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1 INTRODUCTION

1.1 Scope

This document is prepared with the purpose of collecting general specification of Package Control System. The content of this document includes main descriptions, requirements and selection of the Package Control System Equipment as well as project requirements.

1.2 DEFINITION OF TERMS

Throughout this document the words “will”, “shall”, “should” and “may” will be used for the following intended meanings:

Shall	Requirement is mandatory, contractor asserts the provision/realization
Will	Client scope of provision
Should	Solution is preferred but other solutions can be utilized with notice
May	Any third party hired for supplying devices and components Solution is not highly superior to other alternatives and other alternatives can be utilized without notice.

2 TERMINOLOGY

When referring to contractual parties in this document the following meanings is intended:

Client	
Consultant	
EPC Contractor	
Supplier/Vendor	Any third party hired for supplying devices and components

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3 I&C TYPE OF PACKAGES

3.1 Type-1

- This type of package is a single or multiple-skid package with required skid-edge mounted Junction Boxes. The field instruments and junction boxes are installed on skid and wired. The tie-in points are the terminals of junction boxes.
- In this package type all / the most of instruments are skid-mounted. Vendor shall consider the following split of scope of supply:
 - Skid-mounted instruments

Vendor shall install the instruments, cables and junction boxes on skid(s) before shipment. In this case, the isolation valves, 2valve/5valve manifolds, hook-up materials, instrument electrical tracing materials & insulation, cables, junction boxes, cable glands, cabling materials (trays, conduits, etc.), support materials, labels and tagging materials shall be supplied by vendor as installed on skid. Junction boxes shall be ready for main cables termination, power-on and start-up.

- Loose items

Vendor can supply only the loose instruments for loose parts of package such as individual equipment. In this case, vendor shall separately and completely supply all materials mentioned above in previous item except below items. The required cables (secondary & main), junction boxes, cable glands, cabling materials (trays, conduits, etc.), support materials and earthing materials for loose instruments.

- Instrument main cables between the package skid-edge mounted junction boxes and plant control systems are excluded from vendor's scope of supply.
- Vendor shall supply all required special cables.
- Control functions inside the package are accomplished through the package control systems based on the logic diagrams and other design information provided by the package's vendor.

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- Vendor shall guarantee the mechanical design, materials and performance of all supplied equipment.

3.2 Type-2

- This type of package is the same as package type-1, except that local controller(s) and local control panel (LCP) are required and if required the operation facilities are located in plant control system. The scope and responsibilities are also the same. Vendor is responsible for the design, supply, installation, shop tests, commissioning, site tests and start-up of the LCP as well (if specified in relevant material requisition).
- Panel's specifications shall be according to the project requirements and specifications according to following sections.
- Control functions are accomplished through the Local Control Panel. Plant control system have only overall control on the package.
- Signaling between LCP and plant control system is via serial link (Redundant Profinet R1). Using media convertors like Profibus to Profinet shall be avoided. Generally, if it was not possible to use Profinet, using hardwire for signaling is preferred. By the way, in any case of non-conformity Vendor shall inform the Client for the approval.
- Data exchange list between the LCP and plant control system shall be prepared by vendor for purchaser's approval.
- Instrument main cables between the junction boxes and LCP of the package are excluded from vendor's scope of supply.
- Instrument cables and data communication cables (e.g., ethernet cables) between LCP and plant control system are excluded from package's scope of supply.
- Vendor shall supply all required special cables.
- Vendor is responsible for the design, supply, installation, shop tests, commissioning, site tests and start-up of all supplied systems, instruments, and accessories.
- Vendor is responsible and shall guarantee the mechanical design, materials and performance of all supplied equipment and systems.

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3.3 Basic requirements

For all industrial automation systems in this project, it is necessary to consider the following items:

- All the industrial PCs in this project will be connected to Antivirus Server (engineering operating systems, OPC, etc.) in the DMZ area through the firewall, Vendor shall prepare the required privileges etc. for this connection.
- All intelligent industrial automation devices that are equipped with microprocessors shall be updated with the latest firmware version. At the time of temporary or permanent delivery of the project, if a new firmware has been released Vendor shall update the firmware.
- Firewall (Hardware or Software) shall be selected according to control system manufacturer advice, otherwise it shall be confirmed by Client.
- Authorization shall be defined to access all the devices including CPU, Switches, Software, etc.
- Please be notified that any remote connection is prohibited in Copper Complex and Vendors shall provide whatever is required for maintenance, monitoring, update, etc. in order to proper functioning of their products during commissioning, guarantee period and operation by Client, including spare parts, software, applications and training.
- All industrial and non-industrial software installed on industrial automation systems must have an original license and a certificate of authenticity. It is not acceptable to use cracked software.
- Industrial automation system computers must be rack-mount and installed in the panel. It is not allowed to install the computer freely, under or on the operating and engineering tables.
- In any case if the Client decides to have an integrated control scheme instead of distributed control island, Vendors shall issue control philosophy and other requirements for each package to help control the packages in plant control system so-called PCS or DCS instead of local controller.
- At least 20 % spare shall be considered for future development in each panel including I/O Channel, Terminal, cabinet space, etc.

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4 Technical requirements

For all industrial automation systems in this project, it is necessary to consider the following technical items:

- In order to integrate the systems, Client ordered to choose the control system from one of the Siemens or ABB brands, considering the Client interest in the Siemens brand, choosing this brand has priority.
-
- In the packages where the manufacturer has used a brand other than the two mentioned for the control system, first correspond with the manufacturer and propose a replacement with the aforementioned brands. If it is not possible to replace it due to technical reasons, contact other manufacturers of this package. Other brands shall be approved by Client.
- As per contract vendor shall provide commissioning spare parts, operating spare parts that required for the first two years of operation. Spare parts for the instrumentation components shall be readily available in market. All spare parts shall continue to be available for a period of at least 10 years after the production of components.
- The equipment and software used in the industrial automation system must be supported by the manufacturer for at least 10 years. The contractor will not be allowed to use obsolete items or items that will become obsolete before 10 years. Lifecycle documents (PLM effective date) must be provided by the contractor in the proposal.
- It is mandatory to provide the project source for industrial automation systems, and no claims or excuses from the Vendor for not providing the final source are accepted. Please consider that source code means the complete version of archived software not the compiled version uploaded from the CPU.
- All usernames and passwords used by the contractor in industrial automation systems must be provided to the employer.

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5 Compliance with Specification

The Vendor shall comply with all the requirements of this specification and referenced documents and any deviations shall be clearly stated in his Proposal.

In the event of any conflict between this specification and referenced documents, the Vendor shall bring the matter to the EPC Contractor's attention for resolution and approval in writing and, unless agreed by the EPC Contractor, it is understood that the most stringent requirements shall apply.

Compliance by the Vendor with the provisions of this specification does not relieve him of his responsibility to furnish equipment and accessories of a proper design suited to meet the specified service conditions.

6 International Codes and Standards

The supplier shall be responsible for ensuring that his proposed system is in compliance with the applicable provisions of the latest publication of the following codes and standards at the time the system is purchased. In the event of conflict, the most stringent requirements shall apply. This list shall be considered as a minimum the other standards considered in "Instrument Design Criteria" are also applicable:

- ISA
- IEC
- TCO
- NEMA

7 DOCUMENTATION LANGUAGE

English language shall be used in all documents and drawings and other languages even if the English equivalents have been presented is not acceptable.

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8 PLC REQUIREMENTS

8.1 General

In designing the PLC "elementary diagram" and subsequently selecting the manufacturer and sizing the PLC, the scan time shall be carefully considered.

In case that, the logic diagrams involved requires scan time that cannot be met by single PLC, then distributed Networking of PLC shall be considered.

Consideration shall be given to the temperature, rise caused by heat from the power supplies, memories, etc., which will produce excessive temperature inside the cabinet. In such condition inside temperature may be driven 10 to 20°C higher than environmental temperature. Therefore, if ambient temperature reaches above 40 to 45°C, special cooling shall be installed for the PLC equipment.

8.2 System Reliability and Availability

The control system shall maintain high availability with high level of integrity. This shall be achieved by:

- The use of high reliability components.
- The use of redundancy as mentioned hereinafter.
- The provision of automatic self- testing and on–line monitoring.
- Simplified fault identification and repair or replacement methods.

All input, output and control modules shall be capable of being removed and re-inserted without causing damage or spurious action whilst the rest of the system remains operational.

The PCS shall be designed for maximum reliability, safety and integrity while maintaining an availability which shall be explained by the vendor.

Any single system fault shall not degrade system safety or functionality or impact operation of the controlled process.

A system availability analysis shall be provided for the PCS system. Analysis shall include MTBF and availability for each module of the system. The formula for availability calculation is:

$$\text{Availability} = \frac{MTBF}{MTBF + MTTR}$$

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Using a Mean Time To Repair (MTTR) of 8 hours.

The system availability shall be greater than 99.9%

8.3 CPU Selection and Memory Sizing

8.3.1 CPU Selection

The choice of the processor shall be determined by the magnitude and complexity of the I/O task.

The processor specification shall be carefully examined for I/O capacity, the applications program instruction set, memory options, and scan speed, environmental limits and power requirements.

The total I/O capacity of the PLC system must be considered very carefully, especially as the application load approaches the upper limit of the PLC.

According to the I/O table the quantity of required I/O shall be covered by the PLC. Under these circumstances, a larger model of the vendor PLC system shall be selected.

8.3.2 Programming Language

PLC programming languages shall be according to the IEC 61131-3 standard which shall be confirmed by the client:

8.4 Memory Sizing and Selection

Basically, sizing shall be based on evaluating program needs, allowing some extra memory for scratch pad and future expansion. Basic minimal functional amount of memory shall be carefully examined in sizing the memory considering the requirements in the following paragraphs. Vendors shall be requested to declare this amount of memory in their proposal.

For exact sizing, the estimation shall be based on the logic diagram included in the Vendor Package documents considering the instruction required for each element. The manufacturers shall be requested to provide information concerning the number of words used in each instruction, to be used for memory size estimation.

The estimation obtained shall be added to the space required by the input and output data tables considering the memory expansion and the amount of memory requirements as explained before.

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Generally, the internal memory (Load memory, Work memory) shall be sized such that at least 30% spare memory is available after definition of the I/O tables and entry of the application program.

9 HARDWARE REQUIREMENTS

9.1 Cabinets and Consoles

9.1.1 General Requirements

This Specification covers the furnishing of all labor, material, equipment and services for the design of the control panel and remote I/O panels as specified herein.

It is intended that the Vendor shall provide complete and operable units, suitable for continuous operation, including all auxiliaries unless specifically excluded herein.

All equipment shall be completely assembled, wired, tested and ready for installation. Disassembly for shipment, and subsequent re-assembly, shall only be as required to meet shipping restrictions and to ensure safe handling.

The equipment shall be designed and constructed to ensure: safety, system protection, service continuity, minimum maintenance requirements, easy installation, and to permit future expansion.

Wherever possible, the external layout of all cabinets shall have a similar appearance, i.e., louver heights/locations, nameplate heights/locations, etc. The panel construction shall follow the RITTAL standard for dimensions, even wall mounted or free-standing type, however all cabinet color shall be RAL 7035 and 20% spare on all cards and terminals shall be considered. The cabinets shall design and manufacture so that enough space for wiring and trouble has been considered.

Equipment on cabinets normally used by the operator shall be readable and operable with the operator in a standing position. All designs shall be reviewed in detail with EPC contractor prior to cabinet fabrication.

The main requirements for the cabinets are:

- Front access for marshaling cabinets
- Front and rear door access for system cabinets
- Free standing and floor mounting with anchor bolts and any fixing materials
- Key lock system with the same key for all cabinets
- Removable lifting lugs and eye bolts
- Louvers for air ventilation

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- Fitted with forced ventilation where required
- Internal door pocket for drawings
- Lighting controlled by door switches and manual switch on/off
- Cable entry from bottom, with supporting bar and sealing plate (sealed for obtaining fire-proof & vermin-proof installation)
- PVC Cable duct or tray with cover for all cables and wires installed in the cabinet /panel
- Indication lamp for power supply/feeder on the door.

The cabinet/panel design must allow full and easy access to all components, connections, terminations and assemblies by installation, maintenance and repair personnel. All cabinets shall be fully equipped/wired (frames, terminal strips and rail, wire markers and ferrules...) and ready to be installed on site or the related buildings.

Cabinets shall be provided with nameplates conforming to project standard, and with all necessary identification and warning labels.

Cabinet shall be equipped with required following bus-bars located in bottom of cabinets:

- Equipment ground for electrical purposes (non-insulated).
- Instrument signal ground for instrumentation, suitably isolated.

Cabinets shall be provided with internal lighting, and a general-purpose socket outlet, served by the general supply, rated for 230VAC single phase. Suitable isolators shall be provided within the cabinets for both lighting and sockets.

9.1.2 Enclosures

A permanent metal drawing pocket shall be attached inside the door. This pocket shall be at least 300 mm wide and shall be of sufficient depth to accommodate all pertinent drawings.

Door swing shall be 165° minimally and shall be attached to the enclosure body with a continuous hinge.

Additionally, a gland plate shall be incorporated at the bottom of the enclosure. This plate shall be made of steel plates with 2 mm thickness and shall be removable by suitable screws.

The enclosure shall have suitable EIA 19" rack mounting facilities for installing PLC rack modules and a suitably sized circulation fan with removable anti-dust filters shall be incorporated in the enclosure for heat removal. The enclosure ingress protection shall comply with IEC-60529

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The enclosures shall be welded steel enclosure type and the enclosures shall house all PLC rack modules and necessary power supplies. The enclosures shall be arranged in a manner that; one enclosure to house all PLC system modules.

The structure of the enclosure shall be made of heavy duty, minimally 2.0 mm thick metal plates and shall have additional top cable tray entrance, covered by suitable screwed metal sheet plates and provisions shall be made for grounding of the enclosure.

9.1.3 Protection against dust and humidity

Enclosures of instruments and cabinets shall be in accordance and suitable with IEC 60529 standard according to the location of installation and amount of dust, wind and moisture release and at no condition will be less than the following limits:

	Type	Location	Ingress Protection
1	Instruments	Inside the Room	IP42
		Indoor installation	IP54
		Outdoor installation	IP65
		deluge release conditions	IP66
		Submersion installation	IP68
	Panel and JB	Inside the Room	IP42
		Indoor installation	IP54
		Outdoor installation	IP65
3	enclosure/housing	control valves housing	IP65
		MOV	IP65

*- Instrument shall be protected from freezing and sun light where necessary.

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10 Construction

10.1 Mechanical

All cabinets located in buildings shall be fabricated from cold rolled and annealed mild steel. All other construction details shall be as Rittal type specification or equal.

All external surfaces shall be smooth and flat on completion of fabrication.

10.2 Paint Color

Cabinets of carbon steel shall be painted internally and externally. External and internal surfaces shall be finished to RAL 7035. Suitable touch up paint of each colour used shall be delivered with the equipment. Painting thickness shall be 100-120 µm using Epoxy powder coating.

10.3 Lifting Points

All cabinets shall be provided with suitable lifting points complete with removable eyebolts. Roof fixing screws shall be supplied to replace lifting eyes at site.

10.4 Cabinet Doors

Cabinet doors shall be full height, suitably reinforced to prevent distortion, and provided with seals to prevent dust or moisture ingress. Subject to approval single doors shall be hinged on the left, unless otherwise specified.

All doors shall be of the lift off type, and lockable. Keys shall be identical for all cabinets. All doors shall be capable of opening at least 160 degrees, and shall be equipped with mechanical stops suitable for the location.

10.5 Labeling & Tagging

Basically, English language shall be used for labels

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All cabinets shall be furnished with nameplate. These shall show the panel identification number and service and shall be installed properly to be read easily. Where cabinet has double doors, the label shall be on the right-hand door.

Panels and Cabinets shall be provided with nameplates made of phenolic laminate, such as “Trifoliate” or equal, engraved with black block letters on a white background. according to the project numbering procedure. Any label fitted on the outside of cubicles shall be attached with stainless steel screws.

Instruments, terminal boards, fuse/switches and circuit breakers, etc. mounted in cabinet shall be provided with nameplates of multi-layer plastic or equivalent stating the tag numbers, etc.

Terminals shall be clearly and permanently marked according to the data in the related connection list.

All wiring terminations shall be clearly marked using a white plastic slip-on embossed tube with black letters stamped on or other method.

Warning label for power supply terminals and also high voltage terminal (if any) shall be clearly and permanently marked according to the data in the related connection list.

All inter panel cabling/wiring shall be marked so that source and destination can be identified.

For warning and ESD information lettering shall be white on a red background. For Intrinsically Safe information lettering shall be white on a blue background. Adhesive labels may be employed where insufficient space is available for nameplate, or where special symbols are required. Labels shall be of plastic, with indelible text or symbols.

10.6 Radio Interference

In order to comply with the requirements of IEC 61000-4-3, Controller equipment shall be immune to interference from hand-held radio transceivers in the immediate vicinity with signal strength of 10 V/m over the range 27 to 500 MHz, and shall not affect the operation of other equipment.

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10.7 Electromagnetic Compatibility (EMC)

In order to comply with the requirements of IEC 61000 & IEC 60801, all electrical equipment shall meet the current applicable levels of emission and immunity. All applicable equipment shall be designed so that the electromagnetic disturbance it generates does not exceed a level allowing telecommunications equipment and other relevant apparatus to operate as intended.

The design of equipment should be of adequate standard to maintain its performance during its operational life in its installed environment. For the purpose of EMC, the performance of apparatus which must comply is taken as degraded if permanent or temporary loss of function occurs.

10.8 Earthing

10.8.1 General

All Control System Cabinets shall be equipped with Clean Earth (CE) and Protective Earth (PE) bus bars. These shall be located at the bottom of the panel.

Two separate grounding systems shall be provided in the system cabinets and marshalling cabinets:

Instrument Signal Ground (ISG) – used for termination of instrument cable screens in the marshalling cabinets. The CE must be insulated from steelwork or any other grounding system.

Equipment Ground (EG) – Connection to installation ground of all electrical equipment for personnel safety. The Equipment Ground shall be used for panel steel and power supply ground.

The ISG shall be connected to the CE only from one point and it is not allowed to have a loop in CE. The CE shall be connected to the PE through Surge arrester.

10.8.2 Instrument Earth Busbar

The Instrument Earth busbar shall be electrically isolated and minimum 25mm distance from the panel structure. It shall be employed for the earthing of cable screens and as a 0-volt reference point. When the panel consists of a number of bays and contains a number of CE busbars then one shall be selected as master and the other busbars shall be star connected to it.

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10.8.3 Earthing Busbars

All connections to earthing busbars within the cabinets shall be terminated with soldered or crimped compression type ring lugs. Conductor minimum sizes shall be as follows:

- Stranded insulated leads 2.5 mm²
- Flexible bonding connectors 25 mm²
- Copper bonding strips 12mm x 1.5mm
- Earth bars 25mm x 5mm x length as required

10.9 Switches and Lamps

10.9.1 Panel Switches

Front of panel switches shall be designed and located to avoid inadvertent operation. Switches for initiation of safeguarding shall be provided with guards or shrouds.

10.9.2 Double-Pole Isolating-Switch

A double-pole isolating-switch shall be provided and fitted for each main incoming power supply to each panel or rack. Where a panel controls two or more process units, the circuitry and equipment for each unit shall be arranged for separate isolation.

10.9.3 Miniature Circuit Breaker

A miniature circuit breaker (MCCB circuit breakers of minimum 14 kA rating for internal loads) or fuse of approved type and rating shall be provided and fitted for the supply to each electronic instrument circuit. Where instruments are fitted with integral fuses then disconnect switches only shall be provided.

10.9.4 Panel Lamps

All front of panel lamps, including annunciator lamps, shall be provided with a lamp test facility. Lamp illumination shall be achieved via light emitting diodes (LEDs) wherever possible.

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Lamp colors shall be green for motor running or valve open; red for motor stopped or valve closed.

10.9.5 Breakers, Terminals and Fuses

All breakers, terminals, fuses, etc.; shall be clearly labeled and readily accessible.

10.9.6 Socket Outlets

Socket outlets for supplying test equipment, shall be fitted in the cabinet in proper location for external connection like Laptop etc. A miniature fuse of maximum 2A shall be considered for socket. Minimum Conductor size of wire shall be 2.5 mm². The sockets shall be powered from a non-UPS source.

10.9.7 Internal Bulkhead Light Fittings

Totally enclosed panels shall be provided with internal bulkhead light fittings separately fused and wired into protected terminals for connection to a non-UPS power source. The lighting fittings shall be suitably placed to give adequate illumination for maintenance work inside the panel. Lights shall switch on automatically when the cabinet doors open.

10.10 Power Distribution

10.10.1 General

Vendor shall be responsible for designing the power distribution within the cabinets and consoles.

The control and safety system shall be electrically powered from a UPS which sustains all components of the system for a period of time in the event of total power generation failure.

The lighting, fan, socket, heater and all other accessories shall be powered from a non-UPS power source. (230Vac, 50 Hz)

Regardless of the above, the system shall be unaffected by voltage variations up to $\pm 5\%$ and frequency variations up to $\pm 2\%$.

All other voltages (such as 24 Volt DC) required by the Controller shall be derived within the cabinet by the use of suitable internal power supplies and distribution. Power supplies shall be supplied in redundant configuration and shall be sized 20% in excess of the estimated maximum demand.

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The minimum requirement for the power distribution shall be as below:

- Redundant power distribution boards with incoming fused isolators and miniature circuit breakers for distribution.
- Redundant feeders to all redundant consuming devices.
- Redundant feeders with selector switches for non-redundant consuming devices.
- Power isolation means at both ends of the power cables.

The power consumption of the system as well as the heat dissipation for each cabinet and operator console shall be listed. Calculation will take into account spare capacity as defined.

10.10.2 Power Supply Failure

Where power supply failure is not identifiable immediately, e.g., then the panel shall generate an alarm output wired to terminals.

10.10.3 Electrical Connections

Terminals energized above 32VAC or 100VDC, such as mains voltage 220V AC, shall be shrouded. The shroud shall incorporate a label identifying the voltage level.

10.10.4 Interconnecting System Cables

It is a requirement to make maximum use of system cabling to minimize site installation work. The Vendor shall provide system cables for all interconnections within rooms between marshalling cabinets and system cabinets (If there were any), system cabinets to operator workstations, etc. System interconnections shall comprise multi-core cables, with plug and socket assemblies. The connectors shall be of robust construction which when connected, are locked in place with anti-vibration screws. Cable specification shall follow the “Specification for I&C Cables”.

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10.11 Internal Design

10.11.1 Cable Entry

Unless otherwise specified, cabinets shall be designed for the bottom entry of cables or cord sets, and shall be equipped with gland plates. If there were armored cable, when the panel is installed in a field area the cable armoring will be secured at the gland plate. When the panel is installed in a building then the armoring shall be secured below the panel and the gland plate will be employed for sealing purposes only.

10.11.2 Electronic Equipment

Electronic equipment shall be located in fixed racks. Electronic equipment mounted on rails or on swing frames shall be subject to Client approval. Equipment shall be arranged to facilitate access for adjustment and/or maintenance, and shall not be located within 300mm of the bottom of cabinet. All equipment shall be arranged to ensure the flow of cooling air, where necessary.

Where separate PSUs are included within the panel these shall be located to minimize heat flow over other electronic components.

10.11.3 Field Terminals

All terminals shall be rail mounted, and be of the screw clamp type where the screw is not in direct contact with the wire, however, spring clamp type can also be used. All terminals for field cables shall have quick disconnect capability, i.e., knife edge contacts.

Where fused terminals are required, they shall be installed on the positive side and equipped with “blown” indicators.

Field terminals are preferred to be arranged in vertical columns. No double banked/high density terminal arrangement types shall be used.

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10.11.4 Field Multicores Cable

When the cabinet is used for marshalling or for miscellaneous equipment, then sufficient terminals shall be provided to terminate all incoming cable cores in sequence. Incoming cables shall not be terminated in more than 1 cabinet.

10.11.5 Heat removal

Venting shall be used to transfer heat from the PLC to the environment where the enclosure is located in clean areas, such as; control rooms. For proper operation, the vents should be near the top of the enclosure. Additional venting of the package at the bottom allows airflow through the enclosure, thereby increasing the efficiency of heat removal.

Vents shall be designed so that items like screws, nuts, etc., cannot inadvertently fall inside the equipment.

Forced air cooling technique shall be employed for heat removal where required, using fans, blowers, and filtering.

Since, as a mechanical device, fans and blowers are prone to failure and filters may clog with time, the PLC packaging shall be capable to operate reliably without these devices, in case of their failure.

Heat sinking shall be used to remove heat of heat producing devices, such as; power supply transistors. The heat sink radiating surface shall preferably be located outside the enclosure.

11 TERMINATION AND WIRING

11.1 General

Fixed wiring with suitable terminal blocks shall be provided for power supplies and field side of marshalling racks.

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Removable wiring shall be typically used for I/O modules. In this case, the field wiring from the marshalling rack shall be done to a removable terminal block. In order to remove an I/O module for repair or fuse replacement, the terminal block on the I/O shall be detachable, to enable the module to be unplugged from the I/O rack backplane.

Cabinet wiring in general shall be flame retardant to IEC 60332.

All conductors and wires (including the non-used conductors in multi-conductor cables) must be connected on terminals.

Daisy chaining of power wiring is prohibited.

Segregation of cables and wiring shall be in accordance with voltage level.

The cross-section of internal wires shall be according to “Specification for I&C Cables (28C3-D-4IN-SPC-090-0000-00-IN-0003)”.

Sufficient room shall be left inside the cabinets for good access to the spare terminals.

Internal wiring shall be arranged in a way not to interfere with maintenance operation.

All external cables shall be adequately supported and secured to prevent from being dislodged.

20% additional spare space for cabling in PVC cable duct shall be provided for future extension.

All I/O points from I/O modules shall be wired to terminals/connectors. This also applies to installed spare modules.

All wiring shall be installed in well sized plastic cable ducts with removable cover and/or eyehooks.

Color of cable ducts/eyehooks shall be grey for general purpose cable and light blue for intrinsic safe wiring (if any).

DC signals connected to terminals shall be arranged such that the first terminal is "+" and second "-".

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Maximum one wire pin shall be connected at one side of a terminal. Splices inside ducting or on connectors are not allowed.

All terminal rows shall be clearly marked and all terminals shall carry terminal numbers.

Wire pin (wire shoe) with proper size shall be used for all wiring connections with terminals.

All wiring connected to screwed terminals shall carry identification markers. Terminal row and terminal number shall be indicated.

The cabinet Vendor shall take notice of all external cable dimensions, wiring cross diameter, voltage, etc. to ensure that all provisions made for these cables/wiring are sufficient and designed according requirements.

All wires and terminals shall be clearly labeled.

The input devices shall be wired, so that they switch the hot side of the line. A similar method shall be used for the PLC outputs.

The digital outputs shall first trigger an interposing relay from which an open or close contact will be taken for the switch.

Acceptable wiring practice must be followed for all I/Os of the PLC.

Special consideration must be given to execution of Analogue I/O low-level signal sources such as thermocouples.

Where, a voltage divider is used to match a field transmitter voltage range to that of the PLC's A/D, the resistances shall be chosen so as to use as much current from the field device as is permissible, in order to provide the maximum signal-to-noise ratio at the input.

The wirings shall be run in the shortest possible routes.

Joining the cables for increasing the cable length shall be avoided.

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Cabling along vibrating supports or sources shall be avoided.

Minimum 10 cm radius shall be used on cable bends for two core cables.

Different voltage and types of signals shall be separated, as much as possible.

In order to avoid ground loop problems, the shields on shielded cables must be grounded at one end only.

This ground can be conveniently established at the cabinet end of the cable.

As each module wiring is completed, check of the wirings shall be performed for mechanical strength by pulling at each connection and verifying the labeling.

11.2 Terminal Marking

All terminals, and terminal groups, shall be individually identified. This shall be achieved using printed idents and markers supplied by the terminal manufacturer.

Markers shall have black lettering on a white background.

11.3 Stranded Wire

Where stranded wire is employed, wire ends shall be terminated in twin grip, insulated crimp connectors. Crimps shall be selected to suit the wire size, and shall be secured by means of an approved crimping tool. Not more than one wire shall be terminated at any crimp. Only one crimp shall be inserted into any one terminal. In cases where solid core wiring is required crimps shall not be employed.

11.4 Parallel Wire

Where there is a need for parallel wire connections this shall be achieved by the use of combs or shorting bars provided by the terminal manufacturer.

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11.5 Permanent Identification for all Wiring

All wiring shall be permanently identified by sleeve type markers (e.g. Grafoplast or equivalent), correctly sized for the wire, and attached prior to crimping. Lettering of inserts shall be black on a white background.

11.6 Wire Identification

Each wire end shall be identified with source/destination. All lettering or numbering shall read from left to right. Where the wiring is run vertically then indents shall read from below (left) to above (right).

11.7 Wiring, Cross Wiring and Power Distribution

Wiring, cross wiring and power distribution wiring shall be installed in a neat fashion within cabinets and routed via slotted plastic trunking. Trunking shall be fully supported over its complete length, and secured to the panel structure with stud bolts or screws. Trunking shall also be provided for cables and cord sets entering the panel. To facilitate removal, when necessary, the length of trunking covers shall not exceed 1 meter.

11.8 Unused Card Locations

Unused card locations within 19” racks or similar shall be fitted with dummy card cover plates.

11.9 Distances between Terminals

A minimum distance of 50mm shall be maintained between terminals and trunking to ensure that wire markers are fully visible.

11.10 Trunking for Wiring and Cables

Wiring or cables inside trunking shall be supported or secured along the run length. On panel completion the trunking shall not be more than 70% filled.

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11.11 Wire Clusters

Where clusters of wires leave the trunking, they shall be bundled together using Spiro wrap, or similar, and shall be supported suitably. Bundles shall not be routed near sharp surfaces. Where wiring or cables pass through access holes then glands or protective grommets shall be used.

11.12 Wire Segregation

Internal wiring shall be segregated as follows to minimize interference:

- Millivolt signals run in screened twisted pairs to the signal-processing device.
- Run temperature signals in thermocouple or compensating cable RTD signals run in screened twisted triples to the signal processing device
- Pulse signals run in screened twisted pairs to the signal processing device
- AC power feeds run in individual wires, with dedicated trunking which shall be coloured black.

For parallel runs maintain a minimum separation of 75mm from instrument signals, including the above.

IS Signals to be segregated from all other signals and run-in dedicated trunking shall be colored light blue.

Notes:

- All signal separation shall be reviewed where wiring is proposed for the above signals instead of cables, or where the supply voltages differ from what remarked in this Specification.
- Unless specified above, all trunking shall be colored grey and light blue colored for IS signals.