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			ESUP

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DATE	AUG/29/22	OCT/31/22	MAR/28/24	JUN/15/24					
DESIGN	ESUP	ESUP	ESUP	ESUP					
EXECUTION	CLT0	CLT0	CLT0	CLT0					
CHECK	KJK9	ZP0G	U4U8	U4U8					
APPROVAL	UQBE	UQBE	BD36	UQBE					

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1 OBJECTIVE

- 1.1 This specification establishes the general conditions for all electrical equipment of PETROBRAS Offshore Units, including installations in modules and packages.
- 1.2 Requirements stated for equipment in other specific Technical Specifications issued by PETROBRAS (e.g., induction motors, generators, switchgears, MCCs (Motor Control Center), UPSs (Uninterruptible Power System), VSDs (Variable Speed Drive), thyristorized panels, transformers, generic panels, soft starters, inverters, batteries, batteries chargers, lighting, etc., are mandatory and shall prevail over this Technical Specification.
- 1.3 Classification Society requirements shall prevail over requirements of this document.

2 REFERENCE STANDARDS AND DOCUMENT LIST

2.1 GENERAL

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

2.2 CODES, STANDARDS AND RECOMMENDED PRACTICES

2.2.1 IEC – INTERNATIONAL ELECTROTECHNICAL COMMISSION

IEC 60068-2-2	Environmental Testing - Part 2-2: Tests - Test B: Dry Heat
IEC 60079	Explosive Atmospheres - All parts
IEC 60092	Electrical Installations in Ships - All Parts for FPSO and FSO or when required
IEC 60533	Electrical and Electronic Installations in Ships - Electromagnetic Compatibility
IEC 61000	Electromagnetic Compatibility (EMC) - All parts
IEC 61850	Communication networks and systems for power utility automation– All parts
IEC 61892	Mobile and Fixed Offshore Units - Electrical Installations - All parts
IEC 62262	Degrees of Protection Provided by Enclosures for Electrical Equipment Against External Mechanical Impacts (IK Code).


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

2.2.2 IEEE – INSTITUTE OF ELECTRICAL AND ELECTRONIC ENGINEERING

Std 519	IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems
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2.2.3 IMO - INTERNATIONAL MARITIME ORGANIZATION

IMO IA811E	Code for the Construction and Equipment of Mobile Offshore Drilling Units (MODU CODE)
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2.2.4 LABOUR SECRETARY - MINISTRY OF ECONOMY - REGULATORY STANDARDS FOR OCCUPATIONAL SAFETY AND HEALTH						
NR-10 Segurança em Instalações e Serviços em Eletricidade NR-12 Segurança no Trabalho em Máquinas e Equipamentos NR-37 Segurança e Saúde em Plataformas de Petróleo						
2.2.5 INMETRO – INSTITUTO NACIONAL DE METROLOGIA NORMALIZAÇÃO E QUALIDADE INDUSTRIAL						
Portaria nº 115 March 21 st , 2022.						
2.2.6 AMERICAN SOCIETY FOR TESTING AND MATERIALS (WHERE SPECIFIED)						
ASTM B846 Standard Terminology for Copper and Copper Alloys						
2.2.7 ABNT – ASSOCIAÇÃO BRASILEIRA DE NORMALIZAÇÃO TÉCNICA						
ABNT NBR 16820 Sistemas de sinalização de emergência — Projeto, requisitos e métodos de ensaio						
2.2.8 ANVISA – AGÊNCIA NACIONAL DE VIGILÂNCIA SANITÁRIA						
RDC 72/2009 - RESOLUÇÃO Nº 72, DE 29 DE DEZEMBRO DE 2009						
2.3 REFERENCE DOCUMENTS						
[1] I-ET-3010.00-5140-700-P4X-001 - SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS [2] I-ET-3010.00-5140-700-P4X-008 – SPECIFICATION FOR LIGHTING AND ELECTRICAL SIGNALLING FOR OFFSHORE UNITS [3] I-ET-3010.00-1200-956-P4X-002 - GENERAL PAINTING [4] I-ET-3010.00-5400-947-P4X-002 - SAFETY SIGNALLING [5] MOTION ANALYSIS [6] I-ET-3010.00-5140-714-P4X-001 - SPECIFICATION FOR ELECTRICAL BATTERIES FOR OFFSHORE UNITS [7] I-ET-3010.00-5140-741-P4X-001 - LOW-VOLTAGE MOTOR CONTROL CENTER AND SWITCHGEAR FOR OFFSHORE UNITS [8] I-ET-3010.00-1200-940-P4X-002 - GENERAL TECHNICAL TERMS						
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.						



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3 GENERAL EQUIPMENT CONDITIONS

3.1 GENERAL TECHNICAL TERMS

All technical terms used in this specification, such as Manufacturer, Supplier, Vendor, Bidder shall follow the definitions described in I-ET-3010.00-1200-940-P4X-002 - GENERAL TECHNICAL TERMS.

3.2 ENVIRONMENTAL CONDITIONS

All equipment, materials and accessories used in electrical installations shall be suitable for storage, service, and installation on severe petrochemical, marine, tropical, damp, and saline environment described on the MOTION ANALYSIS.

3.2.1 TROPICALIZATION REQUIREMENTS

3.2.1.1 To fulfil this requirement, all electrical and electronic devices, beyond mechanical parts of the equipment, shall be designed and constructed in a tropicalized version.

3.2.1.2 Tropicalization process comprises use of anti-rust materials and accessories and other implementations according to manufacturers' experiences and related rules, aiming to provide a robust and reliable construction.

3.2.2 HUMIDITY REQUIREMENTS

3.2.2.1 Unless otherwise defined by Specific Datasheet or Equipment Technical Specification, relative humidity operation definitions shall be defined by either IEC 61892-1 or Classification Society.

3.2.2.2 Consider climatic class CX typical atmospheric environments related to the estimation of corrosivity categories, as defined in IEC 61892-1.

3.2.3 TEMPERATURE REQUIREMENTS

3.2.3.1 Electrical equipment and its components shall be designed based on reference temperatures established in Datasheets and Technical Specifications.

3.2.3.2 Either IEC 61892-1 or Classification Society rules shall be applied. Temperature conditions different from the established requirements shall be submitted to PETROBRAS approval.

3.2.3.3 Electrical equipment shall be sized and operate properly, for continuous operation at monthly/yearly average temperatures, and minimum to maximum temperatures, all listed in Table 1.

Table 1 - Reference Temperatures
Ambient Temperature for Electrical Equipment Sizing (°C)

Equipment	Local	Indoor Area			Outdoor Area		
		Minimum	Monthly/Yearly Average	Maximum	Minimum	Monthly/Yearly Average	Maximum
Generators and motors		10	45 ⁽⁶⁾	45 ⁽⁶⁾	10	45	45
Panels ⁽¹⁾		10	45	45	10	45	45
Electrical Cables		10	45	45	10	45	45
Transformers, Reactors and Grounding Resistors		10	45	45	10	45	45
Battery ⁽⁷⁾		10	45	45	10	45	45
Battery Chargers and Rectifiers		10	45	45	10	45	45
Electronic Devices Outside Panels		10 ⁽²⁾	70 ⁽²⁾	70 ⁽²⁾	10	55	55
		-5 ⁽³⁾	55 ⁽³⁾	55 ⁽³⁾			
Electronic Devices Inside Panels		10 ⁽²⁾	70 ⁽²⁾	70 ⁽²⁾	10	70	70
		-5 ⁽³⁾	55 ⁽³⁾	55 ⁽³⁾⁽⁵⁾			

Notes: 1) Related to electrical panels unless otherwise defined by Specific Datasheet or Equipment Technical Specification;
 2) For equipment in ventilated room;
 3) For equipment in air-conditioned room;
 4) Equipment inside refrigerant chambers shall comply with Classification Society requirements;
 5) For switches, consider temperature 85°C according to IEC 60068-2-2;
 6) For machine rooms with steam boilers temperature shall be 50°C;
 7) For sizing equipment in Battery Room, for battery sizing see I-ET-3010.00-5140-714-P4X-001 - SPECIFICATION FOR ELECTRICAL BATTERIES FOR OFFSHORE UNITS.

3.3 HEAT DISSIPATION CHARACTERISTICS

3.3.1 For equipment installed in internal rooms, the equipment Manufacturer shall inform the quantity of dissipated heat, under normal and maximum operational conditions.

3.3.2 This information shall be included in vendor documentation.

3.4 MOTION AND INCLINATION LIMITS REQUIREMENTS

3.4.1 When installed in floating units and ships (FPSO and FSO), all electrical equipment shall be suitable to operate under inclination variations (static and dynamic) and acceleration conditions specified by IMO MODU CODE, IEC 61892-5, and Classification Society.

3.4.2 As defined in IEC 61892-5, and according to IMO MODU CODE:

- For normal loads and for main generation systems: machines, equipment, and apparatus in general: 15° either way in list and simultaneously trimmed 5° by the bow or stern.
- For auxiliary generation systems: from upright and in level trim to an angle of inclination of 15° either way and simultaneously trimmed up to 5° by the bow or stern.
- For emergency generation and essential loads: 22° 30' about the longitudinal axis and/or when inclined 10° about the transverse axis, unless otherwise required by the design basis for the unit in the agreed location, see MOTION ANALYSIS.

3.5 VIBRATION LIMITS REQUIREMENTS

All electrical equipment shall operate normally within vibration limits specified in their respective standards. For unit accelerations and movements see MOTION ANALYSIS and Classification Society rules.

3.6 HAZARDOUS AREAS REQUIREMENTS

- 3.6.1 The application of electrical equipment, instruments and accessories on hazardous areas shall follow the requirements of IEC series 60079-14 and 61892-7.
- 3.6.2 All materials and equipment proper to be used in hazardous areas, shall have conformity certificates complying with INMETRO Portaria nº 115, March 21st, 2022, and shall be approved by Classification Society.
- 3.6.3 Packager shall furnish a table with the data presented in Table 2 in a document, for each individual equipment.

Table 2 - Data Requirements for Equipment Installed in Hazardous Areas

Equipment Tag. No. / Component identification	Temperature Class
Equipment Description / Characteristics	Approval Body
Unit Location / Module	Certificate Type
Equipment Manufacturer	Certificate Number
Catalogue / Type Number	Zone of Use
IP Code	Accessories
Type of Ex Protection	Certificate of Conformity
Gas Group	
EPL (Equipment Protection Level)	

- 3.6.4 Electrical equipment installed in hazardous areas shall have the safety execution specified in accordance with standards IEC 60079, IEC 61892 series and, for FPSO/FSO units, IEC 60092.
- 3.6.5 Electrical equipment installed in external safe areas, that shall be kept operating during emergency shutdown (ESD-3P or ESD-3T) shall be certified, at least, for installation in hazardous areas Zone 2 (EPL Gc) Group IIA temperature T3, unless they are automatically disconnected if there is gas in the equipment area, according to IEC 61892-1.
- 3.6.6 All hazardous areas equipment type certificates shall be delivered to Petrobras for acknowledge and approval before equipment delivery. See I-ET-3010.00-5140-700-P4X-001 - SPECIFICATION FOR ELECTRICAL DESIGN FOR OFFSHORE UNITS for requirements.
- 3.6.7 Equipment installed in battery room shall be classified for Zone 1, Group IIC, T1.
- 3.6.8 Equipment installed in Paint rooms shall be classified for Zone 1, Group IIB, T3.
- 3.6.9 All Ex equipment which needs to be operated during ESD condition shall be marked for easy identification with “ESD” label, equal to the one bellow, including Ex equipment installed in safe area (outside hazardous area).



ATENÇÃO

ESTE EQUIPAMENTO SERÁ MANTIDO ENERGIZADO
DURANTE CONDIÇÃO DE ESD.
EMERGENCY SHUT DOWN

3.7 CONSTRUCTION REQUIREMENTS

3.7.1 GENERAL

- 3.7.1.1 All equipment shall be supplied with terminal connectors for power, control, heating, and grounding.
- 3.7.1.2 Unless otherwise stated in specific equipment technical specification, for 3.7.1.1 the connectors shall be made of non-welded type on copper alloy with high mechanical resistance, as ASTM B846, with tin coat.
- 3.7.1.3 Unless otherwise stated in specific equipment technical specification, for control cables, these connectors shall be eye type.
- 3.7.1.4 Suitable sheet or removable covers shall be provided to avoid accidental contact with energized parts in the interior of the equipment live parts, as required in NR-10.

3.7.2 OBSOLESCENCE CRITERIA

- 3.7.2.1 It shall not be acceptable out of date or obsolete equipment or components.
- 3.7.2.2 Technical support and supply of replacement parts shall be guaranteed for, at least, ten (10) years.

3.7.3 FIXING BASE

- 3.7.3.1 All floor-mounted equipment besides their normal base shall have an extra base, to which the normal base shall be fixed by means of screws. The extra base shall be fixed (welded) to the Unit floor.
- 3.7.3.2 This base shall be dimensioned like a two point supported beam on the longitudinal direction to support the whole equipment weight, considering a maximum deflection of 1/500 of the equipment length. This base shall have its sides covered by plates to avoid the access of humidity to the equipment lower section.

3.7.3.3 To avoid a dangerous inclination of equipment when manoeuvring equipment 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 solutions may be accepted if it is previously submitted and approved by PETROBRAS.

3.7.4 PAINTING

3.7.4.1 GENERAL

3.7.4.1.1 Paint system for external coating of all electrical equipment, material and supports shall be proper for offshore installation and pre-qualified according to I-ET-3010.00-1200-956-P4X-002 - GENERAL PAINTING.

3.7.4.1.2 Painting system for internal coating of all electrical equipment and material shall be proper for offshore installation according to manufacturer requirements, when not specified by PETROBRAS.

3.7.4.2 COLOURS

3.7.4.2.1 Colours shall comply with NR-37.

3.7.4.2.2 Unless otherwise stated in equipment documentation, the last coat colour for electrical equipment shall be Light Green Munsell 5G8/4.

3.7.4.2.3 For firefighting associated equipment, the last coat colour shall be Safety Red Munsell 5R4/14.

3.7.4.2.4 For handling equipment, the last coat colour shall be Yellow Munsell 5 Y 8/12.

3.7.4.2.5 For Totally Enclosed Fan Cooled (TEFC) motors, the last coat colour of fan cover shall be the same of the motor enclosure.

3.7.4.2.6 CANCELLED.

3.7.4.2.7 For carbon steel parts of lighting fixtures and junction boxes, the last coat colour shall be White Munsell N9.5.

3.7.4.2.8 For stainless steel lighting fixtures, no coat colour is required.

3.7.4.2.9 For FRP materials, no coat colour is required, unless otherwise required by a standard, regulation, or PETROBRAS.


3.7.4.2.10 For Cable Trays, Steel Conduits, and Junction Boxes:

- If Metallic and indoors – it shall be White (MUNSELL Notation N 9.5).
- If Metallic and outdoor – it shall be Ice Gray (MUNSELL Notation N 8).
- If FRP: no requirement of colour (as defined in 3.7.4.2.9).

3.7.4.3 STAINLESS STEEL

3.7.4.3.1 Stainless steel surfaces shall be painted if exposed do saline atmosphere and temperatures above the limits indicated, as defined in I-ET-3010.00-1200-956-P4X-002 - GENERAL PAINTING:

- 316L - with service temperature over 50°C shall be coated.
- Duplex SS - service temperature over 80°C shall be coated.

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<ul style="list-style-type: none"> • Superduplex SS - service temperature over 90°C shall be coated. 			
3.7.4.4 HDG STAINLESS STEEL			
3.7.4.4.1 HDG (hot-dip galvanized) carbon steel shall be painted according with I-ET-3010.00-1200-956-P4X-002 - GENERAL PAINTING.			
3.7.5 IDENTIFICATION NAMEPLATE			
3.7.5.1 Identification nameplates for equipment with specific Technical Specification (e.g., induction motors, generators, MCCs and switchgears) shall follow the requirements of that specification.			
3.7.5.2 All other equipment shall have 02 (two) identification nameplates.			
3.7.5.3 The first plate shall have the equipment tag number, in black acrylic engraved with white letter for equipment installed indoors and in stainless steel AISI-316 for equipment installed outdoors.			
3.7.5.4 The other plate shall be in stainless steel AISI-316 with the following information, when applicable, in Portuguese language:			
<ul style="list-style-type: none"> • Petróleo Brasileiro S.A. – PETROBRAS. • Fornecedor (vendor name). • Número de Série (equipment serial number). • Ano de fabricação (year of manufacture). • Número do pedido de compra (purchase order number). • Other equipment specific data. • Fabricante (manufacturer name). • Tipo (type). • Padrão de desempenho (performance standard). • Valores nominais para: potência aparente de saída, tensões, frequência, correntes (rated values for: output apparent power, voltage(s), frequency, currents). • Classificação térmica da isolação (thermal classification of insulation). • Grau de proteção IP do invólucro e caixa de terminais (IP code of enclosure and termination box). • Grupo de ligação de bobinas (vector group of windings). • Máxima temperatura admissível para o meio refrigerante (maximum permissible cooling medium temperature). • Valores das impedâncias de curto-circuito (short-circuit impedances values). • Tipo do meio refrigerante (type of cooling medium). • Massa total (total mass). 			

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3.7.6 MECHANICAL PROTECTION DEGREE AND TYPE REQUIREMENTS

- 3.7.6.1 All equipment shall have an IP protection according with the Table 3, unless Classification Society requires a higher level of IP protection.
- 3.7.6.2 All equipment with mechanical protection degree IP44 or higher shall have test certificates issued by an authorized and properly identified laboratory.
- 3.7.6.3 All equipment enclosure shall have an external mechanical impact strength (IK) of minimum IK 08 as defined in IEC 62262.

Table 3 - Hazardous and Minimum IP Protection Code Related to Equipment Type and Location.

Equipment ⇒ Location ↓	Transformer	Panels ⁽⁴⁾	Busbar Trunking	Rectifiers, Battery Chargers and UPSs	Lighting Fixtures ⁽¹⁰⁾	General Equipment and Junction Boxes	Power Switches and Socket-outlets ⁽¹⁰⁾
Process Areas	Ex ⁽⁷⁾	Ex ⁽⁷⁾	(2)	(2)	IP55 Ex ⁽⁸⁾	IP55W Ex e	IP55W Ex de
Machinery Room / Engine Room / Utility Room ⁽¹⁾	IP54W	IP44	IP44	IP44	IP55	IP55W	IP44
Electrical Equipment Room (Normal or Essential)	IP22	IP42	IP42	IP42	IP34	IP44	IP44
Exposed Deck – Non-Hazardous Area ⁽¹⁾	IP55W	IP56W	(2)	(2)	IP56 Ex ⁽⁸⁾	IP56W	IP56W Ex de
Pontoons, Pump Room (below sea water line)	(2)	(2)	(2)	(2)	IP55	IP68	IP44
Pump Room (above sea water line)	(2)	(2)	(2)	(2)	IP55	IP55W	IP55W
Battery Room, Paint Store, acetylene gas Storage Room.	(2)	(2)	(2)	(2)	IP55 Ex ⁽⁸⁾	IP55W Ex e	(2)
Accommodations dry areas	IP22	IP21	IP42	IP21	IP21	IP22	IP20
Accommodations wet spaces, toilets, and dressing rooms.	(2)	(2)	(2)	(2)	IP44	IP55W	IP22
Galley, Laundry, Mess Room ⁽¹¹⁾ and Laboratory ⁽⁶⁾	IP44	IP44	IP44	(2)	IP44	IP44	IP44
Control Room	(2) ⁽⁵⁾	IP42	(2)	IP42	IP22	IP22	IP22
Freezer Room and surrounding areas	(2)	(2)	(2)	(2)	IP55	IP55W	IP55W
Spaces protected by water deluge system ⁽¹⁾	IP55W	IP55	(2)	(2)	IP55	IP55W	IP55W
Spaces which may have water hose washing	IP55W	IP54	(2)	(2)	IP54	IP55	IP56W
Spider deck of SS	(2)	(2)	(2)	(2)	IP55 Ex ⁽⁸⁾	IP56W	IP56W
Main deck of ship, FPSO, FSO, overload tank	(2)	IP56W Ex ⁽⁷⁾	(2)	(2)	IP55 Ex ⁽⁸⁾	IP56W Ex e	(2) ⁽⁹⁾
Production deck of FPSO, FSO when subjected to sea waves (green water)	(2)	IP56W	(2)	(2)	IP55 Ex ⁽⁸⁾	IP56W Ex e	IP56W Ex de
Hazardous Areas	Ex ⁽⁷⁾	Ex ⁽⁷⁾	(2)	(2)	Ex ⁽⁸⁾	Ex e	IP56W Ex de

- Notes:
- 1) Electrical equipment shall be installed below floor grid cellar, subject to flooding, water jet, and damage caused by maintenance or heavy load handling, only if strictly necessary.
 - 2) Equipment shall not be installed in these locations.
 - 3) The suffix W means equipment resistant to hydrocarbon vapours, water, salt atmosphere and oil.
 - 4) For switchgears and motor control centers, see specific technical specifications.
 - 5) Essential and emergency transformers may be acceptable in this area under PETROBRAS approval.
 - 6) Other minimum IP may be accepted for Laboratory, subject to PETROBRAS analysis and approval.
 - 7) When “Ex” only is indicated, it means that Hazardous Protection Code shall be applied considering area specific requirements.
 - 8) See I-ET-3010.00-5140-700-P4X-008 – SPECIFICATION FOR LIGHTING AND ELECTRICAL SIGNALLING FOR OFFSHORE UNITS for Ex classification.
 - 9) Installation of power sockets in main deck shall be submitted to PETROBRAS approval.
 - 10) For LIGHTING FIXTURES and POWER SOCKETS, the IP degree certificates don't have to include the supplementary letter "W", however, vendors shall supply extra documentation (in Technical Proposal) to guarantee that their products are resistant to hydrocarbon vapours, water, salt atmosphere and oil.
For Junction Boxes and Push-buttons, certificates shall include the supplementary letter "W".
For other equipment and/or material it shall be analysed in Technical Proposals.
 - 11) Washing and sanitizing mess room areas is requirement, according to Art. 7 of Anvisa's RDC 72/2009, Section IX, thus defining the IP for Wet spaces (internal dependencies, in non-industrial areas, subject to the presence of moisture and water, in the form of splashes or jets, in normal use or subject to washes).

3.8 WARNING LABELS FOR ELECTRICAL EQUIPMENT

3.8.1 All electrical equipment, floor mounted, panels, or similar in construction to a panel, regardless of the area where it is installed, shall have the warnings as required by NR-10 and NR-12.

3.8.2 Warnings shall follow the standard labels as required in ABNT NBR 16820 for electrical panels risk of shock as informed in I-ET-3010.00-5400-947-P4X-002 - SAFETY SIGNALLING.

3.8.3 For all 690 V panels, 480 V panels, and for all 220 V panels fed by a transformer with rated power higher than 125 kVA, the following label applies. The Panels shall have warning labels following the model below with:

- protective clothing risk category (in field “Nível de Proteção do EPI).
- the values of rated voltage (in field “Tensão Nominal do Painel”).
- arc fault incident energy (in field “Energia Incidente”), in Cal/cm².
- 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.

3.8.4 For CDC and MCC panels, requirements shall follow I-ET-3010.00-5140-741-P4X-001 - LOW-VOLTAGE MOTOR CONTROL CENTER AND SWITCHGEAR FOR OFFSHORE UNITS.



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 by authorized people.

3.8.5 ESD label warnings shall follow requirements of section 3.6.9.

3.9 VOLTAGE REQUIREMENTS

3.9.1 Unless otherwise stated, all A.C. (Alternate Current) equipment shall operate satisfactorily with voltage variations described in Table 4, based on IEC 61892-1. This table shows the maximum acceptable divergence of values referred to the rated voltage.

Table 4 - Reference Values for A.C. Voltage Variation

System withstand requirements				
Voltage characteristics		Value		Comments
Voltage Tolerance	Overtolerance	+6%		Steady state voltage tolerance on switchboards and distribution panels which electrical system and consumers in general shall withstand.
	Undervoltage	-10%		
Voltage transient variation		+15% -15%		Transient voltage tolerance on switchboards and distribution panels which consumers in general shall withstand.
Max. Voltage variation		+20% -20%		Voltage excursions (sum of transient and steady state deviation) on switchboards and distribution panels, which electrical system and consumers in general shall withstand.
System operational requirements				
Voltage characteristics		Value		Comments
		Normal	Emergency	
Voltage tolerance in primary distribution system	Cyclic voltage variation	+2.5% -2.5%	+3.5% -3.5%	Steady state voltage tolerance on generator switchboards.
Voltage tolerance in secondary distribution system	Cyclic voltage variation	+5% -5%		Steady state voltage tolerance on switchboards and distribution panels in secondary distribution system.
Voltage transients: slow transients e.g., due to load variation tolerance (deviation from nominal voltage)	Overtolerance	+20%	+20%	
	Undervoltage	-15%	-15%	
Transients Recovery Voltage		±3 %	±4%	After a transient condition has been initiated, the voltage in a main distribution system shall not differ from the voltage before the transient was initiated by more than ±3 % within 1.5 s. In an emergency system the limit is ±4% within 5 s.
Voltage transients recovery time		1.5 s	5	
Voltage Unbalance		7%		Including phase voltage unbalance because of unbalance of load.

Notes: Voltages are root mean square (RMS) unless otherwise stated.

3.9.2 All A.C. equipment shall operate satisfactorily with harmonic distortion (voltage waveform) in power supply up to the values defined in IEEE 519 for their respective voltage ranges.

For voltages up to 1 kV:

- Maximum total harmonic distortion - 8%.
- Maximum single harmonic content - 5%.

For voltages above 1 kV and up to 69 kV:

- Maximum total harmonic distortion - 5%.
- Maximum single harmonic content - 3%.

3.9.3 All D.C. (Direct Current) equipment shall operate satisfactorily with voltage variations described in Table 5. This table shows the maximum acceptable divergence of values referred to the rated voltage.

Table 5 - Reference Limits for D.C. Voltage Variation

Parameter		Variation [%]
Continuous Operation	Overvoltage ⁽¹⁾	+15
	Undervoltage ⁽¹⁾	-15
	Voltage ripple	2 ⁽²⁾
	Cyclic voltage variation	5
Transitory Events	Overvoltage	+12
	Undervoltage	-15

The transient recovery time shall not exceed 2 s.

Note ⁽¹⁾: Voltage tolerance (continuous), measured at the distribution board.

Note ⁽²⁾: According to IEC 61892-1, for A.C. r.m.s. over steady D.C. voltage, battery in fully loaded condition.

3.9.4 All electrical equipment, materials and components operating in low-voltage isolated neutral systems or in low-voltage high-resistance grounding systems shall withstand continuously, without sacrifice of its useful life, the phase to phase voltage between any phase to ground.

3.10 FREQUENCY REQUIREMENTS

3.10.1 Equipment shall be able to withstand frequency variations as show in Table 6, based on IEC 61892-1. This table shows the maximum acceptable divergence of values referred to 60Hz.

3.10.2 All equipment shall operate satisfactorily with maximum combined voltage and frequency variation of 10%, considering the maximum individual variations described in Table 4 and Table 6.

Table 6 - Reference Limits for Frequency Variation

Parameter	Variations	
Continuous Operation	Overfrequency [%]	+ 5
	Underfrequency [%]	- 5
	Cyclic variation [%]	0.5
Transitory Events	Overfrequency [%]	+ 10
	Underfrequency [%]	- 10
	Minimum Transient Withstand Time [s]	5

3.11 EMC AND RFI REQUIREMENTS

3.11.1 All equipment having electronic components or circuits shall comply with emission and immunity EMC (Electromagnetic Compatibility) and RFI (Radio Frequency Interference) requirements according to IEC 61000 and IEC 60533, presenting Performance Criterion A.

3.11.2 Regarding induced disturbances, all electrical automation equipment shall comply with IEC 61000-4-6 class 3.

3.11.3 Regarding surges, electrical automation equipment shall comply with IEC 61000-4-5 class 4 with wave forms 1.2/50µs and 10/700µs and peaks up to 4kV.

- 3.11.4 Regarding oscillatory waves, all electrical automation equipment shall comply with IEC 61000-4-12 class 3 and common mode disturbances up to 150 kHz as per IEC 61000-4-16 level 4. Data communications and signal circuits shall be tested only in common mode, but at the same surge magnitude as specified for differential mode tests, according to IEC 61850-3.
- 3.11.5 Regarding fast transients, all electrical automation equipment shall comply with IEC 61000-4-4 class 4, or above. In addition, power supply circuits shall be tested according to IEC 61850-3.
- 3.11.6 Regarding electromagnetic disturbances, all electrical automation equipment shall comply with IEC 61000-4-3 class 3.
- 3.11.7 Regarding damped oscillatory magnetic, electrical automation equipment shall comply with IEC 61000-4-10 level 5.
- 3.11.8 Regarding power frequency magnetic field, all electrical automation equipment shall comply with IEC 61000-4-8 level 5 for continuous and short duration fields.
- 3.11.9 All electrical automation equipment shall operate correctly in system variations in accordance with IEC 61850-3.

4 ANNEX I – ABBREVIATIONS AND ACRONYMS

AC	Alternating Current
ANSI	American National Standards Institute
EMC	Electromagnetic Compatibility
EPL	Equipment Protection Level
ESD	Emergency Shutdown
ET	Technical Specification
FPSO	Floating, Production, Storage and Offloading Unit
FSO	Floating, Storage and Offloading Unit
FRP	Fiber Reinforced Plastic
HDG	Hot-Dip Galvanized
IEC	International Electrotechnical Commission
IEEE	Institute of Electrotechnical and Electronic Engineers
INMETRO	Instituto Nacional de Metrologia Normalização e Qualidade Industrial
IP	Ingress Protection
RFI	Radio Frequency Interference
RMS	Root Mean Square
TEFC	Totally Enclosed Fan Cooled
UPS	Uninterruptible Power Supply