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|---|---|---|---|
| PETROBRAS | **TECHNICAL SPECIFICATION** | Nº: I-ET-3010.00-5520-888-P4X-001 | |
| | CLIENT: | | SHEET 1 of 30 |
| | JOB: | | -- |
| | AREA: | | |
| SRGE | TITLE: **AUTOMATION PANELS** | | INTERNAL |
| | | | ESUP |

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## INDEX OF REVISIONS

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| DESIGN | ESUP | ESUP | ESUP | ESUP | ESUP | ESUP | ESUP | ESUP | ESUP |
| EXECUTION | CAMILA | CAMILA | CAMILA | U5D6 | Q082 | U5D6 | U44D | U44D | U44D |
| CHECK | RAFAELJOSE | EDYLARA | GABRIELSA | CLWK | U49R | U49R | U5D6 | U5D6 | U5D6 |
| APPROVAL | PEDRO | ANDRÉ LUIS | ANDREAZC | U49R | U4JB | TZN5 | CDC1 | CDC1 | CDC1 |

# SUMMARY

# 1 INTRODUCTION

## 1.1 Object

1.1.1 This specification establishes the basic design requirements and test guidelines for the following Automation Panels:

- Automation Panels of the UNIT's Control and Safety System (CSS) – controllers and REMOTE I/O PANELS - and Unit Control Panels (UCPs) of PACKAGE UNITS;
- Supervision and Operation System (SOS) Panels and other computers' CPU Panels (CPU PANELS);
- Electro-Optical Conversion Panels (EOCPs).

## 1.2 Definitions

1.2.1 Refer to I-ET-3010.00-1200-940-P4X-002 – GENERAL TECHNICAL TERMS for the definition of words emphasized in upper case along this document.

## 1.3 Abbreviations, Acronyms and Initialisms

| | |
|---|---|
| AC | Alternate Current |
| CPU | Central Processing Unit (controllers, computers) |
| CSS | Control and Safety System |
| DC | Direct Current |
| DE | Drawing (Portuguese: *Desenho*) |
| EMC | Electromagnetic Compatibility |
| EOCP | Electro-Optical Conversion Panel |
| ET | Technical Specification (Portuguese: *Especificação Técnica*) |
| FAT | Factory Acceptance Test |
| FGS | Fire and Gas System |
| FMS | Flow Metering System |
| HDS | Historical Data Server |
| HFGS | Hull Fire and Gas System |
| HMI | Human Machine Interface |
| HSD | Hull Shut Down System |
| I/O | Input / Output |
| IE | Non-intrinsically safe instrumentation grounding |
| IP | Ingress Protection |
| IS | Intrinsically safe instrumentation grounding |
| KVM | Keyboard, Video, Mouse |
| LCD | Liquid Crystal Display |
| LED | Light-emitting Diode |
| LI | List |
| MCT | Multi-cable Transit |
| MTE | Portuguese: *Ministério do Trabalho e Emprego* |
| NR | Portuguese: *Norma Regulamentadora* |
| PCS | Process Control System |

| | |
|---|---|
| PE | Personal protection (safety) grounding |
| PLC | Programmable Logic Controller |
| RMS | Root Mean Square |
| PSD | Process Shut Down System |
| PSL | Low Pressure Switch |
| RTDS | Real Time Data Server |
| SAT | Site Acceptance Test |
| SIT | Site Integration Test |
| SOS | Supervision and Operation System |
| UCP | Unit Control Panel |
| UPS | Uninterruptible Power Supply |
| VAC | Alternate Current Voltage |
| VCI | Volatile Corrosion Inhibitor |
| VDC | Direct Current Voltage |

# 2 REFERENCE DOCUMENTS, CODES AND STANDARDS

## 2.1 External references

### 2.1.1 International Codes, Recommended Practices and Standards

**ASTM – AMERICAN SOCIETY FOR TESTING AND MATERIALS**

| | | |
|---|---|---|
| ASTM | G21 | STANDARD PRACTICE FOR DETERMINING RESISTANCE OF SYNTHETIC POLYMERIC MATERIALS TO FUNGI |
| ASTM | E662 | STANDARD TEST METHOD FOR SPECIFIC OPTICAL DENSITY OF SMOKE GENERATED BY SOLID MATERIALS |

**DLA [IS] – DEFENSE SUPPLY CENTER, PHIL-GENERAL AND INDUSTRIAL ITEMS OF SUPPLY**

| | | |
|---|---|---|
| MIL | C-24643 | CABLE, ELECTRICAL – ALL PARTS |

**IEC - INTERNATIONAL ELECTROTECHNICAL COMMISSION**

| | | |
|---|---|---|
| IEC | 60068 | ENVIRONMENTAL TESTING – ALL PARTS |
| IEC | 60079 | EXPLOSIVE ATMOSPHERES - ALL PARTS |
| IEC | 60092-350 | ELECTRICAL INSTALLATIONS IN SHIPS – PART 350 - GENERAL CONSTRUCTION AND TEST METHODS OF POWER, CONTROL AND INSTRUMENTATION CABLES FOR SHIPBOARD AND OFFSHORE APPLICATIONS |
| IEC | 60092-376 | ELECTRICAL INSTALLATIONS IN SHIPS – PART 376 - CABLES FOR CONTROL AND INSTRUMENTATION CIRCUITS 150/250 V (300 V) |

| | | |
|---|---|---|
| IEC | 60092-504 | ELECTRICAL INSTALLATIONS IN SHIPS - PART 504: AUTOMATION, CONTROL AND INSTRUMENTATION |
| IEC | 60529 | DEGREES OF PROTECTION PROVIDED BY ENCLOSURES (IP CODE) |
| IEC | 60533 | ELECTRICAL AND ELECTRONIC INSTALLATIONS IN SHIPS - ELECTROMAGNETIC COMPATIBILITY (EMC) – SHIPS WITH A METALLIC HULL |
| IEC | 61000 | ELECTROMAGNETIC COMPATIBILITY (EMC) - ALL PARTS |
| IEC | 61086 | COATINGS FOR LOADED PRINTED WIRE BOARDS (CONFORMAL COATINGS) – ALL PARTS |
| IEC | 61892 | MOBILE AND FIXED OFFSHORE UNITS – ELECTRICAL INSTALLATIONS |
| IEC | 62381 | AUTOMATION SYSTEMS IN THE PROCESS INDUSTRY - FACTORY ACCEPTANCE TEST (FAT), SITE ACCEPTANCE TEST (SAT) AND SITE INTEGRATION TEST (SIT) |

**IEEE - INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS**

| | | |
|---|---|---|
| IEEE | 802.3D | FIBER-OPTICAL INTER-REPEATER LINK |

**NFPA - NATIONAL FIRE PROTECTION ASSOCIATION**

| | | |
|---|---|---|
| NFPA | 79 | ELECTRICAL STANDARD FOR INDUSTRIAL MACHINERY |
| NFPA | 496 | STANDARD FOR PURGED AND PRESSURIZED ENCLOSURES FOR ELECTRICAL EQUIPMENT |

**TIA – TELECOMMUNICATIONS INDUSTRIES ASSOCIATION**

| | | |
|---|---|---|
| TIA | 568 | COMMERCIAL BUILDING TELECOMMUNICATIONS CABLING STANDARD – ALL PARTS |
| TIA | 758 | CUSTOMER-OWNED OUTSIDE PLANT TELECOMMUNICATIONS INFRASTRUCTURE STANDARD |
| TIA/EIA | 598 | OPTICAL FIBER CABLE COLOR CODING |

### 2.1.2 Brazilian Codes and Standards

**INMETRO - INSTITUTO NACIONAL DE METROLOGIA, NORMALIZAÇÃO E QUALIDADE INDUSTRIAL**

| | |
|---|---|
| PORTARIA Nº 115 (21/MARÇO/2022) | REQUISITOS DE AVALIAÇÃO DA CONFORMIDADE PARA EQUIPAMENTOS ELÉTRICOS PARA ATMOSFERAS EXPLOSIVAS - CONSOLIDADO. |

2.1.2.1 All *MTE – Ministério do Trabalho e Emprego* regulations (NRs) shall be followed.

### 2.1.3 Classification Society

2.1.3.1 Project's documentation, in all phases (Basic Engineering Design and Detail Engineering Design Phases), will be submitted to approval by Classification Society.

2.1.3.2 The design, installation and operation of the panels herein mentioned shall strictly follow the Classification Society requirements and comments, along with the specific requirements identified in this document, including also all referenced documents' requirements.

## 2.2 Internal References

### 2.2.1 Typical Documents

2.2.1.1 Typical Documents are those that contain functional and technical description of a system or equipment. They shall be used as the main specification to be used in the Project.

2.2.1.2 Typical Document List

| | |
|---|---|
| I-ET-3010.00-1200-940-P4X-002 | GENERAL TECHNICAL TERMS |
| I-ET-3010.00-1200-800-P4X-013 | GENERAL CRITERIA FOR INSTRUMENTATION PROJECTS |
| I-ET-3010.00-5520-861-P4X-001 | CONTROL AND SAFETY SYSTEM – CSS |
| I-ET-3010.00-5520-861-P4X-002 | SUPERVISION AND OPERATION SYSTEM – SOS |
| I-ET-3010.00-1200-800-P4X-002 | AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS |
| I-ET-3010.00-5140-700-P4X-003 | ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS |
| I-ET-3010.00-5140-700-P4X-002 | SPECIFICATION FOR ELECTRICAL MATERIAL FOR OFFSHORE UNITS |
| I-ET-3010.00-5140-741-P4X-004 | SPECIFICATION FOR LOW-VOLTAGE GENERIC ELECTRICAL PANELS FOR OFFSHORE UNITS |
| I-ET-3010.00-5520-861-P4X-003 | VIRTUALIZATION OF AUTOMATION SYSTEM COMPUTERS |
| I-ET-3010.00-5520-800-P4X-004 | AUTOMATION NETWORK REQUIREMENTS |
| I-ET-3010.00-5520-800-P4X-001 | SUPERVISION AND OPERATION SYSTEM (SOS) SCREENS |

### 2.2.2 Specific Project Documents

2.2.2.1 This section mentions documents that are referenced along the text and that are part of a specific Project. The documents title and number may vary slightly from one Project to another. Project's DOCUMENT LIST shall be consulted in order to verify the correct document number and title.

2.2.2.2 Project Document List

TECHNICAL SPECIFICATION (ET) - INSTRUMENTATION ADDITIONAL TECHNICAL REQUIREMENTS

TECHNICAL SPECIFICATION (ET) - FIELD INSTRUMENTATION

DRAWING (DE) - AUTOMATION AND CONTROL ARCHITECTURE

DESCRIPTIVE MEMORANDUM (MD) – AUTOMATION AND CONTROL SYSTEM FUNCTIONS

LIST (LI) – DOCUMENT LIST

LIST (LI) - EQUIPMENT LIST

DRAWING (DE) - CENTRAL CONTROL ROOM LAYOUT

### 2.2.3 PETROBRAS Reference Documents

DR-ENGP-M-I-1.3 SAFETY ENGINEERING

2.3 Brazilian regulation (MTE section) and INMETRO regulation superpose all codes and regulations listed in item 2.2, since they are enforced by Brazilian Law.

## 3 ENVIRONMENTAL AND OPERATIONAL CONDITIONS

3.1 For environmental and operating conditions and/or any requirements regarding this topic, refer to project's technical specification entitled "INSTRUMENTATION ADDITIONAL TECHNICAL REQUIREMENTS".

## 4 DESIGN PREMISES

4.1 The panels will be installed on an offshore UNIT and shall continuously operate in industrial environment requiring high performance, reliability and availability (24 hrs/day and 7 days/week).

4.2 The panels and their components shall be designed and supplied to ensure optimum performance, ease of maintenance, safe operation and durability.

4.3 All Automation panels, including those that will be located in air-conditioned rooms, shall be designed to operate for long periods without air conditioning, including the hookup period and the onshore and offshore tests, under adverse environmental conditions, subject to a damp, salty atmosphere with temperatures varying over an extensive range and inclinations.

4.4 Automation panels shall not be installed in areas classified as Zone 1 or Zone 0. Thus, during Detail Engineering Design Phase, location of all Automation Panels shall be confirmed.

4.5 All Automation Panels shall be designed with mechanisms to prevent radio frequency and electromagnetic interferences.

4.6 The doors shall be fitted with lockable swing handles and door stoppers in order to prevent the doors from opening away from their intended design and/or from moving due to the vessel angular motions (roll, pitch and yaw).

4.7 Cable access shall be from the bottom of the panels (Indoors and Outdoors Panels).

4.8 All panels shall be supplied with locks and keys, as well as internal drawers for documents and manuals.

4.9 Optical fibers, optical cables, patch panels, patch cords, optical converters, switches, routers and any other network element and accessory shall follow I-ET-3010.00-5520-800-P4X-004 – AUTOMATION NETWORK REQUIREMENTS.

4.10 All panels shall clearly be identified by means of a stainless steel engraved plate containing identification (tag name) and description, according to Project's EQUIPMENT LIST and containing identification according to Brazilian standard regulation NR-12 - *SEGURANÇA NO TRABALHO EM MÁQUINAS E EQUIPAMENTOS*. Internal components shall also be identified. Identification shall be in Brazilian Portuguese. External nameplates shall be adequate for external use.

4.11 Compliance with this Technical Specification shall be presented in the Technical proposal, item by item, in a spreadsheet format, and then attested during the tests (FAT, SAT and SIT). Deviations shall also be presented in the same spreadsheet.

# 5 MECHANICAL CHARACTERISTICS

5.1 This chapter stands for CSS Panels (controllers and REMOTE I/O PANELS), PACKAGE UNITS' Control Panels (UCP) and EOCPs. For more information on CSS and PACKAGE UNITS, see I-ET-3010.00-5520-861-P4X-001 - CONTROL AND SAFETY SYSTEM – CSS and I-ET-3010.00-1200-800-P4X-002 - AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS, respectively).

## 5.2 Construction

5.2.1 Maximum size of each section shall be 800 mm x 800 mm x 2,000 mm (length x width x height). For EOCP dimensions, see item 9.5. For shipping purposes, only a maximum of three modular sections are allowed to be fixed together.

5.2.2 Panels' structures shall be constructed of standardized beams, girders and struts with square holes used to accommodate bolts and nuts for the modular assembly and accessories mounting.

5.2.3 Each panel shall be supplied with sub-base and fixing holes to allow secure fixing of the panel to the floor. Incoming and outgoing cables as well as internal wiring shall be supported and routed through plastic gray ducts with covers. In case of intrinsically safe field wiring, the cables shall run through blue plastic ducts with protective cover.

5.2.4 Processors and I/O cards shall be installed at panel's front section. Marshalling terminal strips and field interconnection shall be installed at panel rear section.

5.2.5 Side plates shall not be used between panel sections. Standardized beams and/or struts shall be used for section reinforcement.

5.2.6 Doors shall be of single type and constructed with a 14 gauge (or thicker) steel plate, "U" beam reinforcement, grounding bolts, internal hinges, locks and handles. Locks, handles and hinges shall be designed to allow changing of door opening direction without any further piece of equipment.

5.2.7 Retractable monitors, HMIs or rack mounted notebooks, monitors, keyboards and mice (located in panels or UCPs with local operation) shall be ergonomically placed in order to allow their use by a person in sit-down position (typically 800 mm above floor).

5.2.8 Where local HMIs are used, they shall be ergonomically placed in order to allow their use by a standing person.

5.2.9 Ergonomics requirements for operation and maintenance listed in I-ET-3010.00-1200-800-P4X-013 - GENERAL CRITERIA FOR INSTRUMENTATION PROJECTS shall also be followed.

## 5.3 Accessories

### 5.3.1 Connections

5.3.1.1 Panels with more than one section shall be provided with standardized connections between sections, such as standardized angle brackets.

### 5.3.2 Struts

5.3.2.1 Standardized struts shall be supplied as required for cable trays. These struts shall be of the same type as the ones used for panel structure, but the length and width may vary in accordance with SUPPLIER standards. Typical values (length x width) are 400 mm x 75 mm up to 1,200 mm x 650 mm.

### 5.3.3 Bolts, Nuts and Washers

5.3.3.1 20 % of spare standardized bolts, nuts and washers, per panel section, shall be supplied.

### 5.3.4 Lifting Lugs

5.3.4.1 4 (four) lifting lugs shall be supplied for each panel section, removable and attached to the "T" beams of the panel.

5.3.4.2 Panel SUPPLIER shall be responsible for stress calculation for lifting.

5.3.4.3 Panel structures shall be such that they can be lifted in vertical position with eye bolts without causing resultant distortion.

## 5.4 Identification of Devices and Accessories

5.4.1 Nameplates shall be provided for all devices, accessories, equipment, switches, etc., installed on the front plate or inside the panels, adjacent to each component, so that when the components is replaced, the nameplates shall remain in the panel.

5.4.2 The panels shall be identified on the front and rear plate in a clear and permanent manner by a nameplate attached to the outside, high up in the center of each section, in case of multiple sections or on one of the doors if double doors are used. Nameplate dimension is 200 x 75 mm.

5.4.3 All inscriptions or legends shall be engraved in Brazilian Portuguese language; the contents shall follow Brazilian standard regulation NR-10 - *SEGURANÇA EM INSTALAÇÕES E SERVIÇOS EM ELETRICIDADE*.

5.4.4 Even if devices on the front plate have their own identification incorporated, this identification shall not be used in place of the nameplates.

5.4.5 All cables shall be clearly identified with their tag names according to Project's documentation.

5.4.6 Identification of panels and internal equipment shall follow Brazilian standard regulation NR-12 - *SEGURANÇA NO TRABALHO EM MÁQUINAS E EQUIPAMENTOS*.

## 5.5 Internal Lay-Out

5.5.1 The internal layout shall be designed in order to ensure enough space for maintenance, calibration and tests. Proper circulation of air among the various items to avoid overheating shall also be taken into account. The terminal connections identification tags shall be clearly visible.

5.5.2 Device MANUFACTURER recommendations related to the supports installation shall be followed. Supports installation shall avoid interference with present and future devices.

5.5.3 Removal of any device shall not interfere with operation of adjacent devices.

5.5.4 High-density layout (terminal blocks, trays, cables etc.) shall be avoided.

## 5.6 Heat Dissipation and Ventilation

5.6.1 Ventilation systems shall be designed considering the environmental conditions and internal devices heat dissipation.

5.6.2 If necessary, high heat dissipation devices shall be distributed to sections and racks to avoid heat concentration.

5.6.3 The fans shall be of low noise type. Panel's design shall take into account noise levels emission.

5.6.4 Panel SUPPLIER is responsible for providing heat dissipation calculation and to ensure that the internal devices are adequate for the minimum and maximum temperature specified in project's INSTRUMENTATION ADDITIONAL TECHNICAL REQUIREMENTS, considering the panel final location.

5.6.5 Solar radiation for outdoor panels shall be taken into account. Sun shields shall be provided if necessary.

5.6.6 Air flow inside panel shall such that cold air intake is done though panel's front while the hot air is exhausted though panel's rear, as shown on Figure 1.

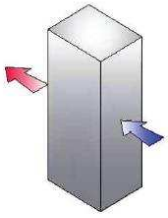


Figure 1 – Expected air flow on automation panels

5.6.7 Panels Rooms Layout shall be such that allows the creation of hot and cold aisle as shown on Figure 2, avoiding air short circuits that leads to loss of efficiency in heat dissipation.

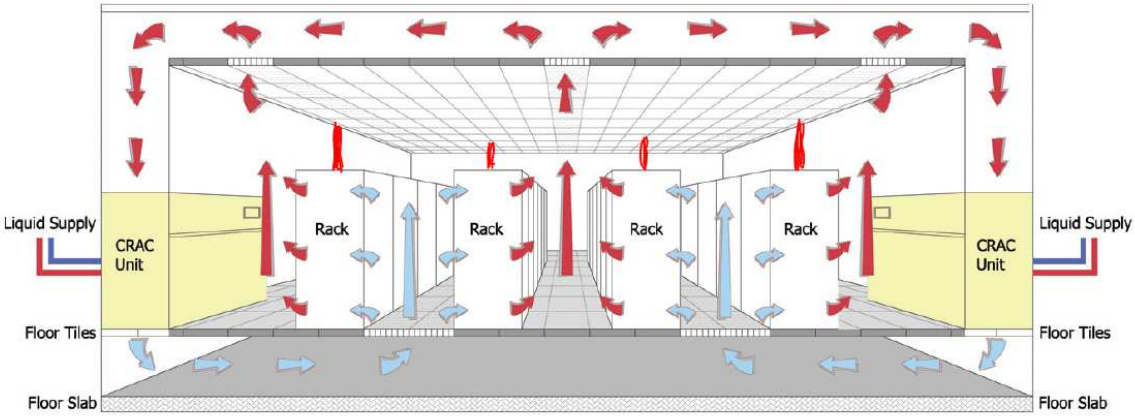


Figure 2 – Expected air flow on automation panels

## 5.7 Working Space

5.7.1 For both front and rear accesses, it shall be left at least 1,000 mm of working space for access to the internal components of the panels. These distances shall be measured from the panel door up to the worker location. As side doors are not required, this working space is not required at the sides, however, it shall be assured that all internal components are accessible from the front or rear door without need to take any component out. The working space height shall be measured from the floor up to, at least, the panel height.

5.7.1.1 For panels that house local retractable workstations (KVM or notebooks), working space shall incorporate the space needed for a person to work in front of the workstation in its non-retracted position.

5.7.1.2 These working spaces shall not be used for any other purpose (storage, for instance).

5.7.1.3 When enclosed live parts are exposed for inspection or servicing, the working space, if in a passageway or general open space shall be suitably guarded.

5.7.1.4 Control panels located across from other control panels or electric panels (e.g., switchgears, motor control centers) may share working space areas as long as it is assured that the doors of both equipment will not be open at the same time. In this case, the largest defined working space shall be adopted.

## 5.8 Specific characteristics for Automation indoor panels

5.8.1 Plates constructed in painted carbon steel are accepted for indoor panels.

5.8.2 Automation Panels located indoors shall have protection degree IP 22 according to IEC-60529, as a minimum. If perforated doors are used, protection degree shall be IP 20 according to IEC-60529.

5.8.3 Doors shall be provided with ventilation slots and air filtering devices at upper and lower part.

5.8.4 Whenever physical arrangement is possible, indoor panels shall be fitted with double doors at both front and rear. In case it is not possible, it shall be used a rear fixed mount plate. For cabinets with width less than or equal to 800 mm, single doors are acceptable.

5.8.5 Front doors can be composed by a full height steel plate or have a 4 mm acrylic resin window located at approximately 1,000 mm from bottom. Depending on the application, perforated doors may be required.

5.8.6 Panels shall be supplied with exhausting fans with filters, controlled by thermocouples.

## 5.9 Specific characteristics for Automation outdoor panels

5.9.1 Outdoor panels shall comply with IEC 61892-1.

5.9.2 Degree of protection shall be IP 56 as a minimum, according to IEC 60529.

5.9.3 Even if not located in hazardous areas, all Automation panels located outdoors shall be suitable and certified for Zone 2, Group IIA, Temperature class T3, according to IEC-60079 and IEC 61892-1, and shall have purge and “Z” pressurization type according to NFPA 496 requirements. Pressurization system (which is generally attached to the outside of the panel) and any other of the panel's external accessories shall be certified for Zone 2 Group IIA Temperature Class T3. It is SUPPLIER’s responsibility to achieve required class approval of outdoor panels for use in hazardous area as specified at design documentation. Protection degree shall also be taken into account during commissioning phase.

5.9.4 Panels shall be provided with hazardous area certificates as established by INMETRO in the regulation presented in item 2.1.2.

5.9.5 Construction plates shall be in ASTM 316L stainless steel, with minimum thickness 2.5 mm.

5.9.6 Panels located outdoors shall have full height steel plate doors, not windows or holes.

5.9.7 The doors of each section of outdoors panels shall be equipped with two limit switches for doors status indication (Open, close) available in CSS for indication

and alarm (Open) in the Supervisory System. The doors limit switches shall be voltage free contact interconnected in series in order to provide one alarm signal by panel. If these limit switches are related to a CSS REMOTE I/O PANEL itself, the signals shall be sent to the corresponding control subsystem input card (PCS/HCS). If the signals are not related to a CSS REMOTE I/O PANEL, they shall be sent to the nearest CSS-PSD or HSD input card.

5.9.8 As outdoors panels shall have internal pressurization, each panel (composed by one section or more) shall be equipped with one low internal air pressure logical switch (PSL) generated by a pressure transmitter. For panels with forced ventilation, high air temperature alarm shall also be provided. All these information shall be available in CSS-PSD for indication and alarm in the Supervisory System.

5.9.9 Each outdoor panel shall be fitted with a pressurization/purge control unit, which shall be pre-certified by an international standard defined during Detail Engineering Design Phase. The panels shall be fitted with instruction plate describing pressurization/purging operational procedure.

5.9.9.1 Instrument air shall be used for panel pressurization.

5.9.9.2 For each outdoor panel, an independent and dedicated air supply system shall be provided for pressurization/purge as a back-up for the main air supply. This feature shall be provided in order to avoid consequences caused by a failure in the main air supply. This dedicated air supply system shall be composed of one air reservoir with all necessary instruments and accessories such as block and drain valves, check valves, pressure gages and safety relief valves.

5.9.9.3 These air reservoirs shall comply with NR-13 - *CALDEIRAS E VASOS DE PRESSÃO* requirements. For air reservoir sizing, the following minimum technical requirements shall be taken into account:

- Maximum air leakage flow: For preliminary dimensioning, minimum leakage shall be considered 2 L/min per panel section. This leakage flow shall be confirmed by appropriate testing of each panel. Testing shall be done with MCT and/or cable glands installed. The requested air leakage flow shall also be guaranteed during SAT, with all cables transiting through the MCT and/or cable glands;;
- Minimum air pressure at the inlet of the air reservoir: 480.5 kPa (4.9 kgf/cm2);
- Air volume of the reservoir shall be sized in order to properly pressurize the panel for, at least, thirty (30) minutes;
- Air supply piping volume and/or other reservoirs' volumes shall not be used in the calculations to reduce the air reservoir volume or the 30 minutes requirement.

5.9.9.4 Panel SUPPLIER shall provide all the necessary devices related to the pressurization control system (e.g., low air pressure switches, timer, doors' limit switches, manometer, filter-regulators, relief valves, manual valves and

electromechanical lock), in order to prevent energization before complete purging of initial internal atmosphere, and other items required by the Classification Society. These devices shall be fitted and terminated to the same panel where they are assembled.

5.9.10 Each outdoor panel shall have a shelter in order to allow maintenance. This protection over the panel shall be constructed in such a way that whenever the doors are open, the arrangement becomes a protected area, e.g., the open doors will be the side protections. Suitable fixing points among doors, floor and shelter shall be provided. The shelter material shall be the same as the panel material.

5.9.11 Removable gland plates or Multi-cable Transits (MCT) shall be fitted for bottom cable entry. Gland plates shall be strong enough to support the necessary glands and cables. The panels shall have mounting legs of 300 mm height to accommodate installation and cable glands or MCTs. Panels shall be supplied with anti-vibration mats to be mounted between panel and mounting legs.

5.9.12 If more than two rows (see Figure 3) of cables are needed, cable glands shall not be used, only MCTs.

5.9.13 If MCT solution is adopted, it shall have all the necessary certification for the area classification, including panel airtight certification, in order to assure adequate panel pressurization. The MCT frame shall be fixed using bolts. The selected model shall be adequate for the cable installation (e.g. in case of angular cable entry, a proper frame shall be selected).

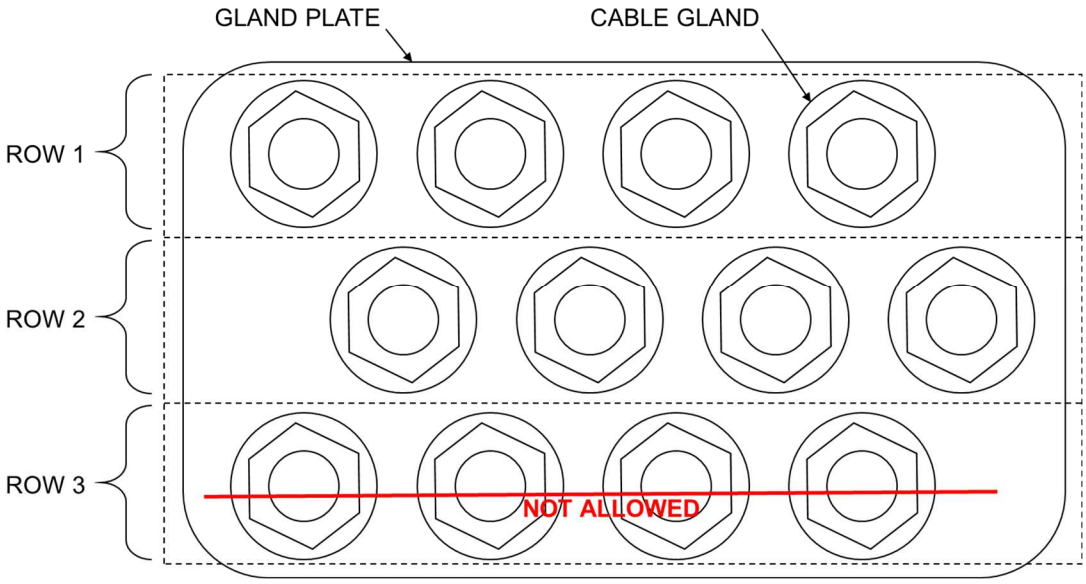


Figure 3 – Cable gland arrangement on gland plate illustration. The arrangement presented (more than two rows) is not allowed.

5.9.14 The location of outdoor panels shall be taken into account in the following Project Safety Studies: EXPLOSION ANALYSIS, FIRE PROPAGATION AND SMOKE

DISPERSION ANALYSIS and DROP OBJECTS STUDY. Panel SUPPLIER shall comply with all the recommendations presented in these studies regarding panel physical location.

5.9.15 Base plate for outdoor panels shall be according to item 17.5 of I-ET-3010.00-1200-800-P4X-013 - GENERAL CRITERIA FOR INSTRUMENTATION PROJECTS.

# 6 ELECTRICAL CHARACTERISTICS

## 6.1 General

6.1.1 All electronic and electrical components shall be conditioned in order to withstand environmental conditions.

6.1.2 This chapter shall be taken into account, where applicable, for all types of panels mentioned in this Specification.

6.1.3 **ATTENTION**: As the panels will be fed by UNIT power supply, all parts at a voltage greater than or equal to 50 VAC RMS or 60 VDC shall be adequately insulated and means shall be provided to prevent unintentional human contact with these parts. These parts shall be clearly identified with the voltage and a warning sign. Openings to these live parts shall not permit the entry of a 12.5 mm diameter rod. Special attention shall be given to the supplied voltage of the UNIT.

6.1.4 All panel components and cables shall be adequately sized in order to assure proper power, voltage and current supply when all panel components are demanded (maximum current / power consumption case). For the CSS REMOTE I/O PANELS, the panel's internal components and cables shall be sized for all the wired I/Os, plus all the spare I/O cards and expansion cards being simultaneously activated and the maximum current being demanded.

6.1.5 Besides the necessary internal power socket outlets, each panel shall have an internal extra power socket outlet to feed electrical tools, such as lamps, notebooks etc. In this power socket outlet, the ground pin shall be connected to the safety ground. This power socket outlet shall be according to I-ET-3010.00-5140-700-P4X-002 - SPECIFICATION FOR ELECTRICAL MATERIAL FOR OFFSHORE UNITS and shall comply with ABNT NBR 14136.

6.1.6 Dehumidifier heating resistors shall be supplied inside each panel for adequate preservation. These resistors shall be according to I-ET-3010.00-5140-741-P4X-004 - SPECIFICATION FOR LOW-VOLTAGE GENERIC ELECTRICAL PANELS FOR OFFSHORE UNITS.

6.1.7 For CSS, independent redundant power supplies shall be provided for PSD, HSD, HCS, FGS, HFGS and PCS systems (i.e. power for processor and I/O modules), within each CSS cabinet.

6.1.8 All instruments, sensors and any additional hardware required in order to implement the panel-related alarms and indications required in document I-ET-3010.00-5520-800-P4X-001 - SUPERVISION AND OPERATION SYSTEM (SOS) SCREENS shall be supplied, installed and commissioned in every Automation panel.

## 6.2 External Wiring

6.2.1 All external connections to the panels shall be carried out through DIN rail mounted terminal blocks of the type permitting addition of extra terminals connectors on the supporting metal rails. Double deck terminal blocks for terminal connectors are not acceptable. Terminal connectors shall be:

- Made of non-hygroscope material;
- Adequate for conductors with 2.5 and 1.5 $mm^2$ cross section;
- Flame retardant;
- Insulated to 300 V;
- Of disconnect type (knife type).

6.2.2 The terminal blocks location shall permit easy interconnection and cable routing and shall be placed at least at 300 mm up from the base.

6.2.3 The terminal blocks shall be segregated by each type of electrical signal, i.e., discrete input, discrete output, analog input, analog output, power supply, in order to assure proper segregation of signals.

6.2.4 Panels with bottom access shall have removable finishing plates in the bottom of each section (at least 300 mm and according to the panel design).

6.2.5 Panels wiring shall terminate at inside of the terminal blocks and field wiring at outside.

6.2.6 All terminal blocks shall be provided with 20% of wired extra terminal connectors and 10% of extra terminal connectors, for future use.

6.2.7 Cable shielding shall be individually connected to a terminal connector in the terminal block.

6.2.8 Weldless pressure type terminal connectors shall be used at the end of the wires, with insulation sleeving, and with suitable identification. All terminals shall be identified with the field device, equipment or accessory tag, and the phase or polarity.

6.2.9 The external cables shall enter at the related panel section. It is not acceptable that cables enter at a panel section and be interconnected in another section.

6.2.10 Steel screws and clamps shall be cadmium dichromate-plated.

## 6.3 Internal Wiring

6.3.1 All cable trays shall be sized in such a way that at maximum 60% of their width are used, considering all spare and future I/O.

6.3.2 All panel wiring shall be identified in both ends, by plastic rings with the terminal block number.

6.3.3 Only one conductor shall be connected to each side of each terminal block connector. If more conductors in parallel connection are needed, a fixed jump shall be used.

6.3.4 Wiring derivations outside the terminal connectors are not allowed.

6.3.5 Power supply cables shall run in cable trays segregated from the marshalling termination wiring, low voltage wiring and communication wiring. These terminals shall be covered with protective plastic covers and shall have warning signs.

6.3.6 All electrical circuits shall be completely wired to the terminal blocks.

6.3.7 Interconnections between sections that need to be separated for transportation shall be suitably prepared for subsequent reassembly at the field.

6.3.8 Some excess cable shall be installed inside the panels so that future maintenance operations may be performed without the need for installing new cables. This excess cable shall be considered in the cable tray sizing of item 6.3.1.

## 6.4 Power Supply

6.4.1 The available power supplied by the UNIT to be used by the Automation panels is defined in I-ET-3010.00-5140-700-P4X-003 – ELECTRICAL REQUIREMENTS FOR PACKAGES FOR OFFSHORE UNITS. It is part of the panel SUPPLIER's scope to convert and redundantly distribute the different power supplies inside panels, including, where necessary, redundant AC/DC or DC/DC stabilized power supply units for cabinet's internal distribution of 24 VDC.

6.4.2 Where necessary due to the internal equipment, incoming power supplies from the UNIT shall be converted inside each panel to a common 24 VDC and connected to a 24 VDC distribution copper bus bar in the panel. AC/DC or DC/DC conversion provided shall be within the tolerances required by the internal hardware.

6.4.3 Each 24 VDC power converter shall be sized to supply all modules and all I/O devices, including full spare capacity, and shall be provided with galvanic isolation between inputs and outputs.

6.4.4 Internal redundant power supplies shall be according to the following items:

- The 2 (two) supply voltages provided by the UNIT to the panel, as per item 6.4.1, shall be converted to 24 VDC for the panel internal devices and for feeding field instruments such as solenoid valves and relays;

- For discrete output circuits that require a higher power supply, greater than 24 VDC and/or current greater than 2A (normally associated to inductive loads of a higher consumption) independent redundant power supplies shall be provided;
- The power supplies shall operate in parallel;
- Each power supply shall have input protection against overvoltage;
- Each power supply shall have circuit-breakers at incoming and outgoing circuits;
- Each 24 VDC power supply shall have the following signaling, to be used for alarm in the Supervisory System: malfunction, ground fault and short circuit. These signals shall be available through independent voltage-free contacts to be sent to the respective CSS panel.
- Interconnection among the power converters and bus distribution bar shall be made through individual static devices. A single failure shall not cause the whole system to fail.
- The calculated load capacity of each power supply and its components shall take into account the electrical power consumption of the installed devices, and the foreseen spare and future expansions;
- 24 VDC positive and negative poles shall not be grounded (floating system);
- The power supplies and systems with battery shall have an output voltage ripple less than 200 mV peak-to-peak (pp) (70 mV RMS).

6.4.5 All panel internal devices, components and accessories shall be adequate to operate with the following power supply specification:

- Voltage: 24 VDC, +10% / -15%.
- Ventilation system and internal lighting: see item 6.4.1 for supply voltage and frequency and item 6.6 for internal lighting. These feeders may be linked to a voltage supervision relay in order to feed the exhaust fans (panel ventilation) and internal panel lighting.

6.4.6 Each powered device (DC or AC) shall be individually protected by circuit breakers. These devices shall be installed in the front of the corresponding section. Power supply distribution shall be designed in such a manner that each section can be isolated (de-energized) even if the other sections are still in service (energized). 10% of spare circuits shall be provided.

6.4.7 For CSS, independent redundant power supplies shall be provided for PSD, HSD, HCS, FGS, HFGS and PCS systems (i.e. power for processor and I/O modules), within each CSS cabinet. For digital output circuits that require a higher power supply (normally associated to inductive loads of a higher consumption) independent redundant power supplies shall be provided for PSD, HSD, HCS, FGS, HFGS and PCS.

6.4.8 AC Power wiring shall be segregated from DC power and signal I/O wiring.

6.4.9 After a power supply failure, on reactivating the system, the panels shall operate without the need for restarting, resetting or maintenance activities.

6.4.10 A normal external power source shall be supplied from the UNIT to the panels for energizing the power socket outlet (see item 6.1.5) and the dehumidifier heating resistor (item 6.1.6). This external power supply does not need to be redundant.

6.4.11 Interconnection among the power converters and bus distribution bar shall be made through individual static devices. A single failure shall not cause a failure in the whole system.

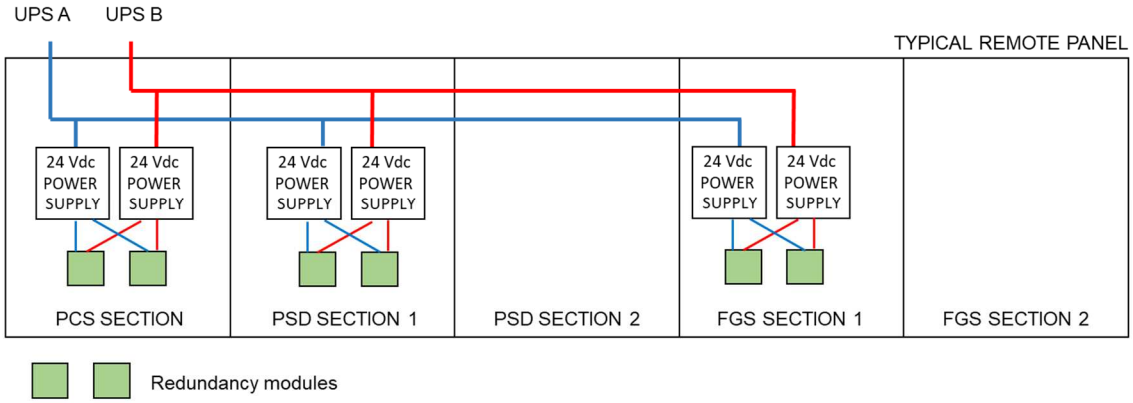


Figure 4 - Typical remote panel with one pair of redundant power supplies per subsystem. Figure also applies to CSS PROCESSORS PANELS.

6.4.12 The dedicated sections of each CSS REMOTE I/O PANEL shall be electrically isolated and the power supply for each dedicated section shall be independent.

6.4.13 Internally to each CSS REMOTE I/O PANEL and CSS PROCESSORS PANEL, the external power shall be converted to 24 VDC, using two redundancy modules. There shall be at least one pair of redundant 24 VDC power supplies for each subsystem (PCS, HCS, PSD, HSD, FGS and HFGS), to feed all internal CSS components. Subsystems shall not share their 24VDC power supplies (Figure 4).

6.4.14 Internally to each panel section, it shall be included two diode modules between the external power supplied by the UNIT and each internal 24 VDC power converter.

## 6.5 Grounding

6.5.1 Panel grounding shall comply with the requirements of IEC 61892 and IEC-60079 and the specific grounding requirements of I-ET-3010.00-1200-800-P4X-013 - GENERAL CRITERIA FOR INSTRUMENTATION PROJECTS.

6.5.2 Three (03) independent bars of electrolytic copper measuring at least 1” x 1/4" cross section mounted on insulators/supports shall be installed inside each section of the panels in order to segregate three types of circuit grounding: non-Ex-i instrumentation grounding (IE), intrinsically safe (Ex-i) instrumentation grounding (IS) and personal protection (safety) grounding (PE). The distance between these insulators/supports shall be 600 mm.

6.5.3 The grounding bars shall be clearly and permanently identified with nameplates in Brazilian Portuguese. The nameplates shall be made of black acrylic material and white lettering. The identifications to be engraved shall be “ATERRAMENTO DE INSTRUMENTAÇÃO NÃO EX-i (IE)” for non-Exi instrumentation grounding, “ATERRAMENTO DE SEGURANÇA (PE)” for personal protection grounding and “ATERRAMENTO DE SEGURANÇA INTRÍNSECA (IS)” for Ex-i instrumentation grounding.

6.5.4 Grounding bars shall have the following connecting capacity for each panel section:

- 1 (one) connector of 50 $mm^2$ section for external grounding;
- Up to 12 (twelve) connectors of 1.5 $mm^2$ cross section to device grounding.

6.5.5 For panels up to 2,000 mm height, each section structure shall be grounded at only one point (bottom), with grounding weldless connector type, by a 50 $mm^2$ bare copper wire. For panels higher than 2,000 mm, PETROBRAS shall be consulted.

6.5.6 Adjacent sections shall be bonded by a 50 $mm^2$ bare copper wire, formed by twisted wires, using earthing mechanical connector.

6.5.7 All panel metallic parts such as structural components, frames and plates shall have electrical continuity among them.

6.5.8 Hinged doors shall be bonded to the main enclosure with flexible grounding straps.

6.5.9 Grounding straps shall be provided for all non-fixed surfaces.

6.5.10 Each panel section shall be supplied with ground fault active detection devices in order to announce alarm in the Supervisory System. Each ground fault detection active device shall be connected to a voltage free contact interconnected to the respective CSS subsystem input card.

6.5.11 It shall be taken into account cables shield interconnection for discrete and analog instrumentation in panel side, defined in I-ET-3010.00-1200-800-P4X-013 - GENERAL CRITERIA FOR INSTRUMENTATION PROJECTS.

### 6.5.12 Personal protection Grounding (PE)

6.5.12.1 Ground connection for panel body electrical safety is required for all panels. Two (02) 8 mm stainless steel grounding bolts shall be fitted in each panel.

6.5.12.2 Personal protection (Safety) grounding shall be used to protect personnel from electric shock by providing a secure fault current path in the event that metallic components become energized. All powered instrument and equipment enclosures shall be connected to this grounding. Armored cable armor shall also be connected to this bar.

### 6.5.13 Instrumentation Grounding (IE)

6.5.13.1 Copper made instrument signal ground bar, isolated from the PE grounding bar, shall be provided for each panel section, with sufficient screws (including spares) for wires termination, considering only one wire per connection.

6.5.13.2 Instrumentation grounding consists of the grounding of all non-Ex-i instruments and signals cable shields. This ground has the objective of reducing false signals or noise in instrument circuits due to induced electrical interference.

6.5.13.3 The cable shields shall be floating in the field end. It shall be electrically continuous from the field equipment and connected to the instrument grounding bar in the panel.

### 6.5.14 Ex-i instrumentation Grounding (IS)

6.5.14.1 Copper made Intrinsic Safety Grounding bar shall be provided for those panels working with intrinsically safe instruments. This bar shall be isolated from the safety and non-Ex-i instrument grounding bars (PE and IE). Also, this bar shall be equipped with sufficient screws (including spares) for wire terminations.

6.5.14.2 Intrinsic Safety Grounding shall follow the requirements of IEC 61892-7, IEC 60079-14 and IEC 60079-11.

## 6.6 Internal Lighting

6.6.1 For internal lighting, either fluorescent or LED lamps are accepted, with the following specifications:

Fluorescent Lamp:

- 15 W each lamp;
- Mounted on panel struts (one lamp in each panel section);
- Provided with limit switch to automatically turn on the lights when any door is opened;
- Instantaneous reactor;
- Power supply: see item 6.4.1.

LED Lamp:

- 7.5 W each lamp;
- Mounted on panel struts distributed throughout all panel sections;
- Provided with limit switch to automatically turn on the lights when any door is opened;
- Power supply: see item 6.4.1.

## 6.7 Signals interchanging standardization

6.7.1 The discrete signals sent from PACKAGE UNITS' UCPs to CSS shall be voltage free dry contacts (1 A @ 24 VDC). The contacts on the PACKAGE UNIT side are energized when in normal operation and de-energized under abnormal process conditions. For discrete signals interchanged between equipment's or PACKAGE UNITS' UCPs and CSS REMOTE I/O PANELS, interposing relays shall be foreseen. The interposing relays shall be individual by discrete I/O and shall be installed in the equipment's panel side, not in CSS panel. See Figure 5.

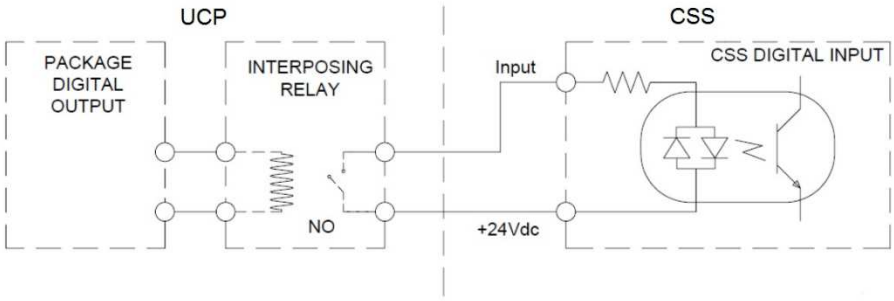


Figure 5 - Interposing Relay for signals from PACKAGE UNITS' UCPs to CSS REMOTE I/O PANELS

6.7.2 In the same way, the discrete signals sent from CSS to PACKAGE UNITS' UCPs shall be 24 VDC energized under process normal conditions and de-energized under process abnormal conditions. Interposing relay shall be installed on the PACKAGE UNIT side. See Figure 6.

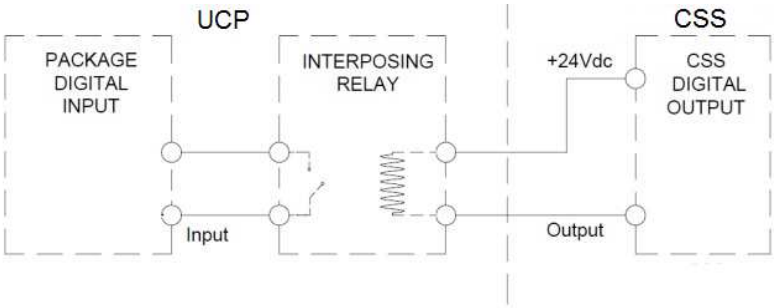


Figure 6 – Interposing Relay for signals from CSS to PACKAGE UNITS'UCPs

6.7.3 The signals sent from CSS or from PACKAGE UNITS to Electrical System Panels may be either for control (commands) or for emergency shutdown (ESD). ESD signals shall be energized in normal conditions and de-energized under abnormal conditions. The command status (energized/de-energized) of control signals shall be according to the safe condition of the controlled load. Interposing relays according to item 6.7.2 shall be foreseen in the Electrical System Panel side. See Figure 7.

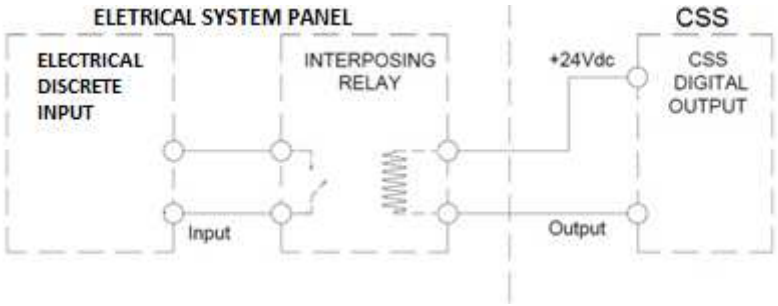


Figure 7 – Interposing Relay for signals from CSS to Electrical Panels

6.7.4 For analog signals interchanged between equipment's or PACKAGE UNITS' UCPs and CSS REMOTE I/O PANELS, galvanic isolators shall be foreseen. These galvanic isolators shall be individual by analog I/O and shall be located in CSS panel side.

6.7.5 For intrinsic safety signals arriving at or leaving the CSS REMOTE I/O PANELS, a certified galvanic Intrinsic Safety barrier shall be included in the panel. The barrier shall be certified according to IEC 60079-11 by an accredited certification body.

6.7.6 For further details, refer to I-ET-3010.00-1200-800-P4X-002 – AUTOMATION, CONTROL AND INSTRUMENTATION ON PACKAGE UNITS.

# 7 PAINTING

7.1 Internal and external Automation panels color shall be light cream (Munsell notation 2.5 Y 9/4). For PACKAGE UCPs, EOCPs and CPU Panels, manufacturer's standard colors may be accepted.

7.2 Panel painting procedures shall be according to panel SUPPLIER's, but shall be submitted to PETROBRAS for approval.

7.3 The internal mounting plate of panels shall be orange (Munsell notation 2.5 YR 6/14).

7.4 Panel painting shall be adequate for saline environment and painting certificate shall be provided.

7.5 A spare can of paint shall be supplied for retouches.

# 8 CPU PANELS

## 8.1 General

8.1.1 This chapter describes the characteristics of the panels that shall hold SOS Servers/HMIs CPUs, Automation computers CPUs and Automation Network equipment (Ethernet switches, patch panels and additional accessories). For more

information on SOS, see I-ET-3010.00-5520-861-P4X-002 - SUPERVISION AND OPERATION SYSTEM – SOS.

8.1.2 In order to prevent damage to computers' CPUs due to dust, especially those that belong to SOS, they shall be located inside panels, named CPU PANELS.

8.1.3 These panels shall be located in safe non-classified enclosed areas (Central Control Room – Equipment Ambiance and/or Automation and Electrical Panels Room - AEPR).

## 8.2 CPU PANELS main characteristics

8.2.1 The CPUs of SOS Servers, HMIs and other Automation computers used for operation shall be allocated in CPU PANELS.

8.2.2 For internal distribution of CPU PANELS used for virtualized computers, I-ET-3010.00-5520-861-P4X-003 - VIRTUALIZATION OF AUTOMATION SYSTEM COMPUTERS shall be consulted.

8.2.3 Non-virtualized Automation computers shall be allocated in Topsides and Hull CPUs Panels, according to the Project document "DESCRIPTIVE MEMORANDUM AUTOMATION AND CONTROL SYSTEM FUNCTIONS".

8.2.4 Whenever there are redundant equipment, they shall be located in distinct sections.

8.2.5 Minimum characteristics of each section:

- Dimensions: Height 2,000 mm (44 u), external length 800 mm (19 inches internally), width 1,100 mm;
- Rapid rail;
- Perforated doors (hole diameter 10 mm) ;
- Front and rear doors, side panels;
- Weight support capability: 0.2 ton;
- Forced air ventilation (internal fans);
- Leveling feet;
- Open bottom;
- Minimum protection degree IP 20 according to IEC-60529;
- Space for ventilation between equipment;
- One power socket for each equipment, in Brazilian standard. Socket gauge shall be suitable for each equipment.

8.2.6 Each section shall be supplied with a built-in rack console, composed of retractable monitor, keyboard, optical mouse and one integrated KVM switch in order to allow computers configuration and maintenance. This integrated KVM switch shall contain as many ports as the quantity of CPUs located in the panel section.

8.2.7 The retractable video monitor shall have 15", be composed of LED backlit LCD, with at least 1280×1024 @ 60/75 Hz resolution. Preferably, height shall occupy 1u.

8.2.8 The internal keyboard shall be a USB 104-key ABNT-2 and shall be mounted over a 1u drawer.

8.2.9 The integrated KVM switch height shall occupy at maximum 2u.

8.2.10 The retractable monitors, keyboards and optical mice shall be ergonomically placed in order to allow their use by a person in sit-down position (typically 800 mm above floor).

8.2.11 Each section of the panels that hold non-virtualized CPUs shall be supplied with KVM extenders. These KVM extenders will be used to allow remote connection to the CPUs from the operators' consoles. There shall be one individual KVM extender pair (transmitter/receiver) per CPU.

8.2.12 Minimum characteristics of the KVM extenders:

- Support for Display Port++ Dual Mode video;
- Audio capabilities (stereo loudspeakers);
- USB ports for at least keyboard mouse;
- Connection with CPU through CAT5 UTP cable;
- Be fed by a dedicated power supply inside the panel;
- The transmitters and receivers shall be of the same manufacturer and model;
- Maximum distance between panel location and the operators' consoles shall be observed for installation of KVM extenders' transmitters/receivers.

8.2.13 Compatibility between KVM extender and video monitors shall be verified before choosing the KVM model (typically 1920 x 1200 in dual monitor configuration).

8.3 The internal arrangement of each sub-section shall be designed taking into account the necessary ventilation and the necessary equipment contained in each sub-section.

8.4 The final layout shall be defined during project's Detail Engineering Design Phase according to the type and quantity of the chosen equipment.

8.5 Other requirements listed in items 5 and 6 shall also apply to the CPU PANELS.

# 9 ELECTRICAL-TO-OPTICAL CONVERSION PANELS (EOCP)

9.1 The Electrical-to-Optical Conversion Panels (EOCPs) are panels dedicated exclusively to the conversion of electrical signals to optical signals and vice versa, which occurs when there is a change of ambient from indoors to outdoors. In this sense, an EOCP is an interface panel between an indoor and an outdoor environment.

9.2 There shall be at least one EOCP for the Topsides and one for the Hull and each panel shall be placed indoors.

9.3 These panels shall be located in safe non-classified enclosed areas, indicated in Project's EQUIPMENT LIST.

9.4 Each EOCP shall be composed of as many sections as needed for the conversion of all optical cables that enter the ambient to electrical cables that shall be connected to the other panels in the room or adjacent rooms.

9.5 Overall characteristics of each EOCP section:

- Dimensions: Height 2,100 mm (44 u), external length 800 mm, depth 1,100 mm;
- Standard 19” mounting rack;
- Front and rear doors, side panels;
- 4 mm acrylic resin window;
- Weight support capability: 0.2 ton;
- Forced air ventilation (internal fans);
- Leveling feet;
- Open bottom;
- Minimum protection degree IP 22 according to IEC-60529;
- Space for ventilation between equipment;
- One power socket for each equipment, in Brazilian standard. Socket gauge shall be suitable for each equipment.

9.6 Each section of an EOCP shall be capable of housing a standard 19-inch rack panel with power supplies, ventilation and any other equipment necessary for adequate performance of the electro-optical converters.

9.7 Electro-optical converters shall be 1u 19-inch rack mounted and there shall be at least 1u free between each converter.

9.8 Electro-optical converters shall be according to I-ET-3010.00-5520-800-P4X-004 – AUTOMATION NETWORK REQUIREMENTS.

9.9 When dimensioning the EOCP and the number of electro-optical converters, safety margins for future expansions shall be taken into account: 20% of additional converters plus 10% of this total value as additional free space.

9.10 The panels internal layout shall foresee the necessary space for the field optical cable interconnection without risks to the fibers integrity.

9.11 The final layout shall be defined during project’s Detailing Design Phase according to the type and quantity of the chosen equipment.

9.12 Other requirements listed in items 5 and 6 shall also apply to the EOCPs.

# 10 TESTS

10.1 All deviations and anomalies found during Factory Acceptance Test (FAT), Site Acceptance Test (SAT) and Site Integration Test (SIT) shall be adequately registered according to punch list control system defined in contract.

## 10.2 Factory Acceptance Tests (FAT)

10.2.1 Factory Acceptance Tests (FAT) shall be in accordance with IEC 62381 requirements, including the following tests:

- Mechanical tests;
- Electrical tests;
- Functional tests;
- Temperature-cycling tests;
- RFI & EMI tests;
- Pressurization/purge tests for the pressurized panels;
- Painting inspection.

10.2.2 FAT shall be witnessed, to be agreed between PETROBRAS and Panel SUPPLIER during Project. FAT report tests shall be signed and sent to PETROBRAS.

10.2.3 Prior to the witnessed FAT, SUPPLIER shall send the Tests proceedings to PETROBRAS, according to Project's schedule, and shall execute previous tests and present the documentation to PETROBRAS, in order to reduce repairs and/or modifications during FAT.

10.2.4 The FAT shall be fully documented, including any equipment failure, repairs or replacements. The FAT procedure shall include handling over all records made during the construction period such as test results, list of changes, as-built drawings, calibration certificates and any other documentation.

10.2.5 All documentation (project and tests) shall be sent in digital media.

10.2.6 Testing methods and accuracy of the measurement shall be subject to the Classification Society and PETROBRAS approval.

10.2.7 Any malfunctions of the equipment shall be rectified and tested again, at Panel SUPPLIER'S expenses, and to PETROBRAS approval. Evidences of the correction shall be presented.

10.2.8 In FAT location, all facilities such as instrument air supply and redundant external power supplies shall be available. Ambiance temperature (with/without air-conditioning) required for the complete panels testing (pressurization/purge, ventilation control, internal power supplies) shall be controlled.

10.2.9 The FAT staging shall be set up so that each panel is fed from two power supplies, simulating the two power supplies provided by the UNIT to the panel. Power supply

switchover will be tested.

10.2.10 The FAT facility shall include adequate air conditioning to ensure that the testing environment (where there are numerous screens and other equipment generating large amounts of heat) is maintained at a comfortable temperature (less than 25 °C).

10.2.11 Mechanical Tests

The mechanical tests shall encompass, at least, the following topics or essays:

- Visual inspection of all components, considering product quality, identification of interconnections, layout arrangement, nameplate inscriptions, accessibility etc.;
- Dimensional check;
- Rigidity and structures self-supporting;
- Shock, vibration and inclination (procedures according to Classification Society Rules).

10.2.12 Electrical, Temperature-Cycling and RFI & EMI Immunity tests shall be according to project's "INSTRUMENTATION ADDITIONAL TECHNICAL REQUIREMENTS" technical specification.

10.2.13 Functional Tests shall be as described below:

- Complete system functional test, with simulation of all input situations and observation of expected outputs; the overall reaction time shall be verified;
- Input / Output Tests;
- Devices shall be tested according to test and operation device manuals.

10.2.14 Pressurization/Purge Tests

- The panels shall be tested in order to verify compliance with all conditions and devices foreseen in the NFPA 496 or IEC 60079-2 (latest versions).
- The air supply flowrate shall be measured; the leakage compensation sequence shall be checked; all the interlocks and alarms shall be tested; the internal pressure shall be tested considering the air supply pressure varying from 70 psig up to 113 psig; other tests foreseen in the NFPA 496 or IEC 60079-2 and by the Classification Society shall be carried out.
- The pressurization/purge shall assure a controlled air flow at low pressure, as required by NFPA 496 or IEC 60079-2, in order to maintain the interior of the panel lightly pressurized, avoiding the ingress of external explosive atmosphere gas and the ingress of saline atmosphere.

10.2.15 FAT report shall include a punch list with all non-impeditive deviations and anomalies that will be treated in field, including the date for treatment deadline.

10.2.16 During FAT, all Ex certificates of each panel component and of the assembly shall be verified and validated.

10.2.17 During FAT, inventory shall be kept of all panel components and spare parts in order to guarantee traceability and availability.

### 10.3 Site Acceptance Test (SAT)

10.3.1 All tests performed at the factory (FAT) shall be repeated at the installation site (SAT). IEC 62381 requirements shall also be taken into account.

10.3.2 Panel functioning shall be tested at full load, i.e. at maximum power / current consumption. It shall be verified that during full load test, the system's capacity is not at its maximum and that enough capacity is available for all spare and future expansion components to be installed.

10.3.3 During SAT, any necessary design modifications after FAT shall be tested and FAT punch list items shall be treated.

### 10.4 Site Integration Test (SIT)

10.4.1 For Site Integration Tests (SIT) refer to IEC-62381 – AUTOMATION SYSTEMS IN THE PROCESS INDUSTRY – FACTORY ACCEPTANCE TEST (FAT), SITE ACCEPTANCE TEST (SAT) AND SITE INTEGRATION TEST (SIT).

## 11 PACKING REQUIREMENTS

11.1 On completion of FAT, all equipment shall be prepared for shipment and storage.

11.2 Equipment supplied loose shall be packed and crated for transportation. In addition, if some rack equipment is susceptible to transportation damage, it shall be removed from the system rack for separate packing and crating.

11.3 In order to prevent corrosion, VCI shall be used adequately, where applicable, as part of preparation for shipment and storage instead of desiccants such as silica gel. The latter shall be used only in cases where VCI is not applicable. Both VCI and desiccants shall not be used together for protecting the same compartment.