

JOHANNESBURG WATER (SOC) Ltd.
BULK WASTEWATER

PARTICULAR SPECIFICATION
VOLUME 3 : PROGRAMMABLE LOGIC
CONTROLLER (PLC) PANELS



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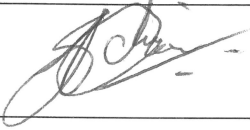


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3 PROGRAMMABLE LOGIC CONTROLLER (PLC) PANELS

3.1 Scope

- 3.1.1 This specification covers the manufacturing, supply and installation of Programmable Logic Controller panels used for process monitoring and control applications at Johannesburg Water wastewater sites.

3.2 Abbreviations

- 3.2.1 In this specification the following abbreviations will apply :-

BS	: British Standards
PLC	: Programmable Logic Controller
I/O	: Input/Output
CPU	: Central Processing Unit
UPS	: Uninterruptible Power Supply
MCC	: Motor Control Centre
MCB	: Miniature Circuit Breaker

3.3 Standards

- 3.3.1 All design standards for cabling shall be subject to the latest amendments and editions of the following standard specifications:-

SANS 10142-1	: National Standards for the wiring of premises.
SANS 1091:2004	: National Colour Standard.
SANS 1274-2005	: Coatings applied by the powder-coating process.
BS 381C:1980	: Paint colour chart.

3.4 General Requirements

- 3.4.1 The PLC control panel shall house the following items:-

- 3.4.1.1 The PLC and all I/O modules and racks.
- 3.4.1.2 Fibre-optic network interface modules.
- 3.4.1.3 All network switches and hubs.
- 3.4.1.4 All field instrumentation and MCC interface cables shall be marshalled in this panel.
- 3.4.1.5 All power supply and distribution circuitry and equipment.
- 3.4.1.6 All lightning and surge protection devices as required.
- 3.4.1.7 Marshalling terminals as required

3.4.1.8 Interposing relays as required.

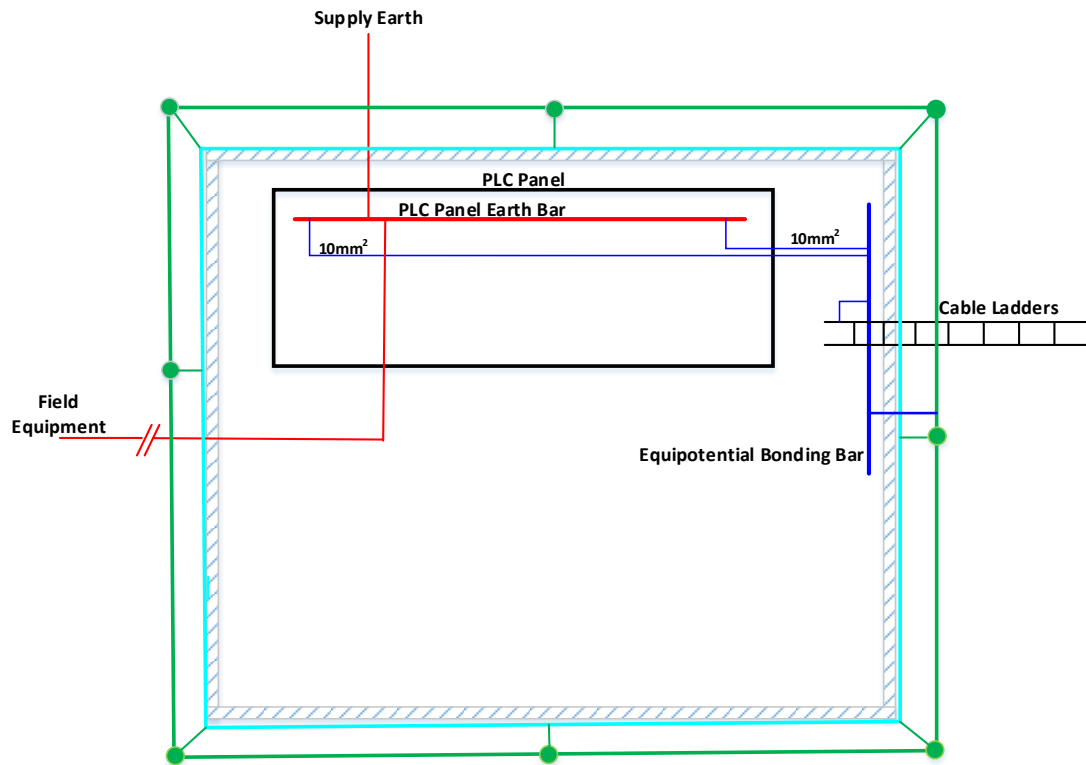
- 3.4.2 The supply and installation shall in general comply with the relevant clauses in all specifications attached to the tender documentation.
- 3.4.3 The panels shall be free standing units with bottom cable entry (via a glanding plate) and have front door access (hinged and lockable).
- 3.4.4 The panel should be manufactured from sheet steel not less than 2,0 mm thick. The panel will have a door on the front which opens to practically the full width and height of the panel. The panel shall be free standing and shall not be more than 2 200 mm high, 2 400mm wide and 600mm deep and it should be sized to accommodate all the PLC and associated equipment required for the actual PLC I/O and future spare capacity as indicated in the PLC schematic diagram.
- 3.4.5 Once the door is open there should be no obstruction to prevent full access to every point inside the panel.
- 3.4.6 The panel shall be epoxy powder coated electric orange (Shade B26) finish. Interior chassis mounting plates will be finished in appliance white. All removable parts and hardware will be cadmium yellow passivized.
- 3.4.7 Each panel and control function should be clearly labelled with labels engraved on laminated engraving board with black letters on a white background. All labels must be attached with chrome plated, screws and nuts or screws and tapped holes. On the backing plate only tapped holes may be used. Screws with nuts on the backing plate will not be acceptable.
- 3.4.8 The panel must be vermin-proof and must have a protection rating of no less than IP 55.
- 3.4.9 This specification must be read in conjunction with the PLC Hardware Specification (Volume 2 of the Automation And Control Standards).
- 3.4.10 All labelling must comply with the requirements as specified in the Labelling Specification (Volume 25 of the Automation And Control Standards).

3.5 Standard Features

- 3.5.1 Each panel shall have the following features as standard:-
- 3.5.1.1 Ventilation fans with air filters shall be mounted on the PLC panel at high level with no air outlets. The fans must pressurise the panel to prevent the ingress of dust.
- 3.5.1.2 Ventilation fans must have proper screw terminals in an enclosed terminal box. No exposed terminations, soldered connections or push-on lugs will be accepted.
- 3.5.1.3 A 230V AC switch socket outlet shall be mounted inside the panel (supplied from the UPS section). This socket must have a shaved earth which shall be used for the PLC programmer only.
- 3.5.1.4 Interior lighting at the top of the panel must be arranged to switch on, via a micro switch, when the panel door is opened. This light must be an LED

light with a CCT (Correlated Colour Temperature) of 4000K to 6000K. The light must be fitted with a diffuser and it must supply no less than 680 lm (Net luminous flux). The lamp must have proper screw terminals in an enclosed terminal box. No exposed terminations, soldered connections or push-on lugs will be accepted.

- 3.5.1.5 A substantial area of removable gland plates on the floor of the panel, split into two or more sections.
- 3.5.1.6 A sheet steel pocket welded onto inside of the door to hold A4 sized drawings, books etc.
- 3.5.1.7 No holes may be drilled for tapping, riveting, bolts & nuts, etc. in any section of the panel where it will compromise the protection rating of the panel. I.e. only in the backing plate or in the glanding plate may holes be drilled. Where drilling is unavoidable, e.g. to affix labels, the holes must be sealed so that the protection rating of the panel is not compromised.
- 3.5.1.8 Bolts with nuts shall not be used to attach equipment to any mounting plate at any point. On mounting plates only bolts in tapped holes will be acceptable. Bolts with nuts will be allowed on enclosure doors however, where the bolts and nuts are easily accessible.
- 3.5.1.9 Where bolts are used on the door or any outside panels of the enclosure, a sealing method (e.g. rubber washers) must be used to ensure that the IP protection rating of the enclosure is not compromised.
- 3.5.1.10 Wherever bolts are used, the bolts must be as short as practically possible so that there are no long protrusions that can injure people or snag clothing, wiring, other equipment, etc. If bolts are cut to the correct length, the ends of the bolts must be neatly de-burred and smoothed so that there are no sharp edges that can cause injuries and so that the nuts can be easily screwed on and off. No more than four threads of the bolt end must be visible beyond the nut. It is however preferred that the correct length of bolts are used so that shortening is not required.
- 3.5.1.11 A copper earth bar running the full width (i.e. left-end to right-end) of the panel at the bottom with solid electrical connection to the panel doors and to the steel of the panel at two or more places and provided with terminals for connection of equipment and screen earth wires. This earth bar must be connected to the equipotential bonding bar of the building via at least 2 x 10mm² earth conductors (one from each end of the panel earth bar), as shown in the sketch below.



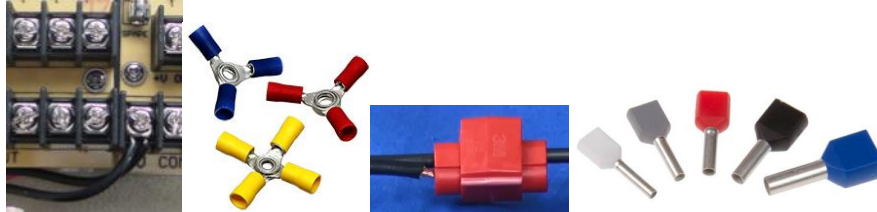
- 3.5.1.12 Separate AC and DC distribution sections if both AC and DC are used.
- 3.5.1.13 A free-standing (i.e. not the PLC rack mounted) 24V DC Power supply for all analogue I/O cards or I/O sub-bases (where required), 24V DC I/O distribution (if required), field instrumentation supplies (if required), etc.
- 3.5.1.14 Where stopper plugs are used to seal holes that are not used, no plastic stopper plugs will be acceptable. All stopper plugs must be threaded, non-corrodible, metal plugs with rubber washers on both sides of the panel to ensure at least an IP65 seal (see examples below).



3.6 Wiring, Relays and Terminals

- 3.6.1 All terminals shall be screw-type terminals and shall be mounted on raised DIN terminal rail, secured to the chassis plate at the back of the panel.
- 3.6.2 Proprietary type wire strippers shall be used and no stranded conductor shall be terminated if one or more strands have been damaged.

- 3.6.3 Not more than one wire shall be connected to any terminal unless the terminal can accept pin lugs on either side of a screw or unless proper connecting material is used (see examples below).



- 3.6.4 Every wire shall be marked at both ends with a numbering system approved by the Engineer, and all terminating wires shall also be suitably crimped to a terminal lug. Not more than one wire shall be crimped into a single lug.
- 3.6.5 All wiring shall be flexible, tinned, annealed, multi-strand copper wire not less than:-
- 3.6.5.1 1,5mm² for 230V AC or 110V AC power
 - 3.6.5.2 1,0mm² for 24V DC or AC power
 - 3.6.5.3 0,5mm² for all PLC I/O wiring between modules and marshalling terminals
 - 3.6.5.4 4,0mm² for earth drain
- 3.6.6 Irrespective of the minimum wire sizes allowed in this specification, contractors must ensure that all cables and wiring are capable of carrying the full system currents, inclusive of de-rating factors as specified in the latest version of SANS 10142.
- 3.6.7 All wire terminations must be done by using suitable lugs. No more than one wire may be crimped into a single lug. Where pin lugs are crimped onto the ends of wires, correctly sized pin lugs must be used, which fit into the terminals properly and such that the tightening of the terminal does not result in the loosening of the pin lug.
- 3.6.8 All panel wiring shall run in suitably sized slotted trunking for as much of their course as possible, thereafter in spiral band or similar conduit to its destination if the exposed run would exceed 100mm.
- 3.6.9 The distance between the terminals and the trunking or between equipment (such as relays, surge protection, circuit breakers, etc.) and trunking shall not be less than 50mm.
- 3.6.10 Control wiring should not run with power wiring and all cross-overs shall be at ninety degrees.
- 3.6.11 A block of terminals shall be allocated to each I/O module. The terminal block shall be labelled with the PLC rack number and module slot allocation.
- 3.6.12 The terminals allocated for the various I/O modules must be as per the design drawings submitted by the Engineer. If it forms part of the contractor's scope of work to submit design drawings, the terminals allocated for the various I/O modules must be approved by the Engineer. All terminals shall be sequentially numbered from top to bottom for each I/O channel for every type of I/O card.

- 3.6.13 Each analogue and digital input and output channel shall have surge protection units as specified in the Clean Power And Surge Protection Specification (Volume 5 of the Automation And Control Standards).
- 3.6.14 Internal wiring shall be colour coded as follows:-
- | | | |
|----------|-------------------------|------------------|
| 3.6.14.1 | <u>230V AC Power</u> | |
| | Live | Brown |
| | Neutral | Blue |
| | Earth | Green and Yellow |
| 3.6.14.2 | <u>24V DC Power</u> | |
| | Positive | Red |
| | Negative | Black |
| 3.6.14.3 | <u>Digital Inputs</u> | |
| | 230V AC | Yellow |
| | 24V DC | Red |
| 3.6.14.4 | <u>Digital Outputs</u> | |
| | 230V AC | Grey |
| | 24V DC | Red |
| 3.6.14.5 | <u>Relay Outputs</u> | |
| | 230V AC | Grey |
| | 24V DC | Red |
| 3.6.14.6 | <u>Analogue Signals</u> | |
| | Positive | Orange |
| | Negative | Purple |
- 3.6.15 A terminal section for AC and DC power distribution shall be included in the PLC panel where both voltages are used for PLC I/O. The terminal groups shall be clearly identified to indicate the various voltages.
- 3.6.16 A separate power distribution section shall be used for the AC and DC supplies where both voltages are used. Miniature circuit breakers (MCB's) shall be used to feed the various items of equipment such as PLC I/O cards, fans, lights, field instruments, etc. Fused terminals may be used if it is indicated as such on the design drawings submitted by the Engineer.
- 3.6.17 Two types of mains supplies shall be made available to the PLC panels: Raw Mains and UPS Mains. The raw mains incomer shall feed the non-critical items such as fans, 24V DC power supplies, 230V AC terminal section, 230V AC I/O modules, relay output modules, etc. The UPS supply shall feed the critical items required for PLC communications in the event of a raw mains power supply interruption. Such items are plugs (for PC), lights (inside the PLC panel), fibre-optic interface modules, PLC Processor, etc. Unless otherwise specified, PLC I/O and field instruments need not be supplied by UPS power.
- 3.6.18 All wiring must be continuous from one termination (in a terminal strip or device such as a relay, contactor, surge arrester, etc.) to the next. No spliced wiring will be accepted.
- 3.6.19 Where relays (not relays that are part of the PLC hardware, such as in I/O sub-bases) are used, such relays must be pluggable, so that relays can be replaced

without the need to disconnect wiring and the relays must have visible indication when it is energised.

3.7 Existing PLC Panels

- 3.7.1 All modifications and wiring changes to existing panels must comply with the specifications as laid down for new panels.

3.8 Factory Acceptance

- 3.8.1 Before delivery of the PLC systems and/or the PLC panels, a comprehensive system factory acceptance test must take place. The Engineer must be notified one week in advance of the proposed test.

- 3.8.2 The test shall comprise of at least, but not be limited to:

- 3.8.2.1 Checking the panel manufacturing and assembly for compliance with this specification.
- 3.8.2.2 Layout, numbering and labelling of equipment.
- 3.8.2.3 Wiring – sizes, numbering, colours, termination, etc.
- 3.8.2.4 Wiring as per drawings, I/O schedules, etc. (i.e. loop checks).

3.9 Loop Isolators

- 3.9.1 Loop isolators are required where the instruments and the relevant PLC are fed from different power sources. Loop isolators must provide isolation between the instrument signals and the power supply. Separately powered isolators are preferred.

3.10 Uninterruptible Power Supply (UPS)

- 3.10.1 An Uninterruptible power supply must be installed to isolate the PLC from the "raw" mains supply.
- 3.10.2 The UPS must comply with the UPS requirements as specified in the Clean Power And Surge Protection specification (Volume 5 of the Automation And Control Design Standards).
- 3.10.3 The raw mains incomer to the PLC panel shall feed the non-critical items such as fans, 24V DC power supplies, 230V AC terminal section, 230V AC I/O modules, relay output modules (if required), etc. The UPS supply shall feed the critical items that keep PLC communications established should the raw mains power supply be interrupted, such as plugs, lights, fibre-optic interface modules, PLC (CPU), etc.
- 3.10.4 Tenderers must satisfy themselves that the UPS rating is adequate to supply all the equipment which they are offering.

3.11 Over-Voltage/Lightning Protection

- 3.11.1 The function of the over-voltage/lightning protection units is to prevent damage

from occurring to the electrical and electronic devices due to destructive voltages, by resistive coupling, capacitive coupling or inductive coupling, arising from extraneous events such as lightning discharges, switching surges etc. All lightning and surge protection must be in accordance with the requirements in the Clean Power And Surge Protection specification (Volume 5 of the Automation And Control Design Standards).

3.11.2 The protection units on the 230V AC mains incomers of the PLC panel (if not provided on the mains elsewhere) shall consist of at least IEC Class II protection. Preferably Class I and Class II, or a combined Class I + Class II protection must be used.

3.11.3 Each individual supply from the 24V DC distribution and from the 230V AC distribution to field instruments or other field supplies must be equipped with at least Class II medium surge protection.

3.12 Spares

3.12.1 The tenderer will be required to provide at least 10% spare fuses and other consumable items which may be required during commissioning. In addition to commissioning spares, a recommended spare list for three years maintenance, should be submitted. This item must be completed so that spares may be ordered as part of the capital contract. Tenderers ignoring this condition may be disqualified.

3.13 Painting (Powder Coating Method)

3.13.1 General

Switchboards and panels shall be epoxy powder coated in accordance with Type 1 coatings to SANS 1274-2005.

Unless specified otherwise, a high gloss finish in the following colour shall be provided:

Colour - Light Orange, Colour No. B26, Munsell Ref. 2,5 YR C/14 to SANS 1091 : 2004 and Colour No. 381C-557 to BS 381C : 1980.

Paintwork must be guaranteed against blistering, peeling, cracking and general deterioration which can lead to rusting, corrosion, etc. for a period of no less than three years. If the tenderer cannot comply with this requirement, it must be clearly stated as such in the tender.

3.13.2 Specifications

The following specifications in accordance with SANS 1274-2005 shall be provided:-

<u>Property</u>	<u>Requirement</u>	<u>Test Method</u>
Thickness, minimum	50 micron	6.7
Marking Resistance (400g)	No marking	6.20
Impact Resistance, J, minimum	6,78	6.10
Water Resistance, h, minimum	720	6.13
Humidity resistance, h, minimum	1000	6.14
Resistance to salt fog, h, minimum	1000	6.16

3.13.3 Surface Preparation

Surface preparation of sheet steel components shall be carried out by means of the multi-bath zinc phosphate/chromate passivation treatment.

All fabricated sheet steel components are to be degreased and de-rusted ready for treatment.

A steel surface is considered ready for treatment when all dirt, grease, rust, mill scale, moisture or other contaminants have been removed in an alkaline degreaser to give a dry, clean, bright, metallic surface.

Steel plate less than 4mm thick - black steel sheet shall be pickled to white metal condition while pre-pickled, bright, cold rolled sheet steel shall be solvent cleaned. These surfaces shall be treated within eight hours in all cases while still uncontaminated and rust-free.

The prepared steel surface shall be treated by means of immersion in a heated zinc phosphate solution bath, rinsing and thereafter chromate passivated by means of immersion in the final treatment bath.

3.13.4 **Powder Coating**

A thermosetting powder consisting of epoxy/polyester resin shall be applied by means of an electrostatic spray gun to give a uniform coating thickness of 50 to 60 micron. Less than 50 micron will not be acceptable.

The powder coating shall be baked at a metal temperature of 185°C so as to melt the powders to form a continuous film over the metal substrate.

3.14 **Drawings And Diagrams**

3.14.1 The tenderer must submit layout drawings, showing the PLC panel size, cable entry, location of equipment, details of equipment (such as fans, lights, plugs, trunking size, circuit breakers, fuses, terminals, etc.), panel colour, material of construction (e.g. 2mm mild steel), etc. for approval by the Engineer before any manufacturing commences.

3.14.2 The drawings must be accompanied with data lists of the proposed equipment. These data sheets must show the type, supplier, make, model, size, etc. of equipment where applicable. For example:

Terminals	- Phoenix SK12, 4mm, white.
MCB's	- Merlin Gerin, 5A, 10kA, single-pole.
Etc.	