device
Ue	Rated Operational Voltage
Ui	Rated Insulation Voltage
Uimp	Rated Impulse Withstand Voltage
Un	Rated Voltage
UPS	Uninterruptible Power Supply
VT	Voltage Transformer