	TECHNICAL SPECIFICATION	No. I-ET-3010.00-5140-741-P4X-003
	CLIENT:	SHEET: 1 of 30
	PROJECT:	--
	UNIT:	
	TITLE: POWER PANEL FOR THYRISTORIZED HEATER FOR OFFSHORE UNITS	INTERNAL
		ESUP

MICROSOFT WORD / V. 365 / I-ET-3010.00-5140-741-P4X-003_J.DOCX

INDEX OF REVISIONS

REV.	DESCRIPTION AND/OR REVISED SHEETS
0	ORIGINAL ISSUE
A	REVIEWED, CORRECTED ITEMS AND REFERENCES, INCLUDED AND EXCLUDED ITEMS INDICATED IN TEXT.
B	REVIEWED WHERE INDICATED
C	ADDED ITEM 4.4.14
D	REVIEWED ITEM 4.18.9.3
E	REVISED ITEM 4.4.3, ACCORDING TO CLARIFICATION NOTICE DUE TO BIDDER QUESTIONS
F	INCLUDED ITEMS 4.14.2 AND 4.13.10. REVISED ITEM 4.17, AND ANNEXES I, II AND III
G	REVISED WHERE INDICATED
H	REVISED WHERE INDICATED
J	REVISED WHERE INDICATED

	REV. 0	REV. J	REV. B	REV. C	REV. D	REV. E	REV. F	REV. G	REV. H
DATE	SET/17/18	MAR/25/24	MAR/24/20	MAR/31/20	JUN/17/20	NOV/25/20	FEB/12/21	AUG/01/22	DEC/02/22
DESIGN	ESUP	EEI/ESES	ESUP	ESUP	ESUP	ESUP	EEI/ESES	EEI/ESES	EEI/ESES
EXECUTION	CAVALIERE	E35D	CAVALIERE	BAYO	BAYO	BAYO	CSJP	CLT0	U4BY
CHECK	MARCELO BP	U4BY	T.ELIAS	T.ELIAS	T.ELIAS	THAYSE	U4RD	U5AL	CLT0
APPROVAL	MATTOSO	BD36	REGGIANI	REGGIANI	REGGIANI	REGGIANI	UQBK	UQBE	UQBE

THE INFORMATION CONTAINED IN THIS DOCUMENT IS PETROBRAS PROPERTY AND MAY NOT BE USED FOR PURPOSES OTHER THAN THOSE SPECIFICALLY INDICATED HEREIN.

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



UNIT:

SHEET: 2 of 30

TITLE:


POWER PANEL FOR THYRISTORIZED HEATER FOR OFFSHORE UNITS

INTERNAL

ESUP

TABLE OF CONTENTS

1.	OBJECTIVE.....	3
2.	CODES, STANDARDS AND REFERENCE DOCUMENTS	4
2.1.	GENERAL	4
2.2.	CODES, STANDARDS AND REFERENCE DOCUMENTS.....	4
2.3.	REFERENCE DOCUMENTS	5
3.	GENERAL CONDITIONS	6
4.	CONSTRUCTIVE CHARACTERISTICS.....	7
4.1.	GENERAL REQUIREMENTS.....	7
4.2.	ENVIRONMENTAL CONDITIONS, INCLINATION REQUIREMENTS AND VIBRATION REQUIREMENTS	8
4.3.	CLASSIFICATION OF ASSEMBLIES.....	9
4.4.	STRUCTURE.....	9
4.5.	PAINTING	10
4.6.	MAIN BUSBARS	10
4.7.	GROUNDING BARS	11
4.8.	WIRING AND CONDUCTORS	11
4.9.	HEATING RESISTORS	12
4.10.	FUNCTIONAL UNITS' MAIN COMPONENTS	12
4.11.	THYRISTORS CONTROL AND COOLING SYSTEMS	14
4.12.	INTERFACE WITH CONTROL PANEL.....	14
4.13.	INTERFACE WITH ELECTRICAL SYSTEM AUTOMATION.....	15
4.14.	PROTECTION	16
4.15.	INCOMING FEEDERS INTERLOCKS	18
4.16.	ELECTROMAGNETIC COMPATIBILITY (EMC)	19
4.17.	CONTROL VOLTAGES	19
4.18.	NAMEPLATES AND MARKINGS	19
5.	TESTS	21
5.1.	GENERAL	21
5.2.	DESIGN VERIFICATION (TYPE TESTS).....	22
5.3.	ROUTINE VERIFICATION.....	22
5.4.	SPECIAL TESTS	22
5.5.	MINIMUM TEST LIST	22
6.	MANUFACTURER DOCUMENTATION	24
6.1.	DOCUMENTS TO PROPOSAL.....	24
6.2.	DOCUMENTS FOR APPROVAL.....	25
6.3.	DOCUMENTS AFTER APPROVAL.....	25
7.	PACKAGE, TRANSPORT AND STORAGE	26
8.	TRAINING	26
9.	SPARE PARTS AND TOOLS.....	27
10.	ACRONYMS	28
11.	ANNEX I - POWER PANEL TYPE I - SIMPLIFIED SCHEMATIC DIAGRAM.....	29
12.	ANNEX II - POWER PANEL TYPE II - SIMPLIFIED SCHEMATIC DIAGRAM	30

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-5140-741-P4X-003	REV. J
	UNIT:	SHEET: 3 of 30	
	TITLE: POWER PANEL FOR THYRISTORIZED HEATER FOR OFFSHORE UNITS	INTERNAL	
		ESUP	

1. OBJECTIVE

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.

1.1.1. This specification applies to thyristor electrical power regeneration heater panels used for:

- Regeneration systems for Gas Dehydration, TEG (Triethylene Glycol) or Molecular sieves applications included in the scope of I-ET-3010.00-1200-498-P4X-002 – ELECTRIC PROCESS HEATERS.
- Heating power application that results in a panel similar to the types indicated in Table 1.

1.1.2. Any other heating system panels shall comply with requirements indicated in I-ET-3010.00-5140-741-P4X-004 - SPECIFICATION FOR LOW-VOLTAGE GENERIC ELECTRICAL PANELS FOR OFFSHORE UNITS.

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

1.3. This specification does not define requirements for control panels for thyristorized electrical heaters, hereinafter called “Control Panel” in this document. However, it defines interface signals between “Power Panels” and “Control Panel”. 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 PACKAGE UNITS and AUTOMATION INTERFACE OF PACKAGE UNITS.

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


1.5. Medium-voltage switchgears and medium-voltage MCCs requirements are defined in specific Technical Specification, see I-ET-3010.00-5140-741-P4X-002 - MEDIUM-VOLTAGE MOTOR CONTROL CENTER AND SWITCHGEAR FOR OFFSHORE UNITS, and respective Data-sheet, in I-LI-3010.00-5140-700-P4X-001 - ELECTRICAL EQUIPMENT DATA-SHEET MODELS.


1.6. Low-voltage switchgears and low-voltage MCCs requirements are defined in specific Technical Specification, see I-ET-3010.00-5140-741-P4X-001 - LOW-VOLTAGE MOTOR CONTROL CENTER AND SWITCHGEAR FOR OFFSHORE UNITS, and respective Data-sheet, in I-LI-3010.00-5140-700-P4X-001 - ELECTRICAL EQUIPMENT DATA-SHEET MODELS.

1.7. Low-voltage panels not included in the scope Low-voltage switchgears and low-voltage MCCs are defined in specific Technical Specification, see I-ET-3010.00-5140-741-P4X-004 - SPECIFICATION FOR LOW-VOLTAGE GENERIC ELECTRICAL PANELS FOR OFFSHORE UNITS.

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

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

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-5140-741-P4X-003	REV. J																																																
	UNIT:	SHEET: 4 of 30																																																	
	TITLE: POWER PANEL FOR THYRISTORIZED HEATER FOR OFFSHORE UNITS	INTERNAL																																																	
ESUP																																																			
<h2>2. CODES, STANDARDS AND REFERENCE DOCUMENTS</h2> <h3>2.1. GENERAL</h3> <p>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.</p> <h3>2.2. CODES, STANDARDS AND REFERENCE DOCUMENTS</h3> <h4>2.2.1. IEC – INTERNATIONAL ELECTROTECHNICAL COMMISSION</h4> <table border="0"> <tr> <td>[1]</td> <td>IEC 60079</td> <td>Explosive Atmospheres – All parts IEC 60079</td> </tr> <tr> <td>[2]</td> <td>IEC 60092-302</td> <td>Electrical Installations in Ships - Part 302: Low-Voltage Switchgear and Controlgear Assemblies</td> </tr> <tr> <td>[3]</td> <td>IEC 60092-302-2</td> <td>Electrical Installations in Ships – Part 302-2: Equipment – Low-Voltage Switchgear and Controlgear Assemblies – Marine power;</td> </tr> <tr> <td>[4]</td> <td>IEC 60309</td> <td>Plugs, fixed or portable socket-outlets and appliance inlets for industrial purposes - Part 4: Switched socket-outlets with or without interlock</td> </tr> <tr> <td>[5]</td> <td>IEC 60417 D.S.</td> <td>Graphical symbols for use on equipment (DATABASE SNAPSHOT);</td> </tr> <tr> <td>[6]</td> <td>IEC 60445</td> <td>Basic and Safety Principles for Man-Machine Interface, Marking and Identification - Identification of Equipment Terminals, Conductors Terminations and Conductors;</td> </tr> <tr> <td>[7]</td> <td>IEC 60529</td> <td>Degrees of Protection Provided by Enclosures (IP Code);</td> </tr> <tr> <td>[8]</td> <td>IEC 60533</td> <td>Electrical and Electronic Installations in Ships – Electromagnetic Compatibility (EMC) – Ships with a Metallic Hull.</td> </tr> <tr> <td>[9]</td> <td>IEC 60721-3-1</td> <td>Classification of environmental conditions - Part 3-1 Classification of groups of environmental parameters and their severities – Storage;</td> </tr> <tr> <td>[10]</td> <td>IEC 60721-3-2</td> <td>Classification of environmental conditions - Part 3-2: Classification of groups of environmental parameters and their severities – Transportation and Handling;</td> </tr> <tr> <td>[11]</td> <td>IEC 60947-2</td> <td>Low-Voltage Switchgear and Controlgear - Part 2: Circuit-Breakers;</td> </tr> <tr> <td>[12]</td> <td>IEC 60947-4-1</td> <td>Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-Starters - Electromechanical Contactor and Motor-Starters;</td> </tr> <tr> <td>[13]</td> <td>IEC 60947-4-2</td> <td>Low-Voltage Switchgear and Controlgear - Part 4-2: Contactors and Motor-Starters - AC Semiconductor Motor Controllers and Starters;</td> </tr> <tr> <td>[14]</td> <td>IEC 61180</td> <td>High-Voltage Test Techniques For Low-Voltage Equipment - Definitions, Test And Procedure Requirements, Test Equipment</td> </tr> <tr> <td>[15]</td> <td>IEC 61439-1</td> <td>Low-Voltage Switchgear and Controlgear Assemblies - Part 1: General Rules;</td> </tr> <tr> <td>[16]</td> <td>IEC 61439-2</td> <td>Low-Voltage Switchgear and Controlgear Assemblies - Part 2: Power switchgear and controlgear assemblies;</td> </tr> </table>				[1]	IEC 60079	Explosive Atmospheres – All parts IEC 60079	[2]	IEC 60092-302	Electrical Installations in Ships - Part 302: Low-Voltage Switchgear and Controlgear Assemblies	[3]	IEC 60092-302-2	Electrical Installations in Ships – Part 302-2: Equipment – Low-Voltage Switchgear and Controlgear Assemblies – Marine power;	[4]	IEC 60309	Plugs, fixed or portable socket-outlets and appliance inlets for industrial purposes - Part 4: Switched socket-outlets with or without interlock	[5]	IEC 60417 D.S.	Graphical symbols for use on equipment (DATABASE SNAPSHOT);	[6]	IEC 60445	Basic and Safety Principles for Man-Machine Interface, Marking and Identification - Identification of Equipment Terminals, Conductors Terminations and Conductors;	[7]	IEC 60529	Degrees of Protection Provided by Enclosures (IP Code);	[8]	IEC 60533	Electrical and Electronic Installations in Ships – Electromagnetic Compatibility (EMC) – Ships with a Metallic Hull.	[9]	IEC 60721-3-1	Classification of environmental conditions - Part 3-1 Classification of groups of environmental parameters and their severities – Storage;	[10]	IEC 60721-3-2	Classification of environmental conditions - Part 3-2: Classification of groups of environmental parameters and their severities – Transportation and Handling;	[11]	IEC 60947-2	Low-Voltage Switchgear and Controlgear - Part 2: Circuit-Breakers;	[12]	IEC 60947-4-1	Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-Starters - Electromechanical Contactor and Motor-Starters;	[13]	IEC 60947-4-2	Low-Voltage Switchgear and Controlgear - Part 4-2: Contactors and Motor-Starters - AC Semiconductor Motor Controllers and Starters;	[14]	IEC 61180	High-Voltage Test Techniques For Low-Voltage Equipment - Definitions, Test And Procedure Requirements, Test Equipment	[15]	IEC 61439-1	Low-Voltage Switchgear and Controlgear Assemblies - Part 1: General Rules;	[16]	IEC 61439-2	Low-Voltage Switchgear and Controlgear Assemblies - Part 2: Power switchgear and controlgear assemblies;
[1]	IEC 60079	Explosive Atmospheres – All parts IEC 60079																																																	
[2]	IEC 60092-302	Electrical Installations in Ships - Part 302: Low-Voltage Switchgear and Controlgear Assemblies																																																	
[3]	IEC 60092-302-2	Electrical Installations in Ships – Part 302-2: Equipment – Low-Voltage Switchgear and Controlgear Assemblies – Marine power;																																																	
[4]	IEC 60309	Plugs, fixed or portable socket-outlets and appliance inlets for industrial purposes - Part 4: Switched socket-outlets with or without interlock																																																	
[5]	IEC 60417 D.S.	Graphical symbols for use on equipment (DATABASE SNAPSHOT);																																																	
[6]	IEC 60445	Basic and Safety Principles for Man-Machine Interface, Marking and Identification - Identification of Equipment Terminals, Conductors Terminations and Conductors;																																																	
[7]	IEC 60529	Degrees of Protection Provided by Enclosures (IP Code);																																																	
[8]	IEC 60533	Electrical and Electronic Installations in Ships – Electromagnetic Compatibility (EMC) – Ships with a Metallic Hull.																																																	
[9]	IEC 60721-3-1	Classification of environmental conditions - Part 3-1 Classification of groups of environmental parameters and their severities – Storage;																																																	
[10]	IEC 60721-3-2	Classification of environmental conditions - Part 3-2: Classification of groups of environmental parameters and their severities – Transportation and Handling;																																																	
[11]	IEC 60947-2	Low-Voltage Switchgear and Controlgear - Part 2: Circuit-Breakers;																																																	
[12]	IEC 60947-4-1	Low-Voltage Switchgear and Controlgear - Part 4-1: Contactors and Motor-Starters - Electromechanical Contactor and Motor-Starters;																																																	
[13]	IEC 60947-4-2	Low-Voltage Switchgear and Controlgear - Part 4-2: Contactors and Motor-Starters - AC Semiconductor Motor Controllers and Starters;																																																	
[14]	IEC 61180	High-Voltage Test Techniques For Low-Voltage Equipment - Definitions, Test And Procedure Requirements, Test Equipment																																																	
[15]	IEC 61439-1	Low-Voltage Switchgear and Controlgear Assemblies - Part 1: General Rules;																																																	
[16]	IEC 61439-2	Low-Voltage Switchgear and Controlgear Assemblies - Part 2: Power switchgear and controlgear assemblies;																																																	

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-5140-741-P4X-003	REV. J
	UNIT:	SHEET: 5 of 30	
	TITLE:	POWER PANEL FOR THYRISTORIZED HEATER FOR OFFSHORE UNITS	
		INTERNAL	ESUP
[17]	IEC 61850	Communication networks and systems for power utility automation – All Parts	
[18]	IEC 61892	Mobile and Fixed Offshore Units – Electrical Installations (All Parts);	
[19]	IEC 61892-1	Mobile And Fixed Offshore Units - Electrical Installations - Part 1: General Requirements and Conditions	
[20]	IEC 61892-3	Mobile And Fixed Offshore Units - Electrical Installations - Part 3: Equipment	
[21]	IEC 62262	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)	
[22]	IEC TR 61000-5-2	Electromagnetic Compatibility (EMC) - Part 5: Installation and Mitigation Guidelines - Section 2: Earthing and Cabling;	
[23]	IEC TR 61641	Enclosed low-voltage switchgear and controlgear assemblies – Guide for testing under conditions of arcing due to internal fault	
2.2.2. IEEE – INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERING			
[24]	IEEE Std. 519	IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems	
2.2.3. ASTM - AMERICAN SOCIETY FOR TESTING AND MATERIAL			
[25]	ASTM F1166	Standard Practice for Human Engineering Design for Marine System, Equipment and Facilities.	
2.2.4. LABOUR SECRETARY - MINISTRY OF ECONOMY - REGULATORY STANDARDS FOR OCCUPATIONAL SAFETY AND HEALTH			
[26]	NR-10	Segurança em Instalações e Serviços em Eletricidade.	
[27]	NR-12	Segurança no Trabalho em Máquinas e Equipamentos	
[28]	NR-30	Segurança e Saúde no Trabalho Aquaviário	
[29]	NR-37	Segurança e Saúde em Plataformas de Petróleo	
2.2.5. IMO - INTERNATIONAL MARITIME ORGANIZATION			
[30]	IMO EA811E	Code for the Construction and Equipment of Mobile Offshore Drilling Units (MODU CODE)	
[31]	IMO MODU CODE	International Maritime Organization for the; design, construction and other safety measures for mobile drilling units	
2.2.6. ABNT – ASSOCIAÇÃO BRASILEIRA DE NORMAS TÉCNICAS			
[32]	ABNT NBR 14136	Plugues e tomadas para uso doméstico e análogo até 20 A/250 V em corrente alternada - Padronização	
2.3. REFERENCE DOCUMENTS			
[33]	I-ET-3010.00-1200-498-P4X-002 – ELECTRIC PROCESS HEATERS		
[34]	I-ET-3010.00-5140-741-P4X-004 - SPECIFICATION FOR LOW-VOLTAGE GENERIC ELECTRICAL PANELS FOR OFFSHORE UNITS		

- [35] AUTOMATION INTERFACE OF PACKAGE UNITS
- [36] I-DE-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION ARCHITECTURE DIAGRAM
- [37] I-ET-3010.00-1200-800-P4X-002 - AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS
- [38] I-ET-3010.00-1200-956-P4X-002 - GENERAL PAINTING
- [39] I-ET-3010.00-5140-700-P4X-001 - SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS
- [40] I-ET-3010.00-5140-700-P4X-002 - SPECIFICATION FOR ELECTRICAL MATERIAL FOR OFFSHORE UNITS
- [41] I-ET-3010.00-5140-700-P4X-005 - REQUIREMENTS FOR HUMAN ENGINEERING DESIGN FOR ELECTRICAL SYSTEMS OF OFFSHORE UNITS
- [42] I-ET-3010.00-5140-700-P4X-009 - GENERAL REQUIREMENTS FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS
- [43] I-ET-3010.00-5140-741-P4X-001 - LOW-VOLTAGE MOTOR CONTROL CENTER AND SWITCHGEAR FOR OFFSHORE UNITS
- [44] I-ET-3010.00-5140-741-P4X-002 - MEDIUM-VOLTAGE MOTOR CONTROL CENTER AND SWITCHGEAR FOR OFFSHORE UNITS
- [45] I-ET-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION ARCHITECTURE
- [46] I-ET-3010.00-5143-700-P4X-001 - ELECTRICAL SYSTEM PROTECTION CRITERIA
- [47] I-ET-3010.00-5400-947-P4X-002 - SAFETY SIGNALLING
- [48] I-ET-3010.00-5520-888-P4X-001 - AUTOMATION PANELS
- [49] I-LI-3010.00-5140-700-P4X-001 - ELECTRICAL EQUIPMENT DATA-SHEET MODELS
- [50] I-LI-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION INTERFACE SIGNALS LIST
- [51] ONE-LINE DIAGRAM for the Project

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. GENERAL CONDITIONS

- 3.1. Power Panel shall contain thyristors suitable for the requested power, the thyristors control system, and all necessary components for the temperature control.
- 3.2. The Power Panel shall be designed, constructed, tested, and supplied according to this specification.

- 3.3. 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 or I-ET-3010.00-5140-741-P4X-002 - MEDIUM-VOLTAGE MOTOR CONTROL CENTER AND SWITCHGEAR FOR OFFSHORE UNITS.
- 3.4. 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 electrical system, as well as guarantee the control and monitoring from Control Panel.
- 3.5. All material and equipment supplied to the Power Panel shall meet applicable standards, Classification Society rules, NR-10.
- 3.6. Power Panel shall comply with safety interlock requirements defined in IEC 60079 when driving equipment installed in hazardous areas.
- 3.7. Manufacturer shall supply all electrical devices, including specific tools, which are necessary for the operation and maintenance of the Power Panel.
- 3.8. Unless otherwise stated in PETROBRAS documentation, Power Panel shall be installed inside a panels' room in a safe area.
- 3.9. Power Panel shall be packed properly for the foreseen transportation, so that no damage occurs during transport, storage and lifting operations.
- 3.10. 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.
- 3.11. It shall not be acceptable out of date or obsolete equipment or components. Technical support and supply of replacement parts shall be guaranteed for ten (10) years.
- 3.12. This specification considers two types of Power Panels. The following table relates the differences:


Table 1 - Power Panel Types


Characteristics	Power Panel Type	
	Type I	Type II
Fed from	CDC, or MCC, or 1 dedicated power transformer	2 dedicated redundant power transformers
Quantity of incoming circuits	1	2
Tie Circuit-Breaker	No	Optional
Incoming feeder switching device	MCB, or none	Air circuit-breaker
Incoming circuit remote monitoring	Yes	Yes
Outgoing circuit remote monitoring	Yes	Yes
Insulation monitoring device (IMD)	Yes, when fed from transformer	Yes
Ground fault detectors (EFI)	Yes	Yes

Note: EFI and IMD requirements are specified in section 4.14.5.

4. CONSTRUCTIVE CHARACTERISTICS

4.1. GENERAL REQUIREMENTS

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-5140-741-P4X-003	REV. J
	UNIT:	SHEET: 8 of 30	
	TITLE:	POWER PANEL FOR THYRISTORIZED HEATER FOR OFFSHORE UNITS	
INTERNAL			
ESUP			
<p>4.1.1. Power Panel shall be designed, manufactured, and tested according to standards listed on item 2.2 and according to reference documents listed on item 2.3.</p> <p>4.1.2. All materials used, shall be non-hygroscopic, flame retarding and resistant to corrosion caused by maritime environment and contact with hydrocarbons.</p> <p>4.1.3. 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.</p> <p>4.1.4. 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.</p> <p>4.1.5. Power Panel shall be suitable for operation with voltage and frequency variations according to I-ET-3010.00-5140-700-P4X-009 - GENERAL REQUIREMENTS FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.</p> <p>4.1.6. Unless otherwise stated in Project documentation, Power Panel shall have minimum rated short-time withstand current I_{cw} for 1s (according to IEC 61439-1) of 25 kA and minimum rated withstand peak current I_{pk} (according to IEC 61439-1) of 52.5 kA.</p> <p>4.1.7. In case of minimum rated short-time currents are above the values defined in 4.1.6, an arc monitor protection device shall be installed in Power Panel. This solution shall be submitted to PETROBRAS approval. Control Panels do not need arc monitor devices.</p> <p>4.1.8. 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 4.1.6, are not in the scope of the Manufacturer.</p> <p>4.1.9. 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).</p> <p>4.1.10. Power Panel rated voltage (3 phases 60 Hz $\pm 5\%$) 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.</p> <p>4.1.11. Manufacturer shall install at least 2(two) socket-outlets inside the Panel that shall comply with standardization defined by ABNT NBR 14136, and, where applicable IEC 60309.</p> <p>4.1.12. The auxiliary circuit branches for internal lighting and internal sockets shall have miniature thermomagnetic circuit-breakers with integrated or additional differential residual current protection (RCD) of 30mA.</p> <p>4.2. ENVIRONMENTAL CONDITIONS, INCLINATION REQUIREMENTS AND VIBRATION REQUIREMENTS</p> <p>4.2.1. The Power Panel shall be designed to operate on closed room with ambient temperature according to I-ET-3010.00-5140-700-P4X-009 - GENERAL REQUIREMENTS FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.</p> <p>4.2.2. Power Panel and equipment shall be tropicalized, according to I-ET-3010.00-5140-700-P4X-009 - GENERAL REQUIREMENTS FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.</p>			

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-5140-741-P4X-003	REV. J
	UNIT:	SHEET: 9 of 30	
	TITLE:	POWER PANEL FOR THYRISTORIZED HEATER FOR OFFSHORE UNITS	
INTERNAL			
ESUP			
<p>4.2.3. Power Panel shall be suitable to operate under vibration and acceleration requirements defined by I-ET-3010.00-5140-700-P4X-009 - GENERAL REQUIREMENTS FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.</p> <p>4.2.4. 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.</p> <p>4.3. CLASSIFICATION OF ASSEMBLIES</p> <p>4.3.1. Power Panel shall be classified according to IEC 61439-1.</p> <p>4.3.2. Power Panel shall be tested according to IEC 61439-1.</p> <p>4.3.3. Power Panel shall be a metallic Multi-Cubicle Type stationary assembly, proper for indoor installation.</p> <p>4.3.4. Power Panel shall have minimum mechanical protection degree IP-42, according to IEC 60529.</p> <p>4.3.5. Power Panel shall be formed by fixed, removable or withdrawable parts. Note: Withdrawable parts shall comply with IEC 61439-2.</p> <p>4.3.6. Protection against electrical shock by direct contact shall be ensured by means of protective barriers or enclosures.</p> <p>4.3.7. Protection against electrical shock by indirect contact shall be ensured by means of protective circuits (earth bar), according to IEC 61439-1.</p> <p>4.3.8. 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.</p> <p>4.3.9. Controller and control modules shall be considered as separated functional units, complying with the form of segregation 4b.</p> <p>4.4. STRUCTURE</p> <p>4.4.1. The maximum height, including the plinth, shall not exceed 2400 mm (excluding cooling fans, cooling exhaust ducts, and the exhaust ducts for expansion of gases from short-circuits).</p> <p>4.4.2. 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.</p> <p>4.4.3. 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.</p> <p>4.4.4. 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 or welded to the floor. Panel Manufacturer shall supply the skid and all accessories necessary to fix the skid to the floor.</p>			

- 4.4.5. To avoid a dangerous inclination of Power Panel when manoeuvring 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.
- 4.4.6. Maximum height for installation of push-buttons and instruments shall be in accordance with I-ET-3010.00-5140-700-P4X-005 - REQUIREMENTS FOR HUMAN ENGINEERING DESIGN FOR ELECTRICAL SYSTEMS OF OFFSHORE UNITS.
- 4.4.7. Power Panel shall be self-supported and provided with lifting eyelets.
- 4.4.8. The panels shall be designed in such a way that a minimum number of columns are connected for mechanical handling. Mechanical handling partition shall be informed to PETROBRAS in documentation for approval (section 6.2).
- Note: if possible, it is desired a maximum of 2 columns.
- 4.4.9. 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.
- 4.4.10. Power Panel shall have isolated handrails along the front side.
- 4.4.11. Vertical sections shall have hinged doors on their front sides.
- Note: Hinged doors shall have an open position lock device.
- 4.4.12. The equipment that 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.
- 4.4.13. The panels shall be constructed so that thermal inspection by optical infrared thermographic devices could be safely performed with the circuits energized. This facility shall not compromise arc withstand capability to comply with IEC TR 61641.

4.5. PAINTING

4.5.1. Painting shall be in accordance with requirements of I-ET-3010.00-5140-700-P4X-009 - GENERAL REQUIREMENTS FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.

4.5.2. Cancelled.

4.6. MAIN BUSBARS

- 4.6.1. Busbars shall be three-phase, of electrolytic copper.
- 4.6.2. 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.
- 4.6.3. 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.
- 4.6.4. The busbars shall be identified with coloured strips as follows:
- Phases (R - S - T): red, white, and black, respectively.
 - Neutral: blue according to IEC 60445

- Ground: bicolour combination green-yellow according to IEC 60445.

4.6.5. The main busbars and the derivations to the circuit-breakers shall be fully insulated.

4.6.6. For IT systems, panels shall not have neutral bar.

4.7. GROUNDING BARS

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

4.7.2. 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-3010.00-5140-700-P4X-001 - SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS.

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

4.7.4. Bolt Grounded Systems

For these systems, the cross section of the safety grounding bar (PE) shall be according to Table 3 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.

4.7.5. 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.

4.7.6. 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 to I-ET-3010.00-5140-700-P4X-001 - SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS.

4.8. WIRING AND CONDUCTORS

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

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

4.8.3. 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.

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

4.8.5. 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.

- 4.8.6. The channels shall be made of material not producing toxic fumes in case of fire on the panel.
- 4.8.7. Each set of control terminal blocks shall have 10% of spares for future application.
- 4.8.8. Power Panel shall be supplied with cable glands and terminal connectors for power and grounding cables.
- 4.8.9. All incoming and outgoing cables entrance shall be according to project documentation. 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.
- 4.8.10. Metallic cable-glands made with material compatible with the removable plates' material shall be supplied with the Power Panel.
- 4.8.11. 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.

4.9. HEATING RESISTORS

- 4.9.1. 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**

- 4.9.2. 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.
- 4.9.3. The auxiliary circuit branches shall be suitably protected with miniature circuit-breakers.

4.10. FUNCTIONAL UNITS' MAIN COMPONENTS

- 4.10.1. For all incoming and outgoing connections, it shall be verified the ONE-LINE DIAGRAM for the Project.
- 4.10.2. Power Panel functional units shall have, at least, the components listed below.
- 4.10.3. Incoming Feeders:
- Moulded-case circuit-breakers (MCB);
 - Required for Power Panels Types I;
 - 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 a dedicated MMR (Microprocessor-based

Multifunction Relay) with communication capabilities. ACBs with incorporated relays are not acceptable.

- For reference, see ANNEX I - POWER PANEL TYPE I - SIMPLIFIED SCHEMATIC DIAGRAM.
- Air circuit-breakers (ACB) with a dedicated MMR (Microprocessor-based Multifunction Relay) with communication capabilities (ACBs with incorporated relays are not acceptable) for the required remote control and monitoring.
 - Required for Power Panel Type II.
 - For reference, see ANNEX II - POWER PANEL TYPE II - SIMPLIFIED SCHEMATIC DIAGRAM.
- Current transformers (CT).
- Ammeter with selector switch.
- Green/Red operation status leds.

4.10.4. Main busbar:

- Current limiting fuses (for VTs).
- Dry-type voltage transformers (VT).
- Voltmeter with selector switch.

4.10.5. Outgoing circuits:

- Moulded Case Circuit-Breakers.
- 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.
- Fast (high-speed) fuses to protect thyristors (which shall be incorporated in Power Electronics / Thyristor modules).

4.10.6. Each resistor bank shall be fed individually by one outgoing circuit as described in item 4.10.5.

4.10.7. Cancelled.

4.10.8. Alternative proposals shall be submitted to PETROBRAS approval.

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

4.10.10. 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).

4.10.11. Test blocks in power panels for protection relay (MMR) secondary injection testing shall be provided to allow relay testing and calibration from the front of the panel without disconnecting wiring.

4.11. THYRISTORS CONTROL AND COOLING SYSTEMS

4.11.1. Thyristors control system shall receive an external set point signal (see item 4.12), 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.

4.11.2. Thyristors control system shall be able to allow the programming of a ramp up in order to gradually increase temperature.

4.11.3. 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-009 - GENERAL REQUIREMENTS FOR ELECTRICAL MATERIAL AND EQUIPMENT FOR OFFSHORE UNITS.

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

4.11.5. 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.

4.11.6. Thyristor protection devices, such as snubbers and MOVs, shall be installed in order to avoid failure due to di/dt spikes. Design of protection devices shall be informed in report annex to documentation. Thyristors and respective protection devices datasheets shall be sent to Petrobras.

4.11.7. Power and control panels for thyristorized electrical heaters shall allow that controlled resistive elements be preserved in order to avoid low insulation when not operating.

4.12. INTERFACE WITH CONTROL PANEL

4.12.1. All external control (ON / OFF) and set point signals 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 PACKAGE UNITS and I-LI-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION INTERFACE SIGNALS LIST.

4.12.2. 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.

4.12.3. 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 I-ET-3010.00-1200-800-P4X-002 - AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS and I-LI-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION INTERFACE SIGNALS LIST. All signals from the heated equipment to A&C shall be sent by Control Panel.

**TECHNICAL SPECIFICATION**

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

REV. J

UNIT:

SHEET: 15 of 30

TITLE:

POWER PANEL FOR THYRISTORIZED HEATER FOR OFFSHORE UNITS

INTERNAL

ESUP

- 4.12.4. Emergency shutdown signals from A&C shall be sent to Control Panel that shall be responsible to turn off the Power Panel.
- 4.12.5. For communication requirements between Control Panel and A&C, see I-ET-3010.00-1200-800-P4X-002 - AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS and I-LI-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION INTERFACE SIGNALS LIST.
- 4.12.6. 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.

4.13. INTERFACE WITH ELECTRICAL SYSTEM AUTOMATION

- 4.13.1. Power Panels Type I MCB of incoming circuits shall have voltage-free contacts for remote monitoring of status (ON / OFF).
- 4.13.2. Power Panels Type II Incoming MMRs shall have communication capability with the Electrical System Automation according to 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.
- 4.13.3. The outgoing circuits shall have voltage-free contacts for remote signalling of status (ON / OFF).
- 4.13.4. Trip in outgoing feeders due to ground fault (see item 4.14.5) shall generate an alarm, for remote signalling, using voltage-free contacts.
- 4.13.5. 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.
- 4.13.6. Power Panels Type I shall include an IED (IR) in order to obtain all signals from internal components as required by I-LI-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION INTERFACE SIGNALS LIST.
- 4.13.7. The IED (IR) shall communicate with protocols according to I-DE-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION ARCHITECTURE DIAGRAM.
- 4.13.8. Power Panel Type II Incoming MMRs shall obtain all signals from internal components as required by I-LI-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION INTERFACE SIGNALS LIST.
- 4.13.9. In type I, where MMR exists, it shall substitute IED (IR) functions above.
- 4.13.10. The Power Panel shall have its internal clock synchronized with Electrical System Automation Time Server through the time protocol according to I-ET-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION ARCHITECTURE. All devices with logging or communication capabilities internal to the Power Panel shall have their internal clock synchronized with Electrical System Automation. All internal devices connected to Electrical System Automation networks shall be synchronized with the Electrical System Automation Time Server through the time protocol according to I-ET-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION ARCHITECTURE. All events and alarms shall be logged in the equipment with the time stamp synchronized with the internal clock, which shall be synchronized with the Electrical System Automation Time Server.

4.14. PROTECTION

4.14.1. Requirements applicable for Power Panels Type II:

4.14.1.1. The minimum protection functions for Power Panel incoming feeders shall be according to Table 2. Protection requirements shall follow I-ET-3010.00-5143-700-P4X-001 - ELECTRICAL SYSTEM PROTECTION CRITERIA.

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

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

Protection Function		Incoming Feeder
Nº	Description	ACB +MMR ^{(1) (2)}
27	Undervoltage	Alarm/Trip
50	Instantaneous Overcurrent	Trip ⁽³⁾
51	Temporized Overcurrent	Trip
86	Lockout	Trip

Notes: (1) ACB = Air Circuit-Breaker; MMR = Microprocessor-based Multifunction Relay.

(2) Protective functions and communication capability required shall be through a MMR.

(3) Instantaneous overcurrent shall be activated only when selector switch is in "Manutenção" position. See item 4.14.1.3 and 4.14.1.4.

4.14.1.3. 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.

4.14.1.4. There shall be a local signalling lamp, turned on with the switch in "Manutenção" position (Maintenance Position), indicating "Coordenação Desativada" (Deactivated Coordination).

4.14.1.5. 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.

4.14.1.6. There shall be a label beside the switch with following warning text:




ATENÇÃO


SELECIONE "MANUTENÇÃO" APENAS QUANDO
 HOVER INTERVENÇÃO NO PAINEL.
 NESSA POSIÇÃO, A COORDENAÇÃO SERÁ
 DESATIVADA, REDUZINDO RISCO AO INTERVENTOR,
 MAS AUMENTANDO O RISCO DE DESLIGAMENTO INDEVIDO.

- 4.14.2. Unless otherwise defined in Project Documentation, communication failure, watchdog, and self-diagnosis routine failure indications in MMRs and IRs shall be signalled as an alarm to Electrical System Automation, and they shall not be used as trip signal.
- 4.14.3. The protection for outgoing circuits shall be executed by thermomagnetic moulded case circuit-breakers and contactors.
- 4.14.4. High-speed fuses shall be provided to protect power semiconductors. The fuses actuation shall generate an alarm signal, to be sent to Electrical System Workstation, through Electrical System Automation.

4.14.5. GROUND FAULT PROTECTION

- 4.14.5.1. Ground fault protection shall be provided by an insulation monitoring device (IMD) for Power Panels Type I fed from transformers and for Power Panels Type II, as defined in Table 1. Protective devices based in residual current shall not be accepted.
- 4.14.5.2. 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.
- 4.14.5.3. 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 kilometres (100 km), without any failure or nuisance actuation.
- 4.14.5.4. Outgoing feeders shall have individual ground fault detector (EFI) devices. EFIs shall be used to disconnect the power supply whenever the insulation resistance is not greater than 50 ohms per volt of rated voltage, in accordance with IEC 60079-14. The trip signals shall be sent to the respective contactor of the faulty feeder. This trip actuation shall generate an alarm signal, to be sent to Electrical System Workstation, through Electrical System Automation.
- 4.14.5.5. For Power Panels Types I, when the IMD is installed in the upstream panel, the EFI shall be connected to this IMD and shall be fully compatible.

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-5140-741-P4X-003	REV. J
	UNIT:	SHEET: 18 of 30	
	TITLE: POWER PANEL FOR THYRISTORIZED HEATER FOR OFFSHORE UNITS	INTERNAL	
		ESUP	
<p>4.14.5.6. Power Panels Type I without dedicated transformer shall be monitored for ground fault by the IMD at outgoing circuit in the upstream panel. As defined in Table 1, EFI shall be installed in outgoing circuits, connected and fully compatible with the IMD of upstream panel.</p> <p>4.14.5.7. Ground fault protection shall have an alarm signal indicating if panel insulation monitoring device (IMD) is turned off. The isolation monitoring devices shall have means to connect to the internal switchgear network switches to communicate with Electrical System Automation (ESA). Signals to be sent to ESA shall be according to I-LI-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION INTERFACE SIGNALS LIST.</p> <p>4.14.5.8. The insulation monitoring devices shall send a discrete alarm signal to an IED (IR) or MMR inside the panel, through a voltage free contact (1A @ 220VAC PF 0.4).</p> <p>4.14.5.9. To indicate that the ground fault detection device is turn off, an alarm shall be sent to IED (IR) or MMR installed inside the panel through a voltage free contact (1A @ 220VAC PF 0.4).</p> <p>4.14.5.10. In case of use of ground fault location devices, it is forbidden the use of voltage transformers connected YNyn (two neutral grounded).</p> <p>4.14.5.11. The interconnection from IRs, MMR and IMD to Electrical System Automation (ESA), among other internal components to be defined in detailed design, shall be made through internal switches according to I-ET-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION ARCHITECTURE.</p> <p>4.15. INCOMING FEEDERS INTERLOCKS</p> <p>4.15.1. Requirements applicable for Power Panels Type II:</p> <p>4.15.1.1. 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.</p> <p>4.15.1.2. In case the optional tie circuit-breaker is installed, it shall not be allowed simultaneous closing of both incoming circuit-breakers unless the tie circuit-breaker is open. It shall be installed a logical interlock to allow the connection of 2 out of 3 circuit-breakers. Load transference from one incoming circuit-breaker to the other shall be carried out with momentary blackout.</p> <p>4.15.1.3. 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.</p> <p>4.15.1.4. The incoming circuit-breakers shall open when the respective upstream circuit-breaker (installed in primary side of the power transformer) opens.</p> <p>4.15.2. 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.</p> <p>4.15.3. Power Panels Type I shall include an IED (IR) in order to obtain all signals from internal components as required by I-LI-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION INTERFACE SIGNALS LIST.</p> <p>4.15.4. The IED (IR) shall communicate with protocols according to I-DE-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION ARCHITECTURE DIAGRAM.</p>			

	TECHNICAL SPECIFICATION	No. I-ET-3010.00-5140-741-P4X-003	REV. J
	UNIT:	SHEET: 19 of 30	
	TITLE: POWER PANEL FOR THYRISTORIZED HEATER FOR OFFSHORE UNITS	INTERNAL	
		ESUP	

4.15.5. Power Panels Type II MMR shall provide the monitoring functions above in the place of the IR.

4.16. ELECTROMAGNETIC COMPATIBILITY (EMC)

4.16.1. 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.

4.17. CONTROL VOLTAGES

4.17.1. Power Panel sections internal control voltages shall be designed to receive internal power supply for the powering of all common control equipment (AFD, Insulation monitoring, HMI, CB control, etc.) as well as powering the contactor coils in the thyristor sections.

4.17.2. The internal control voltages for the Power Panel types I shall be supplied by one internal auxiliary transformer (VT) connected to the main power supply, with secondary voltage 120Vac.

4.17.3. The internal control voltages for the Power Panel types II shall be supplied by two redundant internal auxiliary transformers (VTs) connected to the main power supply, with secondary voltage 120Vac. There shall be a selector switch to select the VT that will be in operation.

4.17.4. 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.

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

4.18. NAMEPLATES AND MARKINGS

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

4.18.2. Power Panel shall be outfitted with plate of supplemental identification containing, at least, the following data:

- PETRÓLEO BRASILEIRO S.A. - PETROBRAS.
- name of the department of the PETROBRAS.
- name of the enterprise (platform).
- TAG number of the panel.
- number of the RM.
- number of the Order of Purchase of Material (PCM).
- number of the Authorization of Material Supply (AFM).
- 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.).

4.18.3. Power Panel's nameplate shall include its feeders/transformers feeder TAG.

4.18.4. 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 D.S..

**TECHNICAL SPECIFICATION**

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

REV. J

UNIT:

SHEET: 20 of 30

TITLE:

POWER PANEL FOR THYRISTORIZED HEATER FOR OFFSHORE UNITS

INTERNAL

ESUP

- 4.18.5. Black acrylic plates with white letters shall identify all outgoing and vertical sections.
- 4.18.6. 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.
- 4.18.7. 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.).
- 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.
- 4.18.8. The circuit-breakers labels shall include rated current and trip current set.
- 4.18.9. 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.
- 4.18.9.1. All electrical equipment, floor mounted, panels, or similar in construction to a panel, regardless of the area where it is installed, shall have the following warnings as required by NR-10.
- 4.18.9.2. Warnings shall follow the standard labels as required in ABNT NBR 13434-2 for electrical panels risk of shock also informed in I-ET-3010.00-5400-947-P4X-002 - SAFETY SIGNALLING.
- 4.18.9.3. The thyristor panels shall have warning labels following the model below, with the values of the protective clothing risk category (in field “Nível de Proteção do EPI”) rated voltage (in field “Nível de Tensão”), arc-flash hazard distance (in field “Distância Segura de Aproximação para Atividades Sujeitas a Arco Elétrico”) and arc fault incident energy (in field “Energia Incidente”). The values to be filled in will be informed to Panel Manufacturer during Detailed Design.




RISCO DE ARCO ELÉTRICO
E CHOQUE
UTILIZE O EPI RECOMENDADO

NÍVEL DE PROTEÇÃO DO EPI: _____
TENSÃO NOMINAL DO PAINEL: _____V
DISTÂNCIA SEGURA DE APROXIMAÇÃO PARA ATIVIDADES
SUJEITAS A ARCO ELÉTRICO: _____cm
ENERGIA INCIDENTE: _____cal/cm²

- 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.

- 4.18.10. 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.
- 4.18.11. Other warning labels may be required by NR-10, those shall be verified in I-ET-3010.00-5400-947-P4X-002 - SAFETY SIGNALLING.
- 4.18.12. No adhesives shall be used to fix plates or labels, except, as indicated in 4.18.7 note.

5. TESTS

5.1. GENERAL

- 5.1.1. The Manufacturer or an independent inspection authority accepted by PETROBRAS shall perform all inspections and tests, in conformity with the specification documents and applicable rules.
- 5.1.2. Manufacturer shall be responsible for obtaining all necessary certification related to the equipment.
- 5.1.3. 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.
- 5.1.4. Cancelled.

5.1.5. 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 and to verify if the Power Panel is ready to start operation.

5.2. DESIGN VERIFICATION (TYPE TESTS)

5.2.1. Type tests, or Design verification shall follow the requirements of IEC 61439-1, IEC 61439-2, IEC 60092-302 and IEC 61892-3. According to IEC 61439-1, the methods that check design verification are testing, comparison with a tested reference design or assessment (confirmation of the correct application of calculations and design rules, including use of appropriate safety margins). Design verification and methods are summarised in Table 3, where they are identified as “D”.

5.2.2. Certified test reports for design verification tests performed for identical panels or a panel tested reference design (when applicable, according to IEC 61439-1) and approved and witnessed by Classification Society are accepted. These reports shall be included as proposal by manufacturer.

5.3. ROUTINE VERIFICATION

5.3.1. Routine tests shall follow the requirements of IEC 61439-1, IEC 61439-2, IEC 60092-302 and IEC 61892-3. They are summarised in Table 3, where they are identified as “R”.

5.3.2. Routine tests shall be carried out for all Panels.

5.4. SPECIAL TESTS

5.4.1. Special tests shall be carried out according to Table 3 where they are identified as “S”.

5.5. MINIMUM TEST LIST

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

Table 3 - Minimum Tests List

Test	D	R	S	Method and Acceptance Criteria
Examination of technical documentation ⁽¹⁾	x	x	x	
Verification of certificate of accuracy for measurement instruments to be used in tests ⁽¹⁾	x	x	x	
Dimensional verification		x		Panel Data-sheet
Visual inspection, verification of data on nameplates and labels and Marking Tests		x		IEC 61439-1 and this ET
Painting (colour, thickness and adhesion)		x		I-ET-3010.00-1200-956-P4X-002 - GENERAL PAINTING and this ET
Verification by testing of the resistance to corrosion	x			Severity Test B – IEC 61439-1
Verification by testing of thermal stability of enclosures	x			IEC 61439-1
Verification by testing of resistance of insulating materials to abnormal heat and fire due to internal electric effects	x			IEC 61439-1
Verification by assessment of resistance to ultra-violet (UV) radiation	x			IEC 61439-1
Lifting test	x			IEC 61439-1

Test	D	R	S	Method and Acceptance Criteria
Verification by assessment of incorporation of switching devices and components	x			IEC 61439-1
Verification by comparison of a reference design or by testing of temperature rise limits	x			IEC 61892-3 and IEC 61439-1
Verification by testing of dielectric properties	x			IEC 61439-1, IEC 61439-2 and IEC 61180
Verification by testing of short-circuit withstand strength ⁽⁶⁾	x			IEC 61439-1
Verification by testing of protection against electric shock and integrity of protective circuits	x	x		IEC 61439-1
Verification by testing of clearance and creepage distances	x	x		IEC 61439-1
Verification by testing of mechanical operation	x	x		IEC 61439-1 and IEC 61439-2
Verification by assessment of degree of protection of enclosure (IP)	x	x		IEC 61439-1, IEC 61439-2 and IEC 60529
Wiring, operational performance and function		x		IEC 61439-1
Mechanical impacts tests	x			IEC 61439-1 and IEC 62262
Verification by assessment of internal electrical circuits and connections	x	x		IEC 61439-1
Verification by assessment of terminals for external conductors	x	x		IEC 61439-1
Inspection of assembly, inspection of wiring and electrical operation test		x		IEC 61439-1
EMC – Conducted emission test ⁽²⁾	x			IEC 60533
EMC – Radiated emission test ⁽²⁾	x			IEC 60533
EMC – Conducted low frequency interference ⁽²⁾	x			IEC 60533
EMC – Power supply variation ⁽²⁾	x			IEC 60533
EMC – Power supply failure ⁽²⁾	x			IEC 60533
EMC – Surge voltage test ⁽²⁾	x			IEC 60533
EMC – Electrical fast transient test ⁽²⁾	x			IEC 60533
EMC – Electromagnetic field test ⁽²⁾	x			IEC 60533
EMC – Electrostatic discharges (ESD) ⁽²⁾	x			IEC 60533
EMC – Conducted radio frequency interference test ⁽²⁾	x			IEC 60533
Dielectric test or verification of insulation resistance		x		IEC 61439-1
Complete functional tests (including interlocks) ⁽⁴⁾		x		Project documents and IEC 61850
Verification of measuring instruments		x		Project documents
Verification of relays parametrization and operation ⁽⁵⁾		x		Selectivity study and IEC 61850
Verification of signalling devices		x		Project documents
Verification of heating resistors operation		x		This ET and Data-sheet
Test of interchangeability of drawers		x		This ET
Temperature rise for circuit-breakers	x			IEC 60947-2
Tripping limits and characteristics for circuit-breakers	x			IEC 60947-2
Dielectric for circuit-breakers	x			IEC 60947-2
Operation performance capability for circuit-breakers, where applicable	x			IEC 60947-2
Overload performance for circuit-breakers, where applicable	x			IEC 60947-2
Short-circuit breaking capability for circuit-breakers, where applicable	x			IEC 60947-2
Short-time withstand current for circuit-breakers, where applicable	x			IEC 60947-2

Test	D	R	S	Method and Acceptance Criteria
Voltage and current harmonic measurement up to 50 th component		x		This ET ⁽⁸⁾
Thyristors efficiency measurement	x			Manufacturer standard ⁽⁷⁾

- Notes:
1. For all witnessed tests;
 2. EMC tests shall be carried out when required in IEC 60533 for the equipment installed in the Panel;
 3. **Cancelled.**
 4. These tests shall include all tests related to network communication among devices (alarms, interlocks, GOOSE, etc.). For IEC 61850 networks, these tests shall use calibration boxes certified for IEC 61850;
 5. These tests shall include check of A/D converters of relays. For relays specified for IEC 61850 protocol, these tests shall use calibration boxes certified for IEC 61850.
 6. Design verification by comparison with a reference design for short-circuit withstand strength of the protective circuit can be submitted for PETROBRAS analysis and approval.
 7. Thyristors measured efficiency shall be equal to or higher than efficiency informed in documents for proposal.
 8. For this measurement either, a power quality meter shall be incorporated to panel, or a safe access to internal voltage and current transformers shall be available. See Note in section 6.3.1 i).

6. MANUFACTURER DOCUMENTATION

Documents provided by 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.

6.1. DOCUMENTS TO PROPOSAL

- 6.1.1. The following documents and information shall be annexed to the 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 i^2t .
 - 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 maximum i^2t values of the moulded case circuit-breakers.

- l) One-line electrical drawings.
- m) Other documents required in project documentation.

6.2. DOCUMENTS FOR APPROVAL

6.2.1. The following documents and information shall be submitted for PETROBRAS 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 maximum i^2t values of the moulded case circuit-breakers.
- 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.
- q) Inspection and Test Plan (ITP) including all tests listed in item 5.

6.3. DOCUMENTS AFTER APPROVAL

6.3.1. 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.

Note: This test measurement shall be done at factory. A power quality monitoring report shall be issued presenting: currents and voltages rms and wave values, and records of voltage and current peaks. Analysis of dV/dt and di/dt maximum values comparing to installed maximum thyristor acceptance values and its protection devices (MOV, Snubber, etc) shall also be submitted.

Provisions shall be provided (safe access to internal voltage and current transformers or a power quality meter) for repeating this test measurement later at site, with loads installed.

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

Note: 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.

7. PACKAGE, TRANSPORT AND STORAGE

- 7.1. Panels shall be packed properly for the foreseen transportation, so that no damage occurs during transport, storage and lifting operations.
- 7.2. Each volume shall be properly identified with:
- a) Storage position.
 - b) PETROBRAS unit, achievement, and business unit.
 - c) Delivery address.
 - d) Material Requisition number.
 - e) Transformer PETROBRAS TAG.
 - f) Manufacturer name and address.
 - g) Weight.
 - h) Contract number.
- 7.3. Equipment transport shall be indicated as defined in IEC 60721-3-2.
- 7.4. Equipment storage conditions shall be indicated as defined in IEC 60721-3-1.

8. TRAINING

- 8.1. Manufacturer shall provide training for at least 10 (ten) PETROBRAS personnel, about Panels system and components.
- 8.2. Training shall be provided in Brazil, during commissioning period, in Portuguese language.

**TECHNICAL SPECIFICATION**

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

REV. J

UNIT:

SHEET: 27 of 30

TITLE:

POWER PANEL FOR THYRISTORIZED HEATER FOR OFFSHORE UNITS

INTERNAL

ESUP

8.3. 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 software, configuration, parameterization and adjustment, equipment, and devices.

8.4. Manufacturer shall provide training record file (audio and video) and training material file (pdf, powerpoint or word) within 5 days after training.

9. SPARE PARTS AND TOOLS

9.1. 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.

9.2. Manufacturer shall provide the necessary spare parts for the commissioning and pre-operation periods.

9.3. Manufacturer shall provide a list of spare parts for all electrical equipment, for at least 2 (two) years of continuous operation, including prices and part number codes.

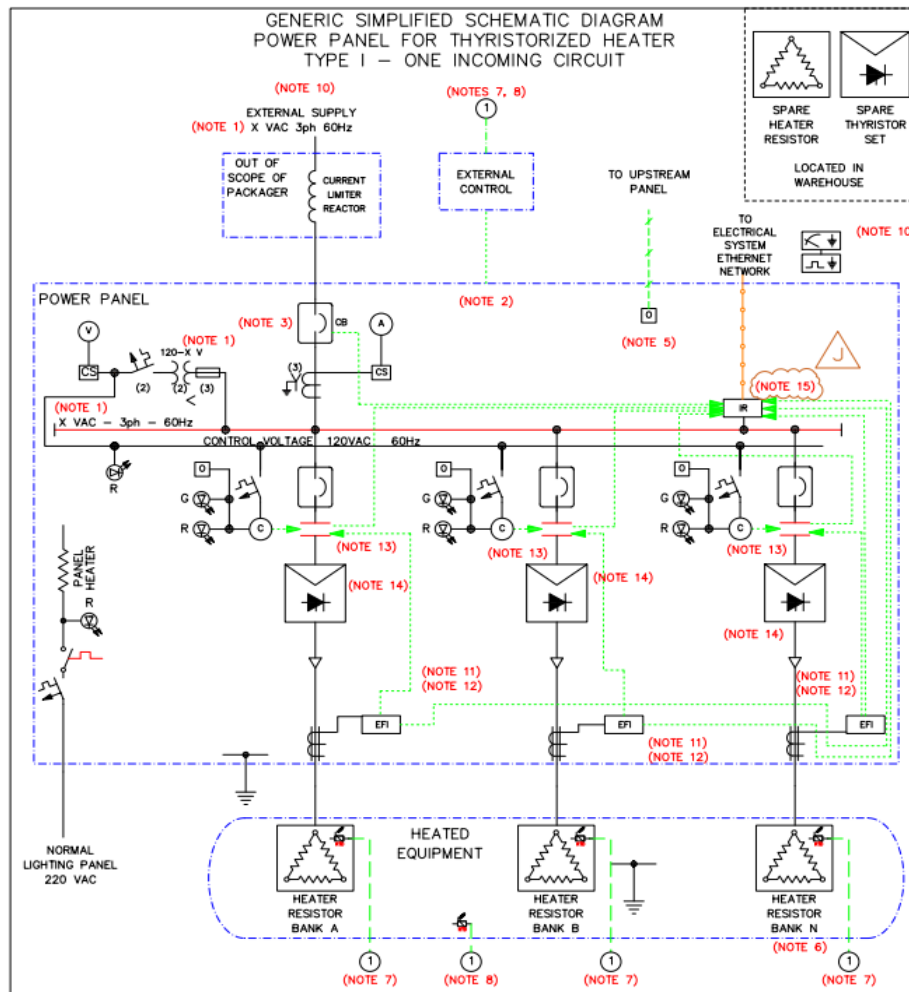
9.4. Manufacturer shall provide all unusual tools necessary for maintenance, assembly or disassembly of the equipment.

9.5. Components requiring periodic replacement shall be listed in the spare parts list with the recommended replacement frequency.

10. ACRONYMS

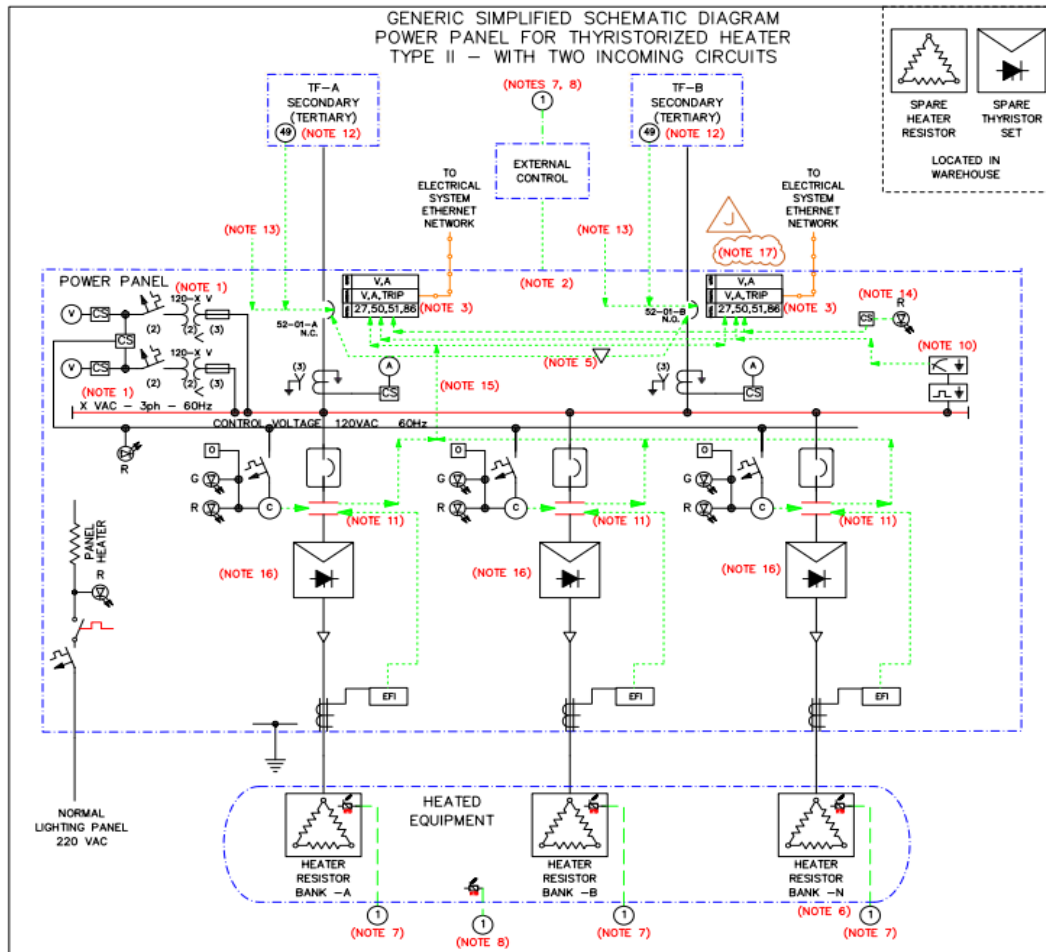
AC	Alternate current	IEC	International Electrotechnical Commission
ACB	Air circuit-breaker	IED	Intelligent Electronic Device
A&C	Automation and Control System	IEEE	Institute of Electrical and Electronics Engineers, Inc
AFD	Arc Flash Detector	IR	Intelligent Relay
ANSI	American National Standards Institute, Inc	IT	Isolated system, or impedance earthed system
ASTM	American Society for Testing and Materials	IMD	Insulation Monitoring Device
CB	Circuit-Breaker	MCB	Moulded-case circuit-breaker
CDC	Switchgear (<i>Centro de Distribuição de Cargas</i>)	MCC	Motor Control Center
CT	Current transformer	MCT	Multi-cable transit
CSS	Control System Station	MMR	Microprocessed-based multifunction relay
DC	Direct current	MODU	Mobile Offshore Drilling Units
EFI	Ground fault detector (Earth Fault Indicator)	MOV	Metal Oxide Varistor
EMC	Electromagnetic Compatibility	MTBF	Mean time between failure
ESD	Emergency shut-down	MTTR	Mean time to repair
FPSO	Floating Production Storage and Operation Unit	NEMA	National Electrical Manufacturers Association
FSO	Floating Storage and Operation Unit	PE	Protective earth (bar)
HMI	Human Machine Interface	PF	Power factor
IE	Instrument earth (bar)	VT	Voltage transformer

11. 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 PACKAGE UNITS.
- 3- Incoming circuit-breaker may be excluded, depending on requirements of item 4.10.3.
- 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- The IMD (Insulation Monitoring Device) is installed in the CDC/MCC upstream of the Power Panel for Thyristorized Heater. Manufacturer shall guarantee full compatibility between EFI and upstream CDC's IMD. When the Power Panel is fed by dedicated transformer, the Power Panel shall be supplied with its own IMD within the Power Panel.
- 11- EFIs shall be used to disconnect the power supply whenever the insulation resistance is not greater than 50 ohms per volt of rated voltage, in accordance with IEC 60079-14. The trip signals shall be sent to the corresponding faulty feeder contactors.
- 12- Low insulation shall generate an alarm signal to be sent to topside electrical system automation controllers.
- 13- Status signals (ON / OFF) to remote monitoring from Electrical System Workstations.
- 14- Power Electronics / Thyristor modules shall include fast (high-speed) fuses to protect thyristors.
- 15- The interconnection from IRs, MMR and IMD to ESA, among other internal components to be defined in detailed design, shall be made through internal switches according to I-ET-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION ARCHITECTURE.

12. 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 PACKAGE 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- EFIs shall be used to disconnect the power supply whenever the insulation resistance is not greater than 50 ohms per volt of rated voltage, in accordance with IEC 60079-14. The trip signals shall be sent to the corresponding faulty feeder contactors.
- 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.
- 14- "Operação / Manutenção" selector switch and respective signalling. See 4.14.1.
- 15- Individual Status SIGNAL from each output to be sent to MMR, as defined in 4.13.3 and 4.13.4.
- 16- Power Electronics / Thyristor modules shall include fast (high-speed) fuses to protect thyristors.
- 17- The interconnection from IRs, MMR and IMD to ESA, among other internal components to be defined in detailed design, shall be made through internal switches according to I-ET-3010.00-5140-797-P4X-001 - ELECTRICAL SYSTEM AUTOMATION ARCHITECTURE.