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Indoor/Outdoor LV Switchboard/Distribution Board

Construction Specification

REVISION STATUS					
Rev	**Date**	**Description**	**Revision by**	**Checked**	**Approved**
0	**18/06/2009**		**Mark Spinks**		
0	**18/06/2009**	**EEM**	**Frank Locke**		

TABLE OF CONTENTS

1. SCOPE

This standard is to be used when designing or constructing LV switchboards or distribution boards.
This specification details the technical requirements for design and construction of metal clad switchboards and enclosures including Distribution Boards for Dawson Mine.

2. COMPLIANCE WITH STANDARDS AND REGULATIONS

The equipment and workmanship shall conform to the most recent requirements of the relevant standards of the relevant statutory Local, State and Commonwealth Authorities and current applicable Australian Standards. Where conflict exists between different Codes, Standards or Regulations, the higher requirement shall apply.
The Supplier shall not deviate from the provisions of the relevant standard without first obtaining agreement in writing from the Principal.
Particular standards and regulations relevant to the work include but are not necessarily limited to the following:

2.1 Australian Standards

Standard Ref	Description of Standard
AS 1000	International System of Units (S.I.) and Its applications 1998
AS 1939	Classification of degrees of protection for enclosures of electrical equipment 1990
AS 2067	Switchgear Assemblies (Busbar Requirements) 1984
AS 2184	Moulded Case Circuit Breakers 1985
AS 2700	Colour Standards for general purposes
AS 3000	Electrical Installations 2007
AS 3007	Electrical installations – Surface mines and associated processing plant 2004
AS 3008	Electrical installations – Selection of cables 1998
AS 3111	Approval and Test Certification for Miniature over current Circuit Breakers 1994
AS 3439.1	Low Voltage Switchgear and Control Gear Assemblies Part 1 – Type Tested and Partially Type Tested Assemblies 2002
AS 3947.3	Low-voltage switchgear and controlgear - Switches, disconnectors, switch-disconnectors and fuse-combination units 2001
AS 60269.1	Low-voltage fuses – General requirements 2005
AS 60947.2	Low-voltage switchgear and control gear – Circuit breakers 2005
AS 5000.1	Electric cables – Polymeric insulated – For working voltages up to and including 0.6/1 (1.2) KV

2.2 Regulations

The Queensland Coal Mining Safety and Health Regulation 2001 and amendments
The Queensland Coal Mining Safety and Health Act of 1999 and amendments
The Queensland Electricity Safety Regulation 2002
The Queensland Electricity Safety Act 2002
The Queensland Workplace, Health and Safety Act of 1995 and amendments

3. DESIGN CRITERIA

3.1 Operating Conditions

The Switchboard / Distribution Board and all components will be required to operate continuously at full load for 24 hours per day, 365 days per year under the climatic conditions detailed in this specification.

3.2 Site Climatic Conditions

Location:	Anglo Coal - Dawson Mine, Moura Queensland.
Ambient Temperature:	Minimum 10 degrees C, Maximum 50 degrees C.

3.3 Operating Requirements

All components of the Switchboard / Distribution Board shall be selected and installed so that all circuits can operate simultaneously at the full load rating shown on the drawings at the worst climatic extreme detailed in Clause 3.2 of the specification.
The full load rating of the circuits shall be their respective circuit breaker rating.

3.4 Switchboard / Distribution Board Performance

The Switchboard / Distribution Board supplied under the contract shall be a Type Tested Assembly (TTA) or Partially Type Tested Assembly (PTTA) in accordance with AS 3439.1. The switchboard being supplied shall in no way be inferior to the type tested assembly or Partially Type Tested Assembly.

3.5 Short Circuit Performance

The main circuits shall be constructed to withstand, without thermal or mechanical damage, the fault rating provided on the Contract drawings.

3.6 Arc Containment Performance

The Switchboard / Distribution Board being supplied under this Contract shall provide `acceptable protection' for operators in the event of an internal arcing fault occurring on the load side of a protective device in any switchboard compartment. The design being offered shall have been tested by a recognised testing authority in accordance with the Standard Test procedures detailed in Appendix `ZD' of AS 3439.1. `Acceptable protection' shall be as defined in Section 7 of the above Appendix.
The construction methods used in the tested Switchboard / Distribution Board (eg venting, door bracing and door mounted equipment shrouding) shall be the same as in the switchboard being supplied under this Contract.

3.7 Main Circuit Rating and Temperature Rise

The main circuit supply rating required for the Switchboard / Distribution Board is shown on the Contract drawings. The main circuit shall provide this rating with a busbar temperature rise of not more than 30 Degrees Celsius (°C) above ambient and within the temperature rise limits detailed in Table 2 of AS 3439.1 2002.
Cables shall not be used in the main circuit supply except as permitted by clause 7.5.5.1.2 of AS 3439.1. When cables are used in the main circuit, they shall be double insulated.

3.8 Equipment Fault Co-ordination

It shall be the Supplier's responsibility to ensure that every item of equipment in the Switchboard / Distribution Board is suitable for operation at the fault level The Supplier may need to stipulate the design fault level for the system in the cover document shown on the Contract drawings.
Protective equipment shall be fully coordinated so that no item is called upon to break fault current in excess of its fault rating.
All isolators & circuit breakers will be full current rated for the intended in situ application.

3.9 General

The Switchboard / Distribution Board shall conform to AS 3439, Form 4. Contact the principle if this cannot be reasonably achieved.
The overall height of the switchboard shall not exceed 2200mm above floor level. Operation handles shall be located so that the highest and lowest points reached by an operator's hand shall be within the limits of 1830mm and 305mm above floor level. Locking devices, and panel handles shall be placed no higher than 1830mm above floor level.
The Switchboard / Distribution Board shall have an ingress protection rating to AS 1939 of not less than IP65.
Facilities for adding circuit breakers for future loads shall be provided. The Supplier shall nominate how this will be achieved.
The Switchboard / Distribution Board shall be provided complete with all Moulded Case Circuit Breakers, Isolators contactors, overloads, residual current devices, live line indication lights and other electrical components necessary for the correct operation and protection of the installation as described in the specification and shown on the Contract drawings.
The switchgear shall be provided complete with housings, bus chambers, busbars, cabling chambers, glands, gland plates, cable trays, conduit entries, wiring trays, cable lugs, secondary wiring terminals, nameplates, labels, lockouts and all accessories, whether described in detail or not, necessary for the correct operation and protection of the installation as described in this specification and shown on the Contract drawings.

3.10 General Arrangement

The board shall be arranged in a way that the flow is from left to right and top to bottom.
Cables will enter the board via the gland plates in the top of the switchboard unless specified otherwise in the drawings.

3.11 Busbars

Insulation in the form of taping is unacceptable.
All parts of the switchboard, which are required to be earthed, shall be effectively connected to the earth busbar. Earthing conductors shall be sized in accordance with requirements of AS 3439. Note maximum cable termination size in provided datasheet and/or drawings.
All bus bar sections should be clearly insulated from each other through the application of heat shrink on each individual bus phase. The colour of the heat shrink insulation shall correspond to the nominate phase colour.

A Phase – Red, B-Phase – White, C-Phase – Blue, Neutral - Black

The earth bar shall be left bare.
Active busbars in the Form 1 section shall be of the moulded and insulated chassis type.
Looping of active cables to form a busbar system will not be accepted.

3.12 Paint Treatment

The surface of the switchboard metalwork shall be degreased and cleaned with solvent, then coated with electro-statically applied powder coat in accordance with paint manufacturers' recommendations.
Internal and external surfaces shall be orange X15 to AS 2700, gear trays and escutcheons shall be gloss white.

3.13 Mounting

3.13.1 Pole/Wall Mounted

The Switchboard / Distribution Board will either be Pole or Wall Mounted on site, cable Shall be bottom entry only, unless state otherwise. All external switchboard/ distribution board need to be weatherproof, it must be IP65 board to comply with site standard, and all electrical equipment, wiring, switches and components shall be installed in accordance with AS/NZS 3000.

3.14 Metal Work

The Switchboard / Distribution Board shall be a completely self supporting rigid structure, constructed from formed zinc annealed mild sheet steel, of minimum thickness 2.0 mm, free from rust, dents and any surface defects.
Equipment mounting panels shall be a minimum 2.0 mm thick mild sheet steel for those panels up to an area of 500mm x 500mm. Where panels are larger, 3mm thick mounting plates shall be used, supported by studs of adequate size welded to the case. Large equipment mounting panels, i.e. exceeding 1000 mm in any direction, shall be secured by a minimum of six welded studs and nuts.
Heavy equipment shall be supported by separate independent framework and shall not rely on the enclosure sheeting.
Equipment mounting panels shall be powder-coated gloss white.
All nuts, bolts and studs shall be cadmium plated mild steel.
Before dispatch from the Supplier's works the whole of the metal work of the equipment detailed in this specification shall be painted with materials of nominated or accepted manufacture, composition and colour. Outdoor Switchboard / Distribution Board must withstand all weather conditions.
All steelwork shall be new and free from rust and scale. After degreasing, one coat of etch primer shall be applied, followed by one coat of compatible undercoat and two coats of synthetic enamel.
The Supplier shall take responsibility for the paint finish and repair any damage sustained during the delivery to site. Any repair work required as a result of transport damage shall be undertaken at the Supplier’s own expense.

3.15 Doors, Removable Covers and Escutcheons

Doors shall be constructed from formed zinc annealed mild sheet steel, of minimum thickness 1.6 mm, free from rust, dents and any surface defects. Door sealing shall be achieved by 120 degree return on case, sealing against neoprene gasket glued to the inside of the door.
Stiffeners shall be fitted to all doors with dimensions in excess of 1000 mm high and 450 mm wide, or as required. Doors shall open a minimum of 100 degrees for equipment access, and shall be fitted with door stays.
All doors are fitted with chrome plated pintle hinges. A minimum of three shall be fitted if the door is over 1200 mm in height. All doors shall be held closed with chrome plated lockable `L' handles. Outside doors are to have a padlock-able eye, not a key. Escutcheon’s to have Centre Pin type 6mm Cam Lock as seen below:

B&R Cam Lock Part No. 2749

Doors up to 450mm high, one 'T' handle shall be installed. Doors above 450mm and up to 1000mm high, two 'T' handles shall be installed. Doors over 1000mm high shall have three 'T' handles.

All doors shall be effectively earthed to the switchboard main earth bar by means of flexible connection not less than 4 mm^2 and larger if required for the potential fault.

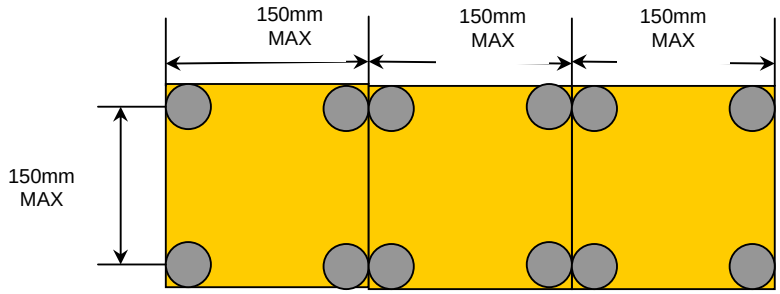
Escutcheons shall be constructed from formed zinc sealed mild sheet steel, of minimum thickness 1.6 mm, free from rust, dents and any surface defects, powder coated gloss white. They shall be hinged and removable in the fully open position. All escutcheons shall have a minimum of two centre pin type Cam Locks fitted. Three are required if the escutcheon is over 1000 mm in height.

All covers shall be secured with coin locks and access restricted by tool keys.

3.16 Gland Plates

Gland Plate design should include the following:

- Gland Plates shall be three pieces, 6mm Brass unless otherwise discussed with the principle.
- The Gland Plate shall be effectively earthed to the Distribution Board / Switchboard cases with an earth cable the same size as the largest earth cable leaving the board. This information must be retrieved from the principle before the board is completed.
- The Gland Plate must fit a 25mm wide neoprene gasket to all gland plates
- The Gland Plate should be secured with 6mm countersunk bolts separated by a maximum of 150mm from centre to centre.



- All Gland Plates installed shall be flush mounted to the corresponding wall of the Distribution / Switchboard as shown below:

3.17 Cable Ducts

Switchboards shall be supplied with cable ducts to each chassis. Cable ducts shall be adequately sized, and designed for ease of installation and maintenance of cables.

3.18 Capacity of Switchboard

The switchboard shall include 20% extra capacity to allow for future circuits including provision in service mains for additional capacity and space on switchboards.

3.19 Switchboard / Distribution Board Compartments

Compartments enclosing circuit breakers and distribution boards shall be fitted with a hinged metal escutcheon mounted behind the compartment door, and the operating handles of the devices shall protrude through holes in the escutcheon. The escutcheons shall be latched with chrome plated tool type latches (As specified in section 3.15) and the overall door shall be equipped with lockable 'T' type handles. The circuit breakers and isolators shall be padlock able in the off position.

3.20 Sealing

All switches, control devices or instruments protruding from a panel shall be sealed to match switchboard degree of protection or mounted behind a sealed Perspex window in the panel to achieve higher rating. Each phase of the connections between the busbars and the line side of functional unit protective devices shall be individually supported and sealed to achieve better sealing i.e. *the three phases shall not be brought through the same hole into the module*. In addition, provision shall be made for sealing the Switchboard / Distribution Board modules after the installation of field cabling. Module cable entry points shall be bushed to prevent cable damage.

3.21 Shrouding

The live main incomer shall be shrouded to IP20 to protect against accidental contact when the enclosure doors or escutcheons are open. Warning labels shall be provided on shrouds.
Plexiglass cover shall be used to shield live termination on line side of the main switch. As a minimum requirement, it should be labelled “Danger, 415V – Isolate Elsewhere Before Removing Cover”.

3.22 CB Lockouts

Form 3/4 circuit breaker handles shall be operable from the front with the compartment door closed.
In the case of Form 1 sections, the operating handles only shall be accessible from behind the compartment door. In this case the operator will be protected from contact with live

terminals to IP3X minimum by means of a full length hinged escutcheon door exposing only the circuit breaker handles.
The position of operating handles shall clearly indicate whether the isolator is in the on, off or tripped position.
All circuit breakers located within the Switchboard / Distribution Board shall be fitted with Padlock able devices as to provide positive isolation. Permanent lockout devices are only acceptable, soft lockout devices not permanently attached to the face of the Main Circuit Breaker or the Escutcheon of Sub Circuit Breakers is not acceptable.
Means shall be provided to lock all circuit breaker handles in the off position using a padlock with a minimum 6mm diameter shackle.

3.23 Equipment Mounting

The Supplier shall ensure that the equipment and devices are installed in such a manner that all necessary electrical clearances are observed and that the rating accuracy of devices is not impaired either thermally or electro-magnetically by the proximity of other devices or cables.
All trip devices that have flags or buttons to show trips are to be clearly visible without opening the Escutcheon or have remote indication lights.
Riveted root nuts or similar approved devices shall fix all equipment located on equipment panels within compartments.

3.24 Switchboard Internal Wiring

Wiring insulation shall be non-hygroscopic, incapable of supporting combustion and shall have a glossy finish. It shall be capable of withstanding the service conditions to which it is subjected.
All wiring for control, protection and indication shall be not less than 1.5 mm² cross-section tinned copper conductors with a stranded construction.
Unprotected conductors in the busbar areas shall be double insulated.
The insulation for wiring within panels shall be 1000V grade PVC, V90 and shall be coloured as follows:

- 415V AC power wiring — Red, White, Blue
- 240V AC power wiring — Red
- 415V/240V neutral — Black
- Earth — Green/Yellow combination
- 110V AC control wiring — White
- Control wiring ELV — Orange
- CT Wiring — Grey

All control Wiring will be clearly identified with terminal strip numbers as well as wire numbers at each & every point of connection. These labels will match those marked on the drawings.
All cabling should be V90 or higher.

3.25 Labelling

All switchgear, apparatus and controls shall be labelled in accordance with the Principal's requirements and in accordance with the Specification. A nameplate shall be provided for the switchboard providing all the information required by AS 3439.1.
Unless otherwise specified all labels shall be traffolyte engraved black lettering on white. The size of lettering and the wording of labels will be subject to approval by the Principal. Label schedules shall be submitted to the Principal prior to manufacture.
The Switchboard / Distribution Board shall be fitted with a main label mounted in a prominent position. The label shall be engraved traffolyte with letters 50mm high minimum.
Labels shall be secured with stainless steel screws. Labels shall be secured in such a manner that they can be easily replaced. Labels shall not be affixed with adhesives.
Labels shall designate circuit number and equipment function.

Labels engraved white on red 13mm high letters and with the following wording shall be fastened to all covers or panels giving access to bus chambers.
“Danger – Live Bars Behind”
Labels shall be included to indicate the source of supply for the purposes of isolation. Particular note should be paid to this requirement under the Queensland Coal Mining Safety and Health Regulation of 2001.
Labels shall also be included to provide identification of individual chassis as detailed in the Contract drawings.
All labels and lettering shall be horizontal.

4. SWITCHBOARD EQUIPMENT

4.1 General

The electrical equipment installed in the Switchboard / Distribution Board shall be new equipment complying with relevant Australian Standards and be suitable for the duty indicated on the Contract drawings.
The equipment shall be installed so that it has the rating shown on the Contract drawings when the Switchboard / Distribution Board is in its fully operational and fully loaded condition ie: all covers and doors are closed, all circuits are at full load (as defined in this specification), and ambient temperature is at maximum (as defined in this specification).
The equipment shall be installed strictly in accordance with the manufacturer's instructions in all regards, particularly concerning clearances, enclosure sizes, temperature rise and maximum continuous current rating.
Equipment shall be securely mounted and braced so that movement cannot occur during operation under normal or fault conditions and so that adjacent equipment is unaffected and personnel operating the equipment are not endangered.
Equipment offered shall satisfy the following requirements:

- The equipment shall meet the requirements of this specification
- Equipment selection shall be consistent ie; all moulded case circuit breakers shall be from the one manufacturer

4.2 Isolators

Switchboard / Distribution Board isolators shall be of the double break, quick make and break type suitable for making and breaking a prospective fault level and for carrying a through fault as noted on the drawings.
Isolators shall be rated to carry continuously, the full load current of their respective circuits, in a totally enclosed non-ventilated compartment. Isolators shall be capable of being padlocked in the "OFF" position. Isolators where required shall be Merlin Gerin by Design.

4.3 Moulded Case Circuit Breakers

Circuit breakers shall be manufactured and tested in accordance with AS 2184.
Circuit breakers shall be Thermal/Magnetic or quick make quick break type and of the size shown on the drawings.
Fault ratings shall be as per the drawings.
All circuit breakers shall be capable of being padlocked in the "OFF" position.
Any questions about this design requirement should be directed back to the principal as soon as possible.
Moulded case circuit breakers shall be as detailed on the contract drawings

4.4 Indicating Lights

The Live Line Indicator (LLI) required on the Escutcheons shall be the same as the part supplied by iPOWER: Part No.A00804 +A00812
The LLI shall be connected to the load side of the main isolator.
Indicating lights shall be low voltage transformer operated LED cluster type or 24 Volt DC LED type as required. Telemecanique by design.
Colours shall be as indicated on the Contract drawings. If colour is not noted then RED LED's are acceptable.

4.5 Tools

The Supplier shall supply any special tools necessary for the maintenance or operation of switchboard equipment.
This shall include the tool to open doors/escutcheon panels.

5. INSPECTION AND TESTING

5.1 General

The Supplier shall carry out inspections and routine testing in accordance with AS 3439.1.
The Supplier shall give written notice to advice the Principal five working days prior to the commencement of testing so that testing may be witnessed by a representative of the Principal. The tests shall include items detailed in sections 5.2 and 5.3.

5.2 Inspections

Equipment shall be checked against the Contract drawings to ensure that the correct type, rating and number of circuits has been installed. The Contract drawings shall be marked up to properly reflect the finished switchboard. Copies shall be forwarded to the Principal.
The following items shall be checked:

- Busbar configuration and support system for consistency with Type Test Certificates
- Sealing of fully welded seams is satisfactory
- Equipment mounting and cable supports to ensure adequate fixing and bracing
- Clearance and creepage distances and degrees of protection
- Doors and access covers for sealing, Hinge arrangements
- Operating handles and interlocks for correct functioning
- Bolted and screwed connections for tightness and adequate contact
- Label wording against relevant schedules

5.3 Electrical Testing

5.3.1 Point-to-Point Tests

Power circuit insulation shall be tested using a 'Megger' or approved equivalent voltage test unit. Power circuit insulation shall be correctly tested for the circuit's nominal operating voltage (Insulation tests should be carried out at twice the rated output voltage of the power cable). Test sheets shall indicate the type & suitability of the meter used & serial number for tracing.
High current micro-ohm resistance tests shall be carried out individually on all joints in the main circuit supply including connections to each outgoing unit. For outgoing units larger than 150A, all power connections shall be tested. Resistance measurements shall be recorded and examined for inconsistent and unusually high readings.
The Supplier shall provide marked up drawings and test sheets detailing the results and extent of the testing.

5.3.2 Earth Leakage Tests

For all circuit breakers that are constructed with internal or external Earth Leakage devices, injection test results must supplied with the completed Distribution / Switchboard. These tests results should indicate:

1. Circuit Breaker Label & Position
2. Earth Leakage Injection Test Trip Time & Trip Current
3. Earth Leakage Test Button Mechanical Test Results (Pass / Fail)

All tests results completed should be clearly dated and signed off by a qualified tester / operator.

6. DOCUMENTATION

6.1 Documentation with Offer

Suppliers shall include with their offer, evidence that a recognised testing authority in accordance with the requirements of this specification has tested the design and equipment being offered. Suppliers shall make available for inspection the complete report from the relevant testing authority complete with drawings, photographs and authority comments.
The details of the Switchboard / Distribution Board, including photographic images (of previous switchboard that are similar), shall be provided in enough detail to permit physical layout to be determined. Typically this would include external dimensions.

6.2 Documentation after Contract Award

Switchboard / Distribution Board manufacture shall not commence until the drawings and the Principal has approved equipment lists.

6.2.1 Drawings

The Supplier shall submit documentation, which shows that Switchboard / Distribution Board construction requirements are being met. This shall include paper & electronic copies including CAD files of:

- Full construction drawings of the Switchboard / Distribution Board being supplied. The drawings shall include busbar sizes, busbar support materials, spacing and phase centres, as well as sealing, hinging and fixing details for metal work fabrication
- Layouts showing location of all power and control equipment as well as cabling and glanding areas
- Make available for inspection/perusal at the manufacturer's premises the type test drawings for confirmation of switchboard design
- Electrical Schematics including single line diagrams. Schematics shall show wiring & termination numbers as well as protection & fuse settings. Transformer and motor sizes are also to be clearly labelled on the drawings. The principal, dependent on the size of the works, may request termination drawings.
- Electronic drawings shall be provided in AutoCAD version 2007 or earlier format.

6.2.2 Equipment Lists

Equipment lists shall detail the equipment type of every item of equipment being installed in the switchboard. This will show the OEM's details including part numbers as well as any relabelled part numbers from the supplier of the switchboard.
Label lists shall be provided for all labels.

6.2.3 Manuals

The Supplier shall provide 3 copies of an equipment and maintenance manual, which describes the equipment provided.
The manuals shall be neatly presented in a folder and ease for easy accessibility. Loose sheets and drawings are not acceptable.
The following information shall be provided:

- Schedule detailing the make, model and number of all separate items of equipment within the switchboards. This shall describe exactly the equipment installed, including which manufacturer's options and accessories are included
- Drawing list showing number, title and revision
- Drawings (including relevant Contract drawings)
- CD/DVD with documentation (including Drawings) in their native applications.

6.2.4 Required Site Documentation

For “Partial Type Tested Boards”, all available type test certificates must be forwarded to site with the completed Board. The Supplier of the board must stipulate clearly if full or partial type testing has been accommodated and to what extent.