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**RAND WATER**

**STANDARD SPECIFICATION**

**FOR**

**CONTROL PANELS**

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## CONTENTS

	Page
<u>1</u> <u>SCOPE</u>	1
<u>2</u> <u>STANDARDS AND REGULATIONS</u>	1
<u>3</u> <u>OPERATIONAL REQUIREMENTS</u>	1
<u>4</u> <u>DRAWINGS TO BE SUBMITTED FOR APPROVAL</u>	1
<u>5</u> <u>MECHANICAL CONSTRUCTION</u>	2
<u>6</u> <u>PAINTING OF SHEET METAL FABRICATIONS</u>	3
<u>7</u> <u>SAFETY FEATURES</u>	4
<u>8</u> <u>ELECTRICAL CONSTRUCTION</u>	4
<u>9</u> <u>EARTHING</u>	6
<u>10</u> <u>MIMIC PANELS</u>	6
<u>11</u> <u>ELECTRICAL EQUIPMENT</u>	6
<u>12</u> <u>QUALITY ASSURANCE REQUIREMENTS</u>	7
<u>13</u> <u>DELIVERY, OFFLOADING AND INSTALLATION ON SITE</u>	8
<u>14</u> <u>SPARES</u>	9
<u>APPENDIX A - APPROVED COMPONENTS</u>	10

## 1 SCOPE

This specification covers the design, manufacture, testing at works, preparation for delivery, delivery and off loading of control panel(s) for electrical and electronic equipment.

## 2 STANDARDS AND REGULATIONS

2.1 The control panel(s) shall be designed to fully meet the requirements of the latest revisions and amendments of the following Acts, Regulations, Standards and Recommendations :-

Occupational Health and Safety Act (Act 85 of 1993)

SABS 0142-1993	Code of Practice for the Wiring of Premises
SABS-IEC 439 Part I	Factory Built Assemblies of Low Voltage Switchgear and Control Gear
IEC 529	Degrees of Protection Provided by Enclosures
IEC 947	Low Voltage Switchgear and Control Gear
Part I	General Rules
Part II	Circuit Breakers
Part III	Switches/Isolators/Switch Isolators and Combination Fuses Switch Units
Part IV	Contactors
Part V	Relays
IEC 99	Surge Arrestors
IEC 269 Part V	Fuses for Protection of Semiconductor Devices
SABS 1507	PVC Cables and Cords
IEC 51	Indicating Instruments
IEC 521	AC Watt hour Meters
SABS 763	Galvanising

## 3 OPERATIONAL REQUIREMENTS

3.1 Environmental operating conditions

Maximum air temperature	+ 40 degrees Celsius
Minimum air temperature	- 10 degrees Celsius
Maximum humidity	95% (non-condensing)
Location	Indoors unless otherwise stated but subject to insect and vermin depredations

## 4 DRAWINGS TO BE SUBMITTED FOR APPROVAL

4.1 Prior to the commencement of manufacture of the control panel(s) the following drawings shall be submitted to Rand Water for approval :-

- Panel general arrangement drawing(s) showing overall dimensions.
- Panel layout drawings showing mounting positions of equipment and free space between equipment.
- Panel door layouts showing relative positions and dimensions of equipment mounted on the panel doors.
- Schedule of all labels showing size of label and letters and the wording of the label.

4.2 Failure to comply with this requirement timeously may result in rejection of the control panel(s).

## 5 MECHANICAL CONSTRUCTION

### 5.1 General

The control panel(s) shall be constructed in such a manner as to form a rigid assembly that will not distort when lifted and transported. A suitable base frame manufactured from channel, or approved alternative section, shall be provided for this purpose. Wall mounted panels shall be provided with suitable brackets external to the enclosure that will permit mounting without having to drill holes in the rear of the control panel. The control panel(s) shall be provided with suitable lifting lugs if required.

### 5.2 Construction methods and systems

5.2.1 The modular system with fully bolted construction is the preferred system for the control panel.

5.3 For small, wall mounted, single enclosure panels welded sheet metal constructions will be accepted.

5.4 Control desks may have a wooden enclosure. If this feature is specified the wood used shall be "American Oak".

### 5.5 Enclosure classification

5.5.1 All control panel(s) intended for indoor application and installed in formal substation rooms shall afford at least degree of protection IP4x. Enclosures for outdoor installations or located within plant areas shall be at least IP65.

5.5.2 On opening compartment doors the level of protection for that compartment shall be at least IP2x and all outgoing cable compartments shall be IP2x enclosures.

### 5.6 Access and component layout

5.6.1 The control panel(s) shall be designed and constructed to meet the following criteria with respect to access and component layout.

5.6.2 It shall be possible to remove and replace components, make cable connections and carry out fault finding procedures without having to unnecessarily disturb wiring. Sufficient space shall be provided for connections of power and control circuits such that normal clearances to earth are maintained and that excessive stresses are not placed on cables and conductors.

5.6.3 For this purpose the manufacturer shall submit to the Engineer drawings of the proposed cubicle and component layouts to verify these requirements have been complied with.

5.6.4 The cubicles shall have sufficient air volume to ensure temperature rises are kept within component manufacturer's recommendations and as recommended in SABS-IEC 439.

5.6.5 The control panel shall include at least 10% free space for the installation of future equipment.

### 5.7 Control panel doors

5.8 Panel doors shall be hung on substantial concealed metallic lift off type hinges and shall be secured by means of handle operated type catches with padlocking facility. Alternatively square key catches are acceptable provided that each door has facility for at least one catch per door to be padlockable. Doors located with pins are not acceptable.

5.8.1 Bolts, studs and domed nuts are not acceptable means for fastening door panels.

### 5.9 Polycarbonate or fibreglass control panel(s).

5.9.1 The polycarbonate or fibreglass system shall be submitted for approval of the Engineer before submission of tenders.

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- 5.9.2 Polycarbonate enclosures shall have bases manufactured from glass filled polycarbonate thermoplastic. Clear covers shall be non-filled thermoplastic.
- 5.9.3 The enclosures shall have a high impact resistance, shall be flame resistant and self extinguishing. The enclosures shall be non-hygroscopic and shall be ultraviolet light resistant.
- 5.9.4 Control panel(s) assembled from polyester or fibreglass enclosures shall be provided with a substantial metal frame to permit handling and installation without distortion or excessive flexing occurring. The finish of the frame shall be suitable for the environmental conditions specified.
- 5.9.5 Removable covers shall be secured by means of captive screws.
- 5.9.6 The degree of protection of the individual cubicles shall be at least IP65 to IEC 529. The coupling of individual enclosures to form control panel(s) shall in no way cause a deterioration in the degree of protection of the overall assembly, or of any individual enclosures.
- 5.9.7 The control panel(s) shall be provided with a separate cable termination compartment.
- 5.9.8 Only polycarbonate or fibreglass enclosures shall be utilised in installations where chlorine or ammonia is present unless the control panel is located remote from any possible contamination. The approval of the Chief Electrical Engineer shall be obtained before sheet metal enclosures are used in these applications.
- 5.10 Programmable logic controller (PLC) cabinets
- The doors of the PLC cabinet shall be fitted with shatterproof glass windows held in place with rubber or neoprene seals. The windows shall be sized so that all input and output cards and device status indication lights are visible without having to open the doors.
- 5.11 Equipment mounting plates (chassis plates)
- 5.11.1 Chassis plates shall be galvanised and sufficiently rigid to carry the components mounted thereon without deflection.
- 5.11.2 The drilling and tapping of holes for the mounting of components is not acceptable, "hank" captive nuts shall be used to secure components.
- 5.12 Gland plates
- 5.12.1 Sectionalised removable gland plates shall be provided and secured by means of "hank" captive nuts or screws and so located that ample space is afforded for the satisfactory entry and termination of cables. Cable entry shall normally be from the bottom. Top entry will only be permitted at the discretion of the Engineer.
- 5.12.2 Gland plates shall be mounted at least 300 mm above ground level.
- 5.12.3 Gland plates shall be manufactured from sheet metal and shall be galvanised. Painted cable gland plates are not acceptable.
- 5.13 Screws, nuts and bolts
- 5.13.1 All screws, nuts and bolts shall be hexagonal to ISO metric, commercial standards and shall be rust proof. Nuts protruding from exterior surfaces shall be domed, and either chrome or cadmium plated.
- 5.13.2 Self tapping screws shall not be utilised for any purpose except for the securing of labels.
- 6 PAINTING OF SHEET METAL FABRICATIONS
- 6.1 Surface preparation
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- 6.1.1 Before the application of paint all traces of grit, grease, oil, rust, mill scale or other contaminants shall be removed by means of shot blasting or acid pickling and washing. Immediately after cleaning, all surfaces shall be covered by an electrolytically applied rust inhibiting, tough, unbroken metal phosphate film and thoroughly dried.
- 6.1.2 The preferred final paint finish is epoxy powder, baked enamel may be offered as an alternative, subject to the approval of the Engineer.
- 6.2 Epoxy powder finish
- 6.2.1 Within 48 hours of phosphating the metal parts shall be heated and then covered by a micro-structure paint powder applied electrostatically. The paint shall then be baked on according to the paint manufacturer's specification.
- 6.2.2 The final paint thickness shall be not less than 70 micrometers.
- 6.3 Baked enamel finish
- 6.3.1 Within 48 hours of phosphating a passivating layer consisting of a high quality zinc chromate primer shall be applied followed by two coats of high quality baked enamel according to SABS 783 Type 1.
- 6.3.2 The minimum final paint thickness shall be 90 micrometers.
- 6.4 Quality of final finish
- 6.4.1 The application of the paint shall be uniform so as to prevent running. Careful attention shall be applied to the application of paint to sharp edges and corners to prevent cracking or peeling of the paint.
- 6.4.2 Any surfaces exhibiting these symptoms shall be rejected and shall be stripped and completely repainted.
- 6.5 Paint colours
- Exterior surfaces shall be "Cornflower Blue" - Colour F29 to SABS 1091. Interiors shall be painted white or Cornflower Blue. Chassis plates shall be galvanised. Galvanised surfaces shall not be painted. Base frames shall be black.
- 6.6 Touch up paint
- The manufacturer shall supply at least 500 ml of each colour of paint used for touch up purposes after the control panel(s) have been installed on site.
- 7 SAFETY FEATURES
- 7.1 Terminal compartments
- All live conductors shall be terminated on protective devices (terminals) which pass the standard finger test (IEC 529) to give IP2x protection. Bolted terminals for larger conductors that cannot comply with these requirements shall be provided with robust insulating shrouds.
- 7.2 Safety barriers
- Robust insulating barrier plates shall be provided over busbars of voltage in excess of 50 volts. The barriers shall be fitted with the yellow triangle and lightning bolt warning label.
- 8 ELECTRICAL CONSTRUCTION
- 8.1 Control and instrument wiring
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- 8.1.1 Control and instrument wiring shall be carried out using 600V grade low halogen PVC insulated, multi-stranded wire with a minimum of 19 strands. The minimum wire sizing for control circuits shall be 1,5 mm<sup>2</sup>, 1 mm<sup>2</sup> wire will be permitted for connections between the PLC cabinet terminals and programmable logic controller cards.
- 8.1.2 Current transformer circuit wiring shall be 4 mm<sup>2</sup> and 2.5 mm<sup>2</sup> for 5 amp and 1 amp current transformer secondary currents respectively.
- 8.1.3 All 4-20 mA current loops shall be wired using 0,75 mm<sup>2</sup> screened wires. Screens shall be earthed at one end only.
- 8.1.4 All wires shall be terminated using compression crimp lugs unless the wire terminates in a pressure pad type terminal in which case compression ferrules shall be used.
- 8.1.5 All wires shall be numbered at both ends using colour coded Legrande type CAB or TAB ferrules (or an approved equivalent). Numbering shall be strictly in accordance with the relevant schematic diagrams.
- 8.1.6 The following colour codes for wiring shall apply :-
- |                           |  |
|---------------------------|--|
| AC live (power circuits)  | Brown  |
| AC Neutral (ditto)        | Black  |
| Metering (phase circuits) | Red, white, blue for respective phase circuits |
| Metering (neutral)        | Black  |
| 110 V DC positive         | Grey   |
| 110 V DC negative         | Grey   |
| 24 V DC +ve               | Pink   |
| 24 V DC -ve               | Orange   |
| 4-20 mA signal            | Purple   |
| Earthing                  | Green or green with yellow trace               |
| Other                     | Yellow   |
- 8.2 Terminals for control and instrument wiring
- 8.2.1 Terminals for control circuits for connections to components external to the control panel and to the PLC if applicable shall be Phoenix type UK-MTK-P/P. On any terminal block or assembly at least 10% spare terminals shall be provided.
- 8.2.2 Only one wire per side of the terminal is permitted and bridging devices between terminals shall be used where more than one wire is required to be connected.
- 8.2.3 Terminals shall be arranged in a logical, numerical sequence. Random organisation of terminals is not permitted. Each terminal shall carry a number and each terminal strip shall be numbered in accordance with the relevant schematic diagrams.
- 8.3 Trunking and control of wiring.
- 8.3.1 Wiring trunking shall be used for the control of wiring in the control panel(s). The trunking shall be sized such that after all cabling has been completed the trunking shall be no more than 75% full.
- 8.3.2 Wiring to devices mounted on cubicle doors shall be so arranged that when the door is opened, a twisting rather than bending motion is imparted to the wires. Wiring to the doors shall be secured and controlled using spiral bindings.
- 8.4 Specific requirements for PLC cabinet wiring
- 8.4.1 Two sets of terminals shall be provided for interfacing with programmable logic controllers. All input and output card terminals shall be wired to a set of terminals arranged so as to mimic the PLC input or
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output card and shall bear a code number reflecting the PLC card number. The terminals shall bear the same number as the PLC card terminal numbers and the wires shall also carry this number.

- 8.4.2 A second set of terminals shall be installed to permit termination of all the cable cores or inter-panel wires. The arrangement of this second set of terminals shall be grouped by cable and each block of terminals shall be provided with a number. Patch wiring shall be provided as required between these sets of terminals. Terminals used for this purpose shall be Phoenix UK-MTK-P/P.

## 9 EARTHING

### 9.1 Earthing busbar

The control panel shall be provided with an earth bar manufactured from hard drawn, high conductivity copper of minimum cross section 20 mm x 6 mm. The earth bar shall be located at the top or bottom of the control panel(s) to match the designated cable entry location and shall run the full length of the control panel(s).

### 9.2 Earthing of components

All sheet metal work shall be bonded to the earth bar. All earthing conductors shall have green or green with a yellow trace insulation.

- 9.3 Earthing terminals shall be Phoenix USLKG or an approved equivalent.

## 10 MIMIC PANELS

- 10.1 Mimic panels shall be assembled using painted tiles 40 mm square. The tile back ground colour shall be black.

- 10.2 The mimic shall be provided with a black anodised aluminium bezel. Suitable bracing shall be provided to ensure the rigidity of the mimic.

- 10.3 The layout of the graphic and the colours used shall be subject to the approval of the Engineer. For this purpose the Contractor shall submit a full scale drawing of the proposed layout of the mimic with all colour details. Colour codes quoted on the drawing shall be the SABS 1091 colour codes.

- 10.4 The manufacture of the mimic shall not proceed prior to approval of the layout and colours of the mimic being obtained from the Engineer. Failure to obtain approval may result in the rejection of the mimic.

## 11 ELECTRICAL EQUIPMENT

### 11.1 General

All electrical equipment and components selected shall comply with the respective IEC, SABS or BS Standards and Recommendations. Equipment selected shall be rated for the more onerous of the continuous or intermittent duty within the manufacturer's recommendations.

### 11.2 Relays

Relays shall have auxiliary contacts as indicated on the relevant schematic diagrams. All relays shall be silent when energised. Noisy components shall be replaced.

Relays for general purpose applications shall be Phoenix ST-REL or Omron LY-series relays.

### 11.3 DC power supplies

Where required 24 V DC power supplies shall be provided and shall be the Conlog Powerterm or Blue Ginger power supplies. The 24 V DC supplies shall be rated at twice (2x) the connected load

and each circuit provided with a miniature circuit breaker suitably rated for that circuit. Typically instrumentation loop circuits shall be protected by 0,5 amp mcbs (for 4-20 mA circuits).

#### 11.4 Surge arrestors

Current loops (4-20 mA) and programmable logic controller input signals shall be protected with Phoenix UF-BK-2-PE/L or approved equivalent surge arrestors on the incoming terminals of field wiring. Internal loops with wiring that does not leave the control panel do not require surge protection.

#### 11.5 Indication lamps, push-buttons and selector switches

11.5.1 Indication lamps, push-buttons and selector switches shall be provided as depicted on the relevant schematic diagrams. Types and trade names are as specified in Appendix "A". Devices shall afford IP65 protection on control panels located outdoors or in environments exposed to moisture. Indicating devices may be mounted inside the enclosure behind a transparent window or cover.

11.5.2 Stop push-buttons shall be of the latching, twist to release type and shall be provided with padlocking facilities to permit padlocking in the OFF position.

11.5.3 Switches used to switch 110 V DC shall have contacts continuously rated for 20 amps and shall be suitable for switching inductive loads.

#### 11.6 Miniature circuit breakers (mcb's)

The minimum fault rating for mcb's shall be 5 kA. The use of mcb's shall be limited to use in control circuits.

#### 11.7 Labelling

11.7.1 Each control panel shall bear a suitable designation label. All equipment shall be provided with engraved labels.

11.7.2 Labels shall be secured using self tapping screws or cheese head brass bolts and nuts. Adhesive type labels are not acceptable.

11.7.3 Main control panel designation labels shall be manufactured from aluminium or brass, have lettering engraved and painted black, letter height 25 mm.

11.7.4 Component labels on panel doors or covers shall be reverse engraved on clear perspex, lettering in black with the rear of the label being over painted with paint of the same colour as the control panel.

11.7.5 Equipment and component labels internal to the control panel shall be manufactured from white, black, white traffolyte with 5 mm lettering.

### 12 QUALITY ASSURANCE REQUIREMENTS

#### 12.1 Quality assurance plan and procedures (QAP)

12.1.1 The manufacturer shall submit to Rand Water a short form copy of its quality assurance procedures manual for appraisal by the Engineer at time of tendering.

12.1.2 After award of the order the manufacturer shall submit a full quality assurance plan for approval by the Engineer. Rand Water shall be given the opportunity to indicate hold and witness points on the plan.

12.1.3 Such QAP in association with a manufacturing programme shall be submitted to Rand Water within three weeks of the order being awarded, at which time the Engineer shall indicate witness and inspection points required.

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- 12.2 Inspection during manufacture
- 12.2.1 The Engineer or his appointed representative shall be permitted to carry out, during normal working hours, periodic inspections of the control panel and equipment covered by this specification over and above the witness and hold points indicated on the QAP.
- 12.3 Inspection before delivery
- 12.3.1 The Engineer or his appointed representative shall be permitted to witness final factory tests of the control panel and equipment before delivery will be permitted. Tests shall include but shall not be limited to :-
- (a) Checks to determine that the control panel(s) and components fully and strictly comply with this specification.
- (b) Full functional tests of all mechanical and electrical components and electrical circuits.
- 12.3.2 The manufacturer shall provide all power supplies, testing equipment, means of simulating related remote devices and competent personnel to conduct the tests.
- 12.3.3 The manufacturer shall give at least five (5) working days notice of readiness for final inspection and factory tests.
- 12.3.4 A list of defects and deviations will be provided by the Engineer on completion of the inspections. The issue of such list does not relieve the manufacturer of his responsibility to ensure full compliance with this specification.
- 12.3.5 All test results shall be recorded on the manufacturer's standard test certificates, three copies of which, duly approved, shall be supplied to Rand Water within one week of the factory tests being completed.
- 12.3.6 Equipment may not be delivered to site until the manufacturer has cleared all defects listed by the Engineer and the Engineer has re-inspected the control panel(s) to confirm rectification of work on the defect list.
- 12.4 Site inspection and tests
- 12.4.1 When site erection and putting into service is called for as part of the scope of supply, the manufacturer or his appointed agent shall carry out site inspection and tests to determine that the control panel(s) and equipment have satisfactorily withstood the effects of shipment and have been properly prepared for service.
- 12.4.2 Testing shall include as a minimum full checks on the functioning of mechanical and electrical components and electrical circuitry.
- 12.4.3 Particulars of these tests and checks and their results shall be recorded and incorporated in site reports, three copies of which, duly signed, shall be supplied to the Engineer within one week of the site tests being completed.
- 13 DELIVERY, OFFLOADING AND INSTALLATION ON SITE
- 13.1 Preparation for delivery
- Control panel(s) to be transported to site shall be wrapped in suitable materials to prevent damage during shipment, both from mechanical and environmental damage.
- 13.2 Off loading
- Includes the provision of all equipment and apparatus for lifting the control panel(s) off the transport vehicle and positioning the control panel(s) and equipment at a location to be determined by the Engineer.
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### 13.3 Installation on site

Site installation shall include for all suitable skilled labour, lifting apparatus and materials necessary for the complete installation and readying for service of the control panels. It shall include all shims, hold down bolts and nuts and connection of busbars and reconnection of any wiring disturbed for shipment. It shall also include the checking of all connections.

## 14 SPARES

14.1 The following commissioning spares shall be provided with each control panel :-

- (a) Ten fuses of each rating used
- (b) One spare mcb of each rating
- (c) Two lamps of each colour used
- (d) One spare operating coil and set of contacts for each type and size of contactor
- (e) One spare relay of each type
- (f) For each variable speed drive type and size installed :-
  - (i) One spare controller card(s)
  - (ii) One spare communication card (if supplied)
  - (iii) One set power transistors/thyristors
  - (iv) Five of each fuse type
  - (v) One of each fan type
  - (vi) One common plug-in diagnostic tool and/or software package, if available
- (g) A further list of any manufacturer - recommended spares for approval by the Engineer.

## APPENDIX A - APPROVED COMPONENTS

The following components are to be used in the manufacture of control panels :-

Device	Approved trade names and models
Control relays	Phoenix ST-REL Omron LY Telemecanique CA2 (or 3)DN Siemens 3TH2
Transducers (to 4 - 20 mA)	Hartmann & Braun / M-System
LED Indication lamps	Kimden KRE/Mimic craft MRE
Push-buttons (22 mm type)	Siemens Telemecanique Cutler Hammer
Selector switches	Stanton
kWh meters	GEC Cyclometer Siemens
Miniature circuit breakers (mcb's)	Merlin Gerin (C45)