

**WATER SUPPLIES DEPARTMENT**  
**STANDARD SPECIFICATION E-11-02**  
**CONTROL PANELS AND SWITCHBOARDS RATED UP TO 160A**

1. GENERAL

This specification covers the design and testing of low voltage control panels and switchboards rated up to 160A.

2. CONSTRUCTION

2.1 Enclosure

The construction of the control panels and switchboards shall conform to the following requirements: -

| Application   | Enclosure rating to IEC 60529 | Material        | Thickness (mm) |     |  |   |                          |     |
|---|-------------------------------|-----------------|----------------|-----|--|---|--------------------------|-----|
|   |                               |                 | Door           |     | Side & Rear Plates (without equipment) |   | Equipment mounting plate |     |
|   |                               |                 | A              | B   | A                                      | B | A                        | B   |
| Indoor  | IP54                          | Mild steel      | 2              | 2.5 | 1.5                                    | 2 | 2                        | 2.5 |
| Outdoor or Chemical Process Area  | IP65                          | Stainless steel | 1.5            | 2   | 1.5                                    | 2 | 1.5                      | 2   |
| A - Enclosure for wall mounting panel<br>B - Enclosure for floor standing panel |                               |                 |                |     |  |   |                          |     |

2.2 Fabrication

Control panels and switchboards exceeding 1000 mm in height shall be floor standing. Floor standing panels shall have a 100 mm high skirt to facilitate mounting, a 3 mm thick brass gland plate for cables entering from the bottom and front and rear access doors. Wall mounted panels shall have a front access door and a 2.5 mm thick brass gland plate for cables entering from the bottom. Swing door openings shall be limited to 120°. All doors and covers shall be fitted with rubber gaskets to minimise entry of dust. Exterior corners and edges of all panels shall be rounded to give a smooth overall appearance. For outdoor applications, all access doors shall be provided with stainless steel door handles.

### 2.3 Steelwork Treatment

Mild steel panels shall be cleaned, degreased and electro-chemically treated to give a rust-protection coating. All surfaces shall receive at least two stoved epoxy based undercoats and two stoved finishing coats of paint. The overall dry film thickness of paint coating shall be not less than 60 µm. The final exterior finishing coat shall be semi-glossy, shade 18B21 to BS 4800 (light grey) or equivalent. Panel interior shall be of white anti-condensation paint.

## 3. ELECTRICAL DESIGN

### 3.1 Rating

All electrical equipment shall be rated, making due allowance for a maximum ambient temperature of 40 °C, for the specified enclosure rating of the panel.

### 3.2 Busbars

Busbars shall be made of hard drawn copper conductors to BS EN 13601 or equivalent. Busbars shall be fully insulated and shall be separated from the rest of the equipment by a solid partition. The rating of busbars, allowing for the ambient temperature and the enclosure, shall be not less than the rating of their incoming supply fuse-switch.

### 3.3 Earthing

A silver-plated or tinned earthing bar, with provision for connection to the station earthing system, shall run the length of the switchboard. All metal equipment enclosures and the gland plate shall be connected to this earthing bar. The minimum dimensions of the earthing bar shall be 25 x 3 mm.

## 4. EQUIPMENT AND COMPONENTS

### 4.1 Mounting

Components or insulation materials shall not be mounted on the side plates of the panel. Components mounted on the swing doors shall have a minimum clearance of 25 mm from the equipment mounted inside when the door is closed.

### 4.2 Supply Isolators

An on-load isolator shall be provided for each power supply panel and motor starter panel. The isolator shall have a rating of not less than the maximum load. The utilisation category of the isolator shall be of AC23 to IEC 60947-3. An interlock shall be provided to prevent the opening of the panel door while the isolator is in "ON" position.

#### 4.3 Protection Devices

##### (a) Short-circuit Protection

A short-circuit protection device (SCPD) consisting of fuses or miniature circuit-breakers (MCBs) shall be installed in the power supply panel and motor starter panel.

All fuses and miniature circuit-breakers (MCBs) shall conform to IEC 60269-1 & IEC 60898 respectively. MCBs shall either have the breaking capacity of the anticipated maximum fault level or be backed up by a fuse upstream. The MCB shall withstand the let through current without incurring damage.

Ratings of all protective devices shall be co-ordinated correctly to afford maximum discrimination against faults and to avoid equipment damage.

##### (b) Earth Fault Protection

A four-pole MCCB/RCCB with core-balance earth fault protection unit and sensitivity of 500 mA and 300 mA shall be installed in each power supply panel and motor starter panel respectively. The earth fault protection unit shall be provided with an adjustable time delay tripping of 0.5 – 3 seconds.

#### 4.4 Motor Starters

A manual-reset type thermal overload protection unit and a single phasing protection unit (for a 3-phase a.c. drive) shall be provided for each motor starter.

Contactors for motor starting and running shall be of standard rating i.e. 16A, 40A, 80A or 160A, AC3 or AC4 duty as specified. Contactors shall be rated to the line current irrespective of their connection in the circuit. For a.c. reversing drives or frequently started drives with consecutive starts in less than 10 minutes, contactors shall be rated for AC4 duty to IEC 60947-4-1. Other a.c. drives shall be rated for AC3 duty to IEC 60947-4-1. The protection devices and contactor rating shall be selected for type '2' co-ordination to IEC 60947-4-1.

Direct-on-line (DOL) starters with contactors rated up to 16A may be accommodated in a common control panel. DOL starters with contactors rated above 16A and assisted starters shall be accommodated in separate cubicles.

'On', 'Off' and 'Tripped' indicating lamps shall be provided for each motor starter.

#### 4.5 Push-buttons and Indicating Lamps

Push-buttons and indicating lamps for corresponding duties shall be of matching construction, shape and colour. They shall have a protection rating of IP54 to IEC 60529.

Emergency stop buttons shall be of twist-knob released type with red mushroom-head. All push-buttons shall have shrouds or guards to prevent inadvertent operation. 'Start' or 'On' push-buttons shall be located on the right hand side of 'Stop' or 'Off' push-buttons when arranged in a row.

The contact for push-button shall be rated for 1 million operations. The rated thermal current of the contact shall be not less than 15A at 220V 50 Hz a.c.

LED indication lamps shall be used. 'Running' or 'On' indicating lamps shall be located on the right hand side of the 'Off' indicating lamps when arranged in a row.

#### 4.6 Instruments

Panel mounted instruments shall have a protection rating of IP55 to IEC 60529. Ammeters and voltmeters shall have 240° scales and have performance and marking in compliance with IEC 60051 of Class Index 1.5.

#### 4.7 Control Selector Switches

Control selector switches shall be of rotary manual operated action and provided with labels to indicate the selected function and the selected control position. The contacts shall be rated for 1 million mechanical operations and a rated thermal current of 16A.

The selector switches shall turn clockwise for 'On' or 'Close' position and anticlockwise for 'Off' or 'Trip' position.

#### 4.8 Current Transformers

Current transformers shall comply to IEC 60044-1 with insulation to Class E and shall be of vacuum impregnated or epoxy encapsulated construction.

#### 4.9 Relays and Timers

Contactors instead of relays shall be used for the switching of power supplies rated above 16A and motor supplies. Control relays shall be used for control circuits, tripping circuits and contactor control circuits. Auxiliary relays may be used for other applications.

Solid state plug in type timers shall be used. The setting error shall be within 5% of the range or 2% of the setting, whichever is lower. Timer contacts shall not be used for direct switching of circuit breakers and contactors with d.c. operating coils.

Contacts for relays and timers shall be rated for 1 million no-load and 0.1 million on-load operating cycles. The rated thermal current of the contacts for control relays shall be not less than 15A at 220V 50 Hz a.c.. Contact ratings for auxiliary relays and timers shall be at least 30% of the control relays.

#### 4.10 Alarm Annunciators and Programmable Logic Controllers

Alarm annunciators and programmable logic controllers (PLCs) shall comply with WSD Standard Specification E-81-06 and E-78-04 respectively.

### 5. WIRING

#### 5.1 Colour Code

Supply cables for 3-phase motor drives shall be colour-coded to conform the latest colour coding requirements as specified in the Code of Practice for the Electricity (Wiring) Regulation. Control wiring shall be black for a.c. and grey for d.c.. Earth connections shall be green/yellow.

#### 5.2 Control Circuit Wiring

Wiring shall be adequately protected against mechanical damage by the use of wiring channels and rubber grommets. A minimum of 30 mm shall be allowed between the components and the wiring channels. Wiring shall be neatly clipped and run vertically or horizontally only. Identification ferrules shall be provided for all wiring and cables.

#### 5.3 Termination

All connections to external devices shall be terminated at terminal blocks. Pre-insulated compression terminals shall be used for conductors up to 6 mm<sup>2</sup>. Terminals for motor supplies shall be rated 30A or the motor rated current, whichever is higher.

Terminal blocks for wiring shall be rated not less than 30A. Each terminal block shall bear a permanent identification number or letter.

A 150 mm minimum separation shall be provided between 2 parallel rows of terminal blocks. Terminal blocks for different voltages shall be separated physically by insulating barriers.

Different wires of the same wire number shall be terminated at different but adjacent terminal blocks and shorted by tinned or nickel-plated copper links. 10% spare terminal blocks shall be provided.

Brass glands with PCP shrouds shall be provided for all external cables.

Brass gland plates of thickness not less than 3 mm shall be provided for bottom entry of external cables. The gland plates shall be fixed by bolt and nuts to the cubicles and shall be detachable.

6. ACCESSORIES

6.1 Locks

A chromium-plated brass cylinder lock and 3 keys shall be provided for each separate enclosure.

6.2 Labels

A permanent engraved label shall be provided for each component. Label shall be located above the corresponding component. Each label shall be permanently secured to the panel surface by chromium-plated raised head screws. Small labels inside an enclosure may be pasted with glue.

Warning labels with red inscription 'DANGER-C.T. TERMINATION' shall be affixed to terminals for current transformer circuits. Warning label 'DANGER-LIVE TERMINALS' shall be provided on supply terminals.

7. INSPECTION AND TESTING

An Independent Inspection Body (IIB) or Purchaser's representative will carry out an inspection of the control panels and switchboard and witness tests at manufacturer's works. The IIB shall be nominated by the Contractor and approved by the Purchaser. The Contractor shall inform the IIB or Purchaser's representative at least seven days before the intended date for the tests and inspection. The Contractor shall provide him with a complete set of drawings approved by the Purchaser. Where several panels forming a complete unit are supplied, they shall be fully assembled at the manufacturer's works for inspection and testing prior to despatch.

A detailed test report shall be submitted within one week after tests to the IIB or Purchaser's representative. Goods shall not be despatched until the IIB or Purchaser's representative has approved the test report.

The scope of inspection shall cover the following:-

- (a) General inspection checks including physical dimensions, workmanship, quality, quantity and standards.
- (b) Verification of routine test reports for current transformers, protection relays and instruments.
- (c) Verification of calibration reports for testing instruments for tests witnessed by IIB.
- (d) Packing and protection checks.

The following tests to IEC 60947 shall be carried out:-

- (a) Power frequency voltage tests on the main circuits.
- (b) Insulation tests on main circuits and wiring circuits.
- (c) Milli-volt drop tests on busbar connections, circuit-breakers, fuse-switches, contactors and switchboard earthing bars.
- (d) Primary injection tests up to rated C.T. primary current for all C.Ts.
- (e) Secondary injection tests for all protection relays.
- (f) Functional tests to demonstrate the correct operations and connections of all control, alarm and indication circuits and equipment.
- (g) Other tests as specified in the Particular Specification.