### TECHNICAL SPECIFICATION

No. I-ET-3010.00-5140-741-P4X-003

**CLIENT:**

**PROJECT:**

**UNIT:**

**TITLE:** POWER PANEL FOR THYRISTORIZED HEATER FOR OFFSHORE UNITS

**UNIT:**

**CLIENT:**

**PROJECT:**

**UNIT:**

**TITLE:**

**INDEX OF REVISIONS**

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**DATE** SET/17/18

**DESIGN** ESUP

**EXECUTION** CAVALIERE

**CHECK** MARCELO BP

**APPROVAL** MATTOSO

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THIS FORM IS PART OF PETROBRAS N-381 REV. K.
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1. OBJECTIVE

1.1.1. This specification establishes the necessary technical requirements for the design, construction, tests and supply of power panels for thyristorized electrical heaters, hereinafter called “Power Panel” in this document, for offshore units.

1.1.2. Additional requirements for Power Panel can be included in PETROBRAS documentation for heated equipment.

1.1.3. This specification does not define requirements for control panels for thyristorized electrical heaters, hereinafter called “Control Panel” in this document. For requirements about Control Panel, see PETROBRAS documentation for heated equipment and I-ET-3010.00-1200-800-P4X-002 - AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGED UNITS.

1.1.4. This specification does not define communication requirements between Control Panel and Automation and Control System (A&C). For these requirements, see I-ET-3010.00-1200-800-P4X-002 - AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGED UNITS.

1.1.5. This specification does not define TAGs, names and connections for each equipment. These definitions are available in PETROBRAS documentation for heated equipment.

2. APPLICABLE STANDARDS

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, NEMA, IEEE and others foreign recognized standards may be used. Their use shall be restricted to specific cases and shall be previously approved by PETROBRAS.

2.2. Applicable Standards

2.2.1. IEC – International Electrotechnical Commission

61439-1 Low-Voltage Switchgear and Controlgear Assemblies - Part 1: General Rules;
61439-2 Low-Voltage Switchgear and Controlgear Assemblies - Part 2: Power switchgear and controlgear assemblies;
60947-2 Low-Voltage Switchgear and Controlgear - Part 2: Circuit-Breakers;
60947-4-1 Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-Starters - Electromechanical Contactor and Motor-Starters;
60947-4-2 Low-Voltage Switchgear and Controlgear - Part 4-2: Contactors and Motor-Starters - AC Semiconductor Motor Controllers and Starters;
60417 Graphical Symbols for Use on Equipment - Database Snapshot;
60445 Basic and Safety Principles for Man-Machine Interface, Marking and Identification - Identification of Equipment Terminals, Conductors Terminations and Conductors;
60529 Degrees of Protection Provided by Enclosures (IP Code);
60092-302 Electrical Installations in Ships – Part 302: Equipment – Low-Voltage Switchgear and Controlgear Assemblies;
TR 61000-5-2 Electromagnetic Compatibility (EMC) - Part 5: Installation and Mitigation Guidelines - Section 2: Earthing and Cabling;
61892 Mobile and Fixed Offshore Units – Electrical Installations (All Parts);
60533 Electrical and Electronic Installations in Ships – Electromagnetic Compatibility (EMC) – Ships with a Metallic Hull.

2.2.2. ASTM - American Society for Testing and Material

2.2.3. Brazilian Labour and Employment Ministry
NR-10 Segurança em Instalações e Serviços em Eletricidade.
NR-12 Segurança no Trabalho em Máquinas e Equipamentos.

2.2.4. IMO - International Maritime Organization
IMO EA811E Code for the Construction and Equipment of Mobile Offshore Drilling Stationary Applications (MODU CODE)

2.2.5. IEEE – INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERING
Std. 519 IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems

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 AND EQUIPMENT FOR OFFSHORE UNITS
[3] I-ET-3010.00-5140-700-P4X-003 - ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS
[4] I-ET-3010.00-5140-700-P4X-005 - REQUIREMENTS FOR HUMAN ENGINEERING DESIGN FOR ELECTRICAL SYSTEMS OF OFFSHORE UNITS
[5] I-ET-3010.00-1200-956-P4X-002 - GENERAL PAINTING
[6] I-DE-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION ARCHITECTURE DIAGRAM
[7] I-ET-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION ARCHITECTURE
[8] I-LI-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION INTERFACE SIGNALS LIST
4. GENERAL CONDITIONS

4.1.1. Power Panel shall contain thyristors suitable for the requested power, the thyristors control system and all necessary components for the temperature control.

4.1.2. The Power Panel shall be designed, constructed, tested and supplied according to this specification.

4.1.3. For information about requirements for upstream panels, see I-ET-3010.00-5140-741-P4X-001 - LOW-VOLTAGE MOTOR CONTROL CENTER AND SWITCHGEAR FOR OFFSHORE UNITS.

4.1.4. Manufacturer is responsible for detailed electrical design and engineering within the Power Panel and shall perform all functions required to interface with the design of the electrical system, as well as guarantee the control and monitoring from Control Panel.

4.1.5. All material and equipment supplied to the Power Panel shall meet applicable standards, Classification Society rules, NR-10 and NR-12.

4.1.6. Manufacturer shall supply all electrical devices, including specific tools, which are necessary for the operation and maintenance of the Power Panel.

4.1.7. Unless otherwise stated in PETROBRAS documentation, Power Panel shall be installed inside a panels’ room in a safe area.

4.1.8. Power Panel shall be packed properly for the foreseen transportation, so that no damage occurs during transport, storage and lifting operations.

4.1.9. Instruments sizes, deflection, type (analogue or digital), position orientation and quantity shall be according to I-ET-3010.00-5140-700-P4X-005 - REQUIREMENTS FOR HUMAN ENGINEERING DESIGN FOR ELECTRICAL SYSTEMS OF OFFSHORE UNITS.

4.1.10. This specification considers three types of Power Panels. The following table relates the differences:

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Power Panel Type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type I</td>
</tr>
<tr>
<td></td>
<td>Type II</td>
</tr>
<tr>
<td></td>
<td>Type III</td>
</tr>
<tr>
<td>Fed from</td>
<td>CDC, or MCC</td>
</tr>
<tr>
<td></td>
<td>CDC, or MCC, or 1 dedicated power transformer</td>
</tr>
<tr>
<td></td>
<td>2 dedicated redundant power transformers</td>
</tr>
<tr>
<td>Quantity of incoming circuits</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Incoming feeder switching device</td>
<td>MCB, or none</td>
</tr>
<tr>
<td></td>
<td>MCB, or none</td>
</tr>
<tr>
<td></td>
<td>Air circuit-breaker</td>
</tr>
</tbody>
</table>
5. CONSTRUCTIVE CHARACTERISTICS

5.1. General Requirements

5.1.1. Power Panel shall be designed, manufactured and tested according to standards listed on item 2 and according to reference documents listed on item 3.

5.1.2. All materials used, shall be non-hygroscope, flame retarding and resistant to corrosion caused by maritime environment and contact with hydrocarbons.

5.1.3. The 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.

5.1.4. In order to avoid electrolytic corrosion contacts between different metallic materials shall be prevented. Galvanic isolation shall be implemented where the contact between different metallic materials is necessary.

5.1.5. Power Panel shall be suitable for operation with voltage and frequency variations according to I-ET-3010.00-5140-700-P4X-002 - SPECIFICATION FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.

5.1.6. Unless otherwise stated in PETROBRAS documentation, Power Panel shall have minimum rated short-time withstand current $I_{cw}$ for 1s (according to IEC 61439-1) of 25kA and minimum rated withstand peak current $I_{pk}$ (according to IEC 61439-1) of 52.5kA.

5.1.7. Unless otherwise stated in PETROBRAS documentation, reactor limiting devices or other solutions included upstream the Power Panel to keep it within the indicated short-circuit limits required in 5.1.6, are not in the scope of the Manufacturer.

5.1.8. Unless otherwise stated in PETROBRAS documentation, Power Panel internal components shall be proper for operation in system with neutral point isolated from ground (IT system).

5.1.9. Power Panel rated voltage (3 phases 60Hz ±5%) shall be according to PETROBRAS documentation for each equipment and shall be confirmed by heater Manufacturer during Detailed Design. Other voltages can be accepted, but this shall be submitted to PETROBRAS approval.
5.2. Environmental Conditions, Inclination Requirements and Vibration Requirements

5.2.1. The Power Panel shall be designed to operate on closed room with ambient temperature according to I-ET-3010.00-5140-700-P4X-002 - SPECIFICATION FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.

5.2.2. Power Panel and equipment shall be tropicalized, according to I-ET-3010.00-5140-700-P4X-002 - SPECIFICATION FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.

5.2.3. Power Panel shall be suitable to operate under vibration and acceleration requirements defined by I-ET-3010.00-5140-700-P4X-002 - SPECIFICATION FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.

5.2.4. When installed in mobile units and ships (FPSO and FSO), the Power Panel shall be suitable to operate normally under motion and inclination limits (static and dynamic) specified by IMO MODU CODE, IEC 61892 and Classification Society.

5.3. Classification of Assemblies

5.3.1. Power Panel shall be classified according to IEC 61439-1.

5.3.2. Power Panel shall be tested according to IEC 61439-1.

5.3.3. Power Panel shall be a metallic Multi-Cubicle Type stationary assembly, proper for indoor installation.

5.3.4. Power Panel shall have minimum mechanical protection degree IP-42, according to IEC 60529.

5.3.5. Power Panel shall be formed by fixed, removable or withdrawable parts. Note: Withdrawable parts shall comply with IEC 61439-2.

5.3.6. Protection against electrical shock by direct contact shall be ensured by means of protective barriers or enclosures.

5.3.7. Protection against electrical shock by indirect contact shall be ensured by means of protective circuits (earth bar), according to IEC 61439-1.

5.3.8. Adjacent functional units shall be separated from each other by means of barriers, providing protection degree at least IP21B, as stated in IEC 60529, and according to Forms 3b or 4b, stated in IEC 61439-2.

5.3.9. Controller and control modules shall be considered as separated functional units, complying with the form of segregation 4b.

5.4. Structure

5.4.1. The maximum height, including the plinth, shall not exceed 2400 mm.

5.4.2. Power Panel shall be comprised of vertical sections, formed by metallic compartments, aiming the flame retardation of a possible fire from one functional unit to another.

5.4.3. The sheets thickness shall be at least 1.98mm ( nº 14 USG).

5.4.4. The base of the Power Panel shall be drilled and the panel shall be fixed to one metallic base (skid) using screws through the holes.
5.4.5. The skid shall be dimensioned just like a bi-supported beam along the longitudinal direction, to support the whole panel weight. The skid shall have sides covered with plates to avoid access of humidity to the Power Panel’s lower portion. The skid shall be drilled and fixed to the floor. Manufacturer shall supply the skid and all necessary accessories to fix the skid to the floor.

5.4.6. To avoid a dangerous inclination of Power Panel when manœuvring it during construction and installation, the two points supported beam on the longitudinal direction fixing base shall also have transversal directional beams. These transversal beams shall not interfere with cable access and any other installation requirements. Other solution may be accepted if it is previously submitted and approved by PETROBRAS.

5.4.7. Power Panel shall be self-supported and provided with lifting eyelets.

5.4.8. Power Panel shall be designed and constructed so that all services, including operation, installation, maintenance, configuration, etc. can be done from the front side, so that Power Panel could be installed with the rear side close to walls.

5.4.9. Power Panel shall have isolated handrails along the front side.

5.4.10. Vertical sections shall have hinged doors on their front sides.

Note: Hinged doors shall have an open position lock device.

5.4.11. The equipment which allows either set or calibration shall be installed in such a way that it shall not be necessary to open the door to proceed the calibration.

5.5. Painting

5.5.1. All electrical materials, equipment and supports shall be painted. Painting process shall be proper for offshore installations, and shall comply with the requirements of I-ET-3010.00-1200-956-P4X-002 - GENERAL PAINTING.

5.5.2. The last coat colour shall be Light Green (MUNSELL notation 5 G 8/4). Inner components mounting plates, internal faces of doors and safety barriers shall be Safety Orange (MUNSELL notation 2.5 Y R 6/14).

5.6. Main Busbars

5.6.1. Busbars shall be three-phase, of electrolytic copper.

5.6.2. Busbars shall have capacity to continuously conduct the rated current I_{nA} (as defined in IEC 61439-1) of the Power Panel defined by Project documentation, with the temperature rise limited to the standard values.

5.6.3. Busbars and supporting systems shall be dimensioned to withstand the mechanical and thermal stresses resulting from short-circuit currents indicated in Data-Sheet or other document.

5.6.4. The busbars shall be identified with coloured strips as follows:
   a) Phases (R - S - T): red, white and black, respectively;
   b) Ground: bicolour combination green-yellow according to IEC 60445.

5.6.5. The main busbars and the derivations to the circuit-breakers shall be fully insulated.
5.7. Grounding Bars

5.7.1. A safety grounding bar (PE) shall be installed in the whole Power Panel length, through the internal lower or upper part.

5.7.2. All metallic parts not intended for current conduction (such as movable parts, panel structure, doors, secondary of instrument transformers, cables armours, cables shields and others) shall be interconnected to the safety grounding bar (PE), using bonding jumpers with cross section according to criteria defined in I-ET-3010.00-5140-741-P4X-001 - LOW-VOLTAGE MOTOR CONTROL CENTER AND SWITCHGEAR FOR OFFSHORE UNITS.

5.7.3. A label note shall be included in panel doors indicating the grounding system used for power and control circuits.

5.7.4. Bolt Grounded Systems

For these systems, the cross section of the safety grounding bar (PE) shall be according to Table 5 of IEC 61439-1. Each end shall be provided with non-welded type connectors, suitable for bare copper cables, stranded and with cross-sectional area according to I-ET-3010.00-5140-700-P4X-001 - SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS.

5.7.5. Ungrounded Systems and High Resistance Grounded Systems (IT systems)

For these systems, the minimum cross section of the safety grounding bar (PE) shall be according to I-ET-3010.00-5140-700-P4X-001 - SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS. Each end shall be provided with non-welded type connectors, suitable for bare copper cables.

5.7.6. Electronic Reference Bar (IE)

Power Panel shall have an electronic reference bar (IE) to grounding of instruments and intelligent devices signals circuits, according to requirements of the IEC TR 61000-5-2 and I-ET-3010.00-5140-700-P4X-001 - SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS.

5.8. Wiring and Conductors

5.8.1. Cables shall comply with requirements of I-ET-3010.00-5140-700-P4X-002 - SPECIFICATION FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.

5.8.2. All internal wiring shall be duly identified through plastic rings, at the ends, with the codification shown on the wiring drawings.

5.8.3. The insulation colour of cables used for D.C. circuits shall be red for wiring with positive voltage and black for wiring with negative voltage.

5.8.4. Power Panel shall be delivered with all connections between installed components done.

5.8.5. The wiring between sections separated for transport shall finish on terminal blocks, so that the final interconnection could be easily completed with jumpers, by the time the sections are assembled.

5.8.6. The channels shall be made of material not producing toxic fumes in case of fire on the panel.
5.8.7. Each set of control terminal blocks shall have 10% of spares for future application.

5.8.8. Power Panel shall be supplied with cable glands and terminal connectors for power and grounding cables.

5.8.9. All incoming and outgoing cables shall enter through the bottom side. For this purpose the manufacturer shall provide removable plates with a minimum thickness of 2.8 mm, made of copper free aluminium or non-magnetic material.

5.8.10. Metallic cable-glands made with material compatible with the removable plates’ material shall be supplied with the Power Panel.

5.8.11. MCT system is also acceptable for wiring and conductor entrance, but it shall be designed and installed in a way that no force is transferred to internal terminals or isolators.

5.9. Heating Resistors

5.9.1. Power Panel shall be provided with an internal heating circuit, fed from external source 220VAC, 2 ph, 60 Hz isolated from ground (IT). Each vertical section shall be provided with heating resistors automatically controlled by thermostat, with maximum range 60°C. Power Panel shall have externally accessible terminals to energize the heating circuits during the storage period. These terminals shall have a label with:

TERMINAIS PARA ENERGIZAÇÃO DAS RESISTÊNCIAS DE AQUECIMENTO

5.9.2. The heating resistors shall be protected against accidental contacts. The wiring next to them (about 30 cm) shall have special insulation in order to avoid damage due to high temperature.

5.9.3. The auxiliary circuit branches shall be suitably protected with miniature circuit-breakers.

5.10. Functional Units Main Components

5.10.1. For all incoming and outgoing connections it shall be verified the ONE-LINE DIAGRAM for the Project.

5.10.2. Power Panel functional units shall have, at least, the components listed below.

5.10.3. Incoming Feeders:

- Moulded-case circuit-breakers (MCB);
  - Required for Power Panels Types I and II;
  - May be excluded, if the Power Panel is fed from a CDC or MCC installed in the same room and the outgoing circuit of this upstream panel has a protective circuit-breaker;
  - For exceptional cases, if PETROBRAS approves calculated equivalent thermal short-circuit current at Power Panel above 25 kA, the MCB shall be replaced by air circuit-breaker (ACB) with incorporated protection relays with communication capabilities;
For reference, see ANNEX I - POWER PANEL TYPE I - SIMPLIFIED SCHEMATIC DIAGRAM and ANNEX II - POWER PANEL TYPE II - SIMPLIFIED SCHEMATIC DIAGRAM.

- Air circuit-breakers (ACB) with incorporated protection relays with communication capability for the required remote control and monitoring;
- Required for Power Panel Type III;
- For reference, see ANNEX III - POWER PANEL TYPE III - SIMPLIFIED SCHEMATIC DIAGRAM.

- Current transformers (CT);
- Ammeter with selector switch;
- Green/Red operation status leds.

5.10.4. Main busbar:
- Current limiting fuses (for VTs);
- Dry-type voltage transformers (VT);
- Voltmeter with selector switch.

5.10.5. Outgoing circuits:
- Switches or circuit-breakers in series with high-speed fuses;
- Thyristors sets;
- Contactors;
- Green/Red operation status leds;
- Off push-button without return (emergency stop) (it shall not be possible to turn on the outgoing circuits from Power Panel);
- Ground fault sensors.

5.10.6. Each resistor bank shall be fed individually by one outgoing circuit as described in item 5.10.5.

5.10.7. Alternative proposals shall be submitted to PETROBRAS approval.

5.10.8. The number of resistors banks will be defined in PETROBRAS documentation for heated equipment.

5.10.9. All functional units shall have labels indicating:
- protection adjusted values and the reference documents for details of adjustment configuration;
- maximum continuous operating current;
- upstream feeding panel, or transformer;
- the UPS autonomy time, if control system is fed by UPS system;
- information if this unit will be shut down or not in case a fault to earth, in case of isolated system (IT).

5.11. Thyristors Control and Cooling Systems

5.11.1. Thyristors control system shall receive an external set point signal (see item 5.12), in order to modulate the semiconductors conduction time. The thyristors and their control shall allow continuous control from 0% up to 100% of rated capacity, following the set point value.

5.11.2. Thyristors triggering shall be controlled in such way to synchronize this triggering to the instant the sine wave has a zero value, avoiding undesirable transients in the electrical system.
NOTE: Harmonic content shall be kept within IEEE Std. 519 and on IEC 61892-1 limits as required in I-ET-3010.00-5140-700-P4X-002 - SPECIFICATION FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.

5.11.3. The control system shall be constructed in a modular way, in order to make easy the installation and maintenance.

5.11.4. Power Panel shall be fitted with a double cooling system with automatic changeover and alarm, so that in case of failure of a set, the remaining units shall be enough to permit the panel operation without derate.

5.12. Interface with Control Panel

5.12.1. All external control (ON / OFF) and set point signals (that may be 4–20 mA) shall be received from Control Panel, besides any other interface defined by heated equipment Manufacturer and from A&C, according to interface requirements defined in I-ET-3010.00-1200-800-P4X-002 - AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGED UNITS.

5.12.2. Power Panel shall be controlled by Control Panel of heated equipment, or from A&C, according to PETROBRAS documentation for heated equipment. The communication standard (network or hardwired) between Power Panel and Control Panel shall be according to PETROBRAS documentation for heated equipment.

5.12.3. Power Panel shall have local visual alarms for internal malfunction and shutdown. Resume alarm signals shall be sent to Control Panel according to PETROBRAS documentation for heated equipment and to A&C according to interface requirements defined in I-ET-3010.00-1200-800-P4X-002 - AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGED UNITS. All signals from the heated equipment to A&C shall be sent by Control Panel.

5.12.4. Emergency shutdown signals from A&C shall be sent to Control Panel that shall be responsible to turn off the Power Panel.

5.12.5. For communication requirements between Control Panel and A&C, see I-ET-3010.00-1200-800-P4X-002 - AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGED UNITS and I-LI-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION INTERFACE SIGNALS LIST.

5.13. Interface with Electrical System Automation

5.13.1. Requirements applicable for Power Panels Type II and III:

5.13.1.1. The ACB of incoming circuits shall have communication capability to be connected to Electrical System Ethernet Network, according to I-ET-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION ARCHITECTURE.

5.13.1.2. The MCB of incoming circuits shall have voltage-free contacts for remote monitoring of status (ON / OFF).

5.13.1.3. The outgoing circuits shall have voltage-free contacts for remote signalling of status (ON / OFF).
5.13.1.4. Trip in outgoing feeders due to ground fault (see item 5.14.3) shall generate a alarm, for remote signalling, using voltage-free contacts.

5.13.1.5. For electrical system automation interfaces, criteria and requirements see I-ET-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION ARCHITECTURE and I-LI-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION INTERFACE SIGNALS LIST.

5.14. Protection

5.14.1. Requirements applicable for Power Panels Type III:

5.14.1.1. The minimum protection functions for Power Panel incoming feeders shall be according to Table 2.

5.14.1.2. The MMRs (Microprocessor-based Multifunction Relay) shall have the function of circuit-breakers coils monitoring activated and sending alarm signal to Electrical System Workstations.

Table 2 - Minimum Protection Functions for Incoming Feeders (Power Panel Type III)

<table>
<thead>
<tr>
<th>Nº</th>
<th>Description</th>
<th>Incoming Feeder</th>
</tr>
</thead>
<tbody>
<tr>
<td>27</td>
<td>Undervoltage Alarm/Trip</td>
<td>ACB + BETU (+MMR)</td>
</tr>
<tr>
<td>50</td>
<td>Instantaneous Overcurrent Trip</td>
<td>Trip (3)</td>
</tr>
<tr>
<td>51</td>
<td>Temporized Overcurrent Trip</td>
<td></td>
</tr>
<tr>
<td>86</td>
<td>Lockout Trip</td>
<td></td>
</tr>
</tbody>
</table>

Notes:  
(1) ACB = Air Circuit-Breaker; MMR = Microprocessor-based Multifunction Relay; BETU = Built-In Electronic Trip Unit.  
(2) When BETU does not provide all protective functions or the communication capability required, an MMR shall be added. In any case the short-circuit protection function shall be carried out by BETU.  
(3) Instantaneous overcurrent shall be activated only when selector switch is in “Manutenção” position. See item 5.14.1.3 and 5.14.1.4.

5.14.1.3. The Power Panel shall have one key activated selector switch in its front side, with the positions "Operação / Manutenção" (Operation / Maintenance). When this selector switch is in "Manutenção" position, the instantaneous overcurrent protection (function 50) of the relays of incoming functional unit shall be activated or its set points changed, overriding the protection coordination and minimizing damage in case of internal fault.

5.14.1.4. There shall be a local signalling lamp, turned on with the switch in "Manutenção" position, indicating "Coordenação Desativada".

5.14.1.5. A network remote signalling of the position of the switch shall be sent to Electrical System Workstation, through Electrical System Controllers Panel, from the incoming circuit-breaker MMRs.

5.14.1.6. There shall be a label beside the switch with following warning text:
5.14.2. The protection for outgoing circuits shall be executed by high-speed fuses and by the power semiconductors control system.

5.14.3. Ground Fault Protection

- Ground fault protection shall be provided by an insulation monitoring device (IMD) for Power Panels Type II fed from transformers and for Power Panels Type III. Protective devices based in residual current shall not be accepted.

- The IMD shall indicate the measured insulation resistance value between phases and ground. The trip value shall be adjustable and the device shall be capable to detect simultaneous faults, even in three different circuits.

- The IMD shall be capable to measure the insulation level and to detect the ground fault in systems with cable total length (three phases) of one hundred kilometers (100 km), without any failure or nuisance actuation.

- Outgoing feeders shall have individual ground fault detector (EFI) devices that shall instantaneously trip the respective contactor and stop triggering the respective thyristors, if the resistances are installed in, or if their cables cross hazardous area Zone 1. This trip actuation shall generate an alarm signal, to be sent to Electrical System Workstation, through Electrical System Controllers Panel.

- For Power Panels Type II, when the IMD is installed in the upstream panel, the EFI shall be connected to this IMD.

- Power Panels Type I shall be monitored for ground fault by the IMD and EFI at outgoing circuit in the upstream panel.

5.15. Incoming Feeders Interlocks

5.15.1. Requirements applicable for Power Panels Type III:

5.15.1.1. It shall not be allowed simultaneous closing of both incoming circuit-breakers and it shall be installed an internal mechanical interlock to avoid this operation. Load transference from one incoming circuit-breaker to the other shall be carried out with momentary blackout.

5.15.1.2. It shall be possible to close each incoming circuit-breaker only if the respective upstream circuit-breaker (installed in primary side of the power transformer) is closed.
5.15.1.3. The incoming circuit-breakers shall open when the respective upstream circuit-breaker (installed in primary side of the power transformer) opens.

5.16. Electromagnetic Compatibility (EMC)

5.16.1. The panels and all their components shall comply with the emission and immunity requirements for electromagnetic compatibility stated in IEC 60533, presenting performance criterion A.

5.17. Control Voltages

5.17.1. The internal control voltages for the Power Panel shall be supplied from main busbar through internal voltage transformers (VTs) with secondary voltage 120Vac.

5.17.2. The primary windings of the VTs shall be protected by fuses. The secondary winding and each control circuit branch shall be suitably protected with miniature circuit-breakers.

5.17.3. The secondary windings of the VTs shall have one terminal bolted grounded.

5.18. Nameplates and Markings

5.18.1. Power Panel’s characteristics nameplates shall be made with AISI-316 stainless steel and shall include all items listed in IEC 61439-1.

5.18.2. Power Panel shall be outfitted with plate of supplemental identification containing, at least, the following data:
   a) PETRÓLEO BRASILEIRO S.A. - PETROBRAS;
   b) name of the department of the PETROBRAS;
   c) name of the enterprise (platform);
   d) TAG number of the panel;
   e) number of the RM;
   f) number of the Order of Purchase of Material (PCM);
   g) number of the Authorization of Material Supply (AFM);
   h) in alternative to paragraph f) and g), the number of the contract, in the cases of acquisition built-in in contract of the type lump sum ("Turn Key", "Lump Sum", etc.).

5.18.3. Power Panel’s nameplate shall include its feeders/transformers feeder TAG.

5.18.4. Power Panel shall have its compartments signalled with literal and graphical labels of instructions, cares, warnings and alert of dangers according to the requirements for identification plates listed in ASTM F1166 and IEC 60417.

5.18.5. Black acrylic plates with white letters shall identify all outgoing and vertical sections.

5.18.6. For outgoing identification the following information shall be included:
   - at the first line, the load tag number;
   - at the second line, the load name in Portuguese;
   - at the third line, the rated current of the load and circuit number.
5.18.7. Internally to Power Panel, all equipment and components shall be identified with black acrylic plates, with white letters, containing the codification compatible with design documents (list of materials, diagram, etc.).

5.18.8. The circuit-breakers labels shall include rated current and trip current set.

5.18.9. The Power Panels shall have warning labels following the model below, with the values of rated voltage (in field “Nível de Tensão”), arc fault incident energy (in field “Energia Incidente”) and arc-flash hazard distance (in field “Distância Segura de Aproximação para Atividades Sujeitas a Arco Elétrico”). The values to be filled in will be informed to Panel Manufacturer during Detailed Design.

![Warning Label](Image)

**Notes:**

1. Power Panels shall have warning labels indicating the protective clothing risk category that shall be used for technical intervention.
2. Power Panels shall have warning labels indicating that any technical intervention in the panels shall be executed only for authorized people.

5.18.10. There shall be provided warning plates at all incomings of Power Panel listing the circuit-breakers that shall be extracted to permit the maintenance of the respective Power Panel heater.

5.18.11. Other warning labels may be required by NR-10 and NR-12, those shall be verified in I-ET-3010.00-5400-947-P4X-002 - SAFETY SIGNALLING.

5.18.12. No adhesives shall be used to fix plates or labels.

**5.19. Spare Parts**

5.19.1. Manufacturer shall provide a spare, not installed set of thyristors with local control board (set related to one outgoing feeder). Any control board common to all thyristors shall also be included as spare.
6. MANUFACTURER DOCUMENTATION

6.1.1. The following documents shall be provided by Panel Manufacturer, at proposal:
   a) Documents list;
   b) Dimensional drawings including frontal and upper views, estimated weight and thermal dissipation at full and half load;
   c) Full thyristors and heatsinks data, including i²t;
   d) Technical catalogues with information about all components;
   e) Spare parts list for two years of operation, including item, part number, quantity, description, MTBF (Mean Time Between Failure) and prices for each part;
   f) Technical assistance prices and representative address;
   g) Panel Data-sheet fulfilled with Manufacturer data and with identification of the person responsible for the filling. This Data-sheet shall be submitted to PETROBRAS approval;
   h) List of applicable standards;
   i) Inspection and test schedule, including acceptance criteria for each test;
   j) Type tests certificates;
   k) Time-current curves, current peak limiting curves and i²t minimum and total values of the limiting fuses;
   l) One-line electrical drawings;
   m) Other documents required in project documentation.

6.1.2. The following documents shall be provided by Panel Manufacturer, for approval:
   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 for each unit for transportation;
   d) Total weight and thermal dissipation at half load and full load;
   e) Electrical drawings, including one-line, three-lines and functional diagrams;
   f) Connection diagrams, including all terminal blocks;
   g) Saturation curves of current transformers;
   h) Components and material list per functional unit;
   i) Time-current curves, current peak limiting curves and i²t minimum and total values of the limiting fuses;
   j) Package and transportation instructions;
   k) Warranty certificate and declaration of availability of spare parts for 10 (ten) years;
   l) Voltage and current harmonic contents spectrum up to 50th component;
   m) Network architecture internal to the Panel (if applicable);
n) Network configuration, parameterization, screens, and monitoring documentation for all equipment that will be connected by network (if applicable);

o) Expected MTTR (Mean Time to Repair) for each functional unit and for each component;

p) Type tests certifications.

6.1.3. The following documents shall be provided by Panel Manufacturer, with the Panel:

a) Data-sheet fulfilled "as built";

b) Storage, lifting and unpacking instructions;

c) Installation and assembly instructions;

d) Operation instructions;

e) Maintenance instructions, including list of necessary equipment, accessories and tools;

f) Spare parts lists;

g) "As built" technical catalogue for all components;

h) Complete tests report, including type, routine and special tests;

i) Voltage and current harmonic contents spectrum measurement report, up to 50th component;

j) Only for parallel circuits with incoming air circuit-breaker incoming circuits case: a complete version of configuration, parameterisation and monitoring softwares related to communication capability of incoming air circuit-breaker and any other equipment that could be configured or monitored by software. These softwares shall provide facilities for full diagnosis of respective device.

k) Complete manuals for installation and configuration of all software.

Note: All reference manuals, shall be provide, in at least, two copies in English language and two copies in Brazilian Portuguese language and comply with NR-12 requirements.

7. TRAINING

7.1.1. Manufacturer shall provide training for at least 10 (ten) PETROBRAS personnel, about Panels system and components.

7.1.2. Training shall be provided in Brazil, during commissioning period, in Portuguese language.

7.1.3. Training plan shall include at least control diagram analysis, storage, transportation, installation, operation, corrective maintenance, preventive maintenance, disassembly, assembly, extraction and insertion of drawers, use of tools and accessories, interface with automation, use of softwares, configuration, parameterization and adjustment, equipment and devices.
8. TESTS

8.1.1. Manufacturer shall be responsible for contact the Classification Society, in order to define the procedures to be followed, related to the submission of documents, and to carry out the necessary inspections and tests to certificate the Power Panel.

8.1.2. Manufacturer shall be responsible for obtaining all necessary certifications related to the Power Panel.

8.1.3. All related costs for tests, inspections and certificates shall be included in prices.

8.1.4. Type tests shall follow the requirements of IEC 61439-1, IEC 60092-302 and IEC 61892-3. They are summarised in Table 3, where they are identified as “T”. Certified test reports for type tests performed for identical Power Panels and approved and witnessed by Classification Society are accepted.

8.1.5. Routine tests shall follow the requirements of IEC 61439-1, IEC 60092-302 and IEC 61892-3. They are summarised in Table 3, where they are identified as “R”.

8.1.6. Manufacturer shall be present at site, after the panel assembly and transport, to verify, together with PETROBRAS, if the Power Panel is at the same conditions as it was when factory delivered it or to verify if the Power Panel is ready to start operation.

8.1.7. The manufacturer shall perform for panels all tests indicated below:

Table 3 - Minimum Tests List

<table>
<thead>
<tr>
<th>Test</th>
<th>T</th>
<th>R</th>
<th>Method and Acceptance Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Examination of technical documentation (1)</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Verification of certificate of accuracy for measurement instruments to be used in tests (1)</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Dimensional verification</td>
<td>x</td>
<td></td>
<td>Panel Data-sheet</td>
</tr>
<tr>
<td>Visual inspection, verification of data on nameplates and labels</td>
<td>x</td>
<td></td>
<td>IEC 61439-1 and this ET</td>
</tr>
<tr>
<td>Painting (colour, thickness and adhesion)</td>
<td>x</td>
<td></td>
<td>This ET</td>
</tr>
<tr>
<td>Verification of temperature rise limits</td>
<td>x</td>
<td></td>
<td>IEC 61892-3</td>
</tr>
<tr>
<td>Verification of dielectric properties</td>
<td>x</td>
<td></td>
<td>IEC 61439-1</td>
</tr>
<tr>
<td>Verification of effectiveness of the protective circuit</td>
<td>x</td>
<td></td>
<td>IEC 61439-1</td>
</tr>
<tr>
<td>Verification of clearance and creepage distances</td>
<td>x</td>
<td></td>
<td>IEC 61439-1</td>
</tr>
<tr>
<td>Verification of mechanical operation</td>
<td>x</td>
<td></td>
<td>IEC 61439-1</td>
</tr>
<tr>
<td>Verification of degree of protection of enclosure (IP)</td>
<td>x</td>
<td></td>
<td>IEC 61439-1 and IEC 60529</td>
</tr>
<tr>
<td>Inspection of assembly, inspection of wiring and electrical operation test</td>
<td>x</td>
<td></td>
<td>IEC 61439-1</td>
</tr>
<tr>
<td>Dielectric test or verification of insulation resistance</td>
<td>x</td>
<td></td>
<td>IEC 61439-1</td>
</tr>
<tr>
<td>Checking of protective measures and of electrical continuity of the protective circuits</td>
<td>x</td>
<td></td>
<td>IEC 61439-1</td>
</tr>
<tr>
<td>EMC – Conducted emission test (2)</td>
<td>x</td>
<td></td>
<td>IEC 60533</td>
</tr>
<tr>
<td>EMC – Radiated emission test (2)</td>
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<td></td>
<td>IEC 60533</td>
</tr>
<tr>
<td>EMC – Conducted low frequency interference (2)</td>
<td>x</td>
<td></td>
<td>IEC 60533</td>
</tr>
<tr>
<td>EMC – Power supply variation (2)</td>
<td>x</td>
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<td>IEC 60533</td>
</tr>
<tr>
<td>EMC – Power supply failure (2)</td>
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<td></td>
<td>IEC 60533</td>
</tr>
<tr>
<td>EMC – Surge voltage test (2)</td>
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<td></td>
<td>IEC 60533</td>
</tr>
<tr>
<td>Test</td>
<td>T</td>
<td>R</td>
<td>Method and Acceptance Criteria</td>
</tr>
<tr>
<td>---------------------------------------------------------------------</td>
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<td>-------------------------------</td>
</tr>
<tr>
<td>EMC – Electrical fast transient test (2)</td>
<td>x</td>
<td></td>
<td>IEC 60533</td>
</tr>
<tr>
<td>EMC – Electromagnetic field test (2)</td>
<td>x</td>
<td></td>
<td>IEC 60533</td>
</tr>
<tr>
<td>EMC – Electrostatic discharges (2)</td>
<td>x</td>
<td></td>
<td>IEC 60533</td>
</tr>
<tr>
<td>EMC – Conducted radio frequency interference test (2)</td>
<td>x</td>
<td></td>
<td>IEC 60533</td>
</tr>
<tr>
<td>Complete functional tests (including interlocks and external interface and communication)</td>
<td>x</td>
<td></td>
<td>This ET</td>
</tr>
<tr>
<td>Verification of measuring instruments</td>
<td>x</td>
<td></td>
<td>Project documents</td>
</tr>
<tr>
<td>Verification of signalling devices</td>
<td>x</td>
<td></td>
<td>This ET</td>
</tr>
<tr>
<td>Verification of heating resistors operation</td>
<td>x</td>
<td></td>
<td>This ET</td>
</tr>
<tr>
<td>Temperature rise for circuit-breakers</td>
<td>x</td>
<td></td>
<td>IEC 60947-2</td>
</tr>
<tr>
<td>Tripping limits and characteristics for circuit-breakers</td>
<td>x</td>
<td></td>
<td>IEC 60947-2</td>
</tr>
<tr>
<td>Dielectric for circuit-breakers, where applicable</td>
<td>x</td>
<td></td>
<td>IEC 60947-2</td>
</tr>
<tr>
<td>Operation performance capability for circuit-breakers, where applicable</td>
<td>x</td>
<td></td>
<td>IEC 60947-2</td>
</tr>
<tr>
<td>Overload performance for circuit-breakers, where applicable</td>
<td>x</td>
<td></td>
<td>IEC 60947-2</td>
</tr>
<tr>
<td>Short-circuit breaking capability for circuit-breakers, where applicable</td>
<td>x</td>
<td></td>
<td>IEC 60947-2</td>
</tr>
<tr>
<td>Short-time withstand current for circuit-breakers, where applicable</td>
<td>x</td>
<td></td>
<td>IEC 60947-2</td>
</tr>
<tr>
<td>Voltage and current harmonic measurement up to 50th component</td>
<td>x</td>
<td></td>
<td>This ET</td>
</tr>
<tr>
<td>Thyristors efficiency measurement</td>
<td>x</td>
<td></td>
<td>Manufacturer standard (5)</td>
</tr>
</tbody>
</table>

**Notes:**
1. For all witnessed tests;
2. EMC tests shall be carried out when required in IEC 60533 for the equipment installed in the Power Panel.
3. Thyristors measured efficiency shall be equal to or higher than efficiency informed in documents for proposal.

## 9. ACRONYMS

| AC     | ACB | A&C | ANSI | ASTM | BETU | CDC | CT | DC | EFI | EMC | ESD | IEC | IEEE | IT | IMD | MCC | MCT | MMR | MCB | MDR | MCTB | MTBF | MTTR | NEMA |
|--------|-----|-----|------|------|------|-----|----|----|-----|-----|-----|-----|-----|------|----|-----|-----|-----|-----|-----|-----|-----|------|------|------|
| AC     | ACB | A&C | ANSI | ASTM | BETU | CDC | CT | DC | EFI | EMC | ESD | IEC | IEEE | IT | IMD | MCC | MCT | MMR | MCB | MDR | MCTB | MTBF | MTTR | NEMA |
| AC     | ACB | A&C | ANSI | ASTM | BETU | CDC | CT | DC | EFI | EMC | ESD | IEC | IEEE | IT | IMD | MCC | MCT | MMR | MCB | MDR | MCTB | MTBF | MTTR | NEMA |
| AC     | ACB | A&C | ANSI | ASTM | BETU | CDC | CT | DC | EFI | EMC | ESD | IEC | IEEE | IT | IMD | MCC | MCT | MMR | MCB | MDR | MCTB | MTBF | MTTR | NEMA |
| AC     | ACB | A&C | ANSI | ASTM | BETU | CDC | CT | DC | EFI | EMC | ESD | IEC | IEEE | IT | IMD | MCC | MCT | MMR | MCB | MDR | MCTB | MTBF | MTTR | NEMA |
| AC     | ACB | A&C | ANSI | ASTM | BETU | CDC | CT | DC | EFI | EMC | ESD | IEC | IEEE | IT | IMD | MCC | MCT | MMR | MCB | MDR | MCTB | MTBF | MTTR | NEMA |

| AC     | ACB | A&C | ANSI | ASTM | BETU | CDC | CT | DC | EFI | EMC | ESD | IEC | IEEE | IT | IMD | MCC | MCT | MMR | MCB | MDR | MCTB | MTBF | MTTR | NEMA |

**ACRONYMS:**
- AC: Alternate current
- ACB: Air circuit-breaker
- A&C: Automation and Control System
- ANSI: American National Standards Institute, Inc
- ASTM: American Society for Testing and Materials
- BETU: Built-in electronic trip unit
- CDC: Switchgear (Centro de Distribuição de Cargas)
- CT: Current transformer
- DC: Direct current
- EFI: Ground fault detector (Earth Fault Indicator)
- EMC: Electromagnetic Compatibility
- ESD: Emergency shut-down
- IEC: International Electrotechnical Commission
- IEEE: Institute of Electrical and Electronics Engineers, Inc
- IT: Isolated system, or impedance earthed system
- IMD: Insulation Monitoring Device
- MCC: Motor Control Center
- MCT: Multi-cable transit
- MMR: Microprocessed-based multifunction relay
- MODU: Mobile Offshore Drilling Units
- MTBF: Mean time between failure
- MTTR: Mean time to repair
- NEMA: National Electrical Manufacturers Association
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FPSO</td>
<td>Floating Production Storage and Operation Unit</td>
<td>PE</td>
<td>Protective earth (bar)</td>
</tr>
<tr>
<td>FSO</td>
<td>Floating Storage and Operation Unit</td>
<td>VT</td>
<td>Voltage transformer</td>
</tr>
<tr>
<td>IE</td>
<td>Instrument earth (bar)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
10. ANNEX I - POWER PANEL TYPE I - SIMPLIFIED SCHEMATIC DIAGRAM

Notes:

1- Rated voltage, indicated as "X", shall be according to PETROBRAS documentation for the heated equipment and to be confirmed by Detailed Design;

2- External control could be Control Panel or CSS, depending on each equipment. Communication according to PETROBRAS documentation for the heated equipment and I-ET-3010.00-1200-800-P4X-002 - AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGED UNITS;

3- Incoming circuit-breaker may be excluded, depending on requirements of item 5.10.3;

4- ONE-LINE DIAGRAM for the Project shall be verified for Power Panel incoming connections;

5- Push-button to open and block upstream circuit-breaker;

6- Quantity of outgoing circuits according to PETROBRAS documentation for the heated equipment;

7- Signal from temperature sensors installed in resistive elements, to avoid overtemperature at these elements. Installed (including quantity) when required in PETROBRAS documentation for the heated equipment and when required by Manufacturer. Mandatory installation for flammable gas heaters;

8- Signal from temperature sensors installed in heated equipment, to control the temperature. Installed (including quantity) when required in PETROBRAS documentation for the heated equipment and when required by Manufacturer. Mandatory installation for flammable gas heaters;

9- Other signals, devices and connections may be included according to PETROBRAS documentation for the heated equipment and when required by Manufacturer;

10- Ground fault is monitored and controlled by upstream panel, tripping the upstream outgoing circuit.
11. ANNEX II - POWER PANEL TYPE II - SIMPLIFIED SCHEMATIC DIAGRAM

Notes:

1. Rated voltage, indicated as “X”, shall be according to PETROBRAS documentation for the heated equipment and to be confirmed by Detailed Design;

2. External control could be Control Panel, or CSS, depending on each equipment. Communication according to PETROBRAS documentation for the heated equipment and I-ET-3010.00-1200-800-P4X-002 - AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGED UNITS;

3. Incoming circuit-breaker may be excluded, depending on requirements of item 5.10.3;

4. ONE-LINE DIAGRAM for the Project shall be verified for Power Panel incoming connections;

5. Push-button to open and block upstream circuit-breaker;

6. Quantity of outgoing circuits according to PETROBRAS documentation for the heated equipment;

7. Signal from temperature sensors installed in resistive elements, to avoid overtemperature at these elements. Installed (including quantity) when required in PETROBRAS documentation for the heated equipment and when required by Manufacturer. Mandatory installation for flammable gas heaters;

8. Signal from temperature sensors installed in heated equipment, to control the temperature. Installed (including quantity) when required in PETROBRAS documentation for the heated equipment and when required by Manufacturer. Mandatory installation for flammable gas heaters;

9. Other signals, devices and connections may be included according to PETROBRAS documentation for the heated equipment and when required by Manufacturer;

10. Alarm signal (ground fault) to remote monitoring from Electrical System Workstations. IMD required only if the upstream panel is galvanically isolated. EFI always required.

11. Status signals (ON / OFF) to remote monitoring from Electrical System Workstations.
12. ANNEX III - POWER PANEL TYPE III - SIMPLIFIED SCHEMATIC DIAGRAM

Notes:
1- Rated voltage, indicated as "X", shall be according to PETROBRAS documentation for the heated equipment and to be confirmed by Detailed Design;
2- External control could be Control Panel, or CSS, depending on each equipment. Communication according to PETROBRAS documentation for the heated equipment and I-ET-3010.00-1200-800-P4X-002 - AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGED UNITS;
3- Communication capability for incoming circuit-breaker according to I-ET-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION ARCHITECTURE;
4- ONE-LINE DIAGRAM for the Project shall be verified for Power Panel incoming connections;
5- Interlock to avoid simultaneous closing of both circuit-breakers;
6- Quantity of outgoing circuits according to PETROBRAS documentation for the heated equipment;
7- Signal from temperature sensors installed in resistive elements, to avoid overtemperature at these elements. Installed (including quantity) when required in PETROBRAS documentation for the heated equipment and when required by Manufacturer. Mandatory installation for flammable gas heaters;
8- Signal from temperature sensors installed in heated equipment, to control the temperature. Installed (including quantity) when required in PETROBRAS documentation for the heated equipment and when required by Manufacturer. Mandatory installation for flammable gas heaters;
9- Other signals, devices and connections may be included according to PETROBRAS documentation for the heated equipment and when required by Manufacturer;
10- Alarm signal (ground fault) to remote monitoring from Electrical System Workstations;
11- Status signals (ON / OFF) to remote monitoring from Electrical System Workstations;
12- Incoming circuit-breaker of Power Panel shall open in case of actuation of protection function 49 (overload) in upstream transformer;
13- Interlock with circuit-breaker in transformer primary. Secondary circuit-breaker shall open when primary circuit-breaker opens;