GLADSTONE REGIONAL COUNCIL	**ENGINEERING STANDARD**			
	Motor Control Centres			
	Document:	**GRC-ES004**	Revision:	**2**

REVISION HISTORY

Rev	*Date*	*Description*	*Prepared By*	*Approved By*
1	25/08/2011	First Issue	J. Hickey	C. Swanton
2	21/04/2017	Revised and Updated	B. James	C. Swanton

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1 PURPOSE

The purpose of this Engineering Standard is to describe the requirements for the design, manufacture, supply, testing and delivery to site of 415V Motor Control Centre switchboards for Gladstone Regional Council. This Engineering Standard shall be read in conjunction with the attached Motor Control Centre data sheet.

2 SCOPE

This Engineering Standard is applicable to all 415V Motor Control Centre switchboards, for indoor and outdoor areas supplied for use at Gladstone Regional Council sites, where the primary supply is 415V three phase.

3 RESPONSIBILITIES

All persons involved in the purchasing, design, fabrication and supply of 415V Motor Control Centres for use on any GRC site shall comply with this Engineering Standard.

Any variations proposed that are contrary to the requirements of this Engineering Standard shall be specifically identified and referred to GRC, in writing, for approval.

The Purchaser shall complete the attached Motor Control Centre data sheet for each switchboard required.

4 DEFINITIONS

Term	*Definition*
Council	Gladstone Regional Council or its nominated representative or agent.
GRC	Gladstone Regional Council or its nominated representative or agent.
Hz	Hertz
LV	Low Voltage, Exceeding 32VAC or 115VDC but not exceeding 1000VAC or 1500VDC.
Manufacturer	The corporation or business that manufactures and/or assembles the equipment described by this Engineering Standard.
MCB	Miniature Circuit Breaker
MCC	Motor Control Centre
MCCB	Moulded Case Circuit Breaker
MEN System	Multiple Earthed Neutral. A system of earthing in which the parts of an electrical installation required to be earthed in accordance with AS/NZS 3000 are connected to the general mass of earth and, in addition are connected within the electrical installation to the neutral conductor of the supply system.
Purchaser	The individual or corporation responsible for purchasing the equipment described by this Engineering Standard on behalf of GRC.
RCBO	Residual current Circuit Breaker with Overload protection.
Specifier	Any individual specifying equipment for use in electrical installations on a GRC site.
Superintendent	Person authorised to act on behalf of GRC with respect to the Contract works.
Supplier	The individual or corporation with whom GRC enters an agreement to purchase the equipment described by this Engineering Standard. Note that in some instances, the Supplier may also be the Manufacturer.
TOL	Thermal Overload

5 REFERENCE DOCUMENTS

All equipment shall be designed, manufactured and tested in accordance with the latest edition of the following GRC Engineering Standards, Australian Standards, Acts and Regulations.

5.1 GRC Engineering Standards

Standard	*Title*
GRC-ES001	Electrical Work
GRC-ES002	Preferred Electrical Components
GRC-ES005	Light & Power Distribution Boards
GRC-ES008	Equipment Identification

5.2 GRC Standard Drawings

Drawing	*Title*
GRC-ED-010	Typical Schematic < 4kW DOL Starter
GRC-ED-011	Typical Schematic 4-40kW Soft Starter
GRC-ED-012	Typical Schematic > 40kW VSD
GRC-ED-013	Typical MCC DB, UPS, 24VDC Power Supply

5.3 Australian Standards

Standard	*Title*
AS 1319	Safety Signs for Occupational Environment
AS 2700	Colour Standards for General Purposes
AS/NZS 3000	Electrical Installations (Australian/New Zealand Wiring Rules)
AS/NZS 3008	Electrical Installation – Selection of Cables
AS/NZS 3017	Electrical Installations – Testing and Inspection Guidelines
AS/NZS 3820	Essential Safety Requirements for Electrical Equipment
AS 60529	Degrees of Protection Provided by Enclosures (IP Code)
AS/NZS 60947	Low-voltage Switchgear and Controlgear
AS/NZS 61439	Low Voltage Switchgear and Controlgear Assemblies
AS 62103	Electronic Equipment for Use in Power Installations
AS 60044	Instrument Transformers

5.4 Acts and Regulations

Title
Electrical Safety Act 2002
Electrical Safety Regulation 2002
Work Health and Safety Act 2001
Work Health and Safety Regulation 2011

6 TECHNICAL REQUIREMENTS

6.1 General

6.1.1 Quality Assurance

The Manufacturer shall have an integrated quality assurance system in place at the locations where the motor control centres are designed, manufactured and assembled. The system shall be 'third party accredited' to AS/NZS ISO 9001:2000 and frequently audited for compliance. The Manufacturer shall provide documentation proving any claims made with respect to the above if requested by the Purchaser.

6.1.2 Prohibited Materials

Components that contain asbestos, mercury, cadmium, PCB's, silica gel containing the indicating agent cobalt chloride or any other products either known to or suspected of having carcinogenic or other detrimental long or short term effects on the health of personnel if they are inhaled, ingested or otherwise contacted during normal and reasonable use are not permitted in electrical equipment to be used on the Purchaser's site.

This requirement shall apply to all fabrication tools and equipment used that could leave dust particles or other residues inside the assemblies as well as components used in the construction of the MCC's and associated components covered by this Standard.

6.1.3 Standardisation of Parts and Equipment

The Supplier shall select all components, parts and equipment used in the construction and fabrication of the switchboard from the Preferred Electrical Components List GRC-ES002.

If the Supplier wishes to utilise items not included in the preferred components list, approval shall be obtained from GRC in accordance with the requirements of GRC-ES002.

6.1.4 Service Conditions

The switchboard and associated equipment shall be designed to operate continuously, 24 hours per day, 365 days per year.

The switchboard shall be capable of continuously carrying the rated current at rated frequency without exceeding allowable temperatures, in accordance with the Manufacturers type tested rating.

All components and equipment within the Motor Control Centre shall have an ambient temperature rating of not less than 55°C. The thermal design shall be such that the maximum temperature within the switchboard when operating under an ambient temperature of 45°C shall not exceed 55°C. The thermal design shall be based on natural heat dissipation. Ventilation openings shall not be used unless specified.

6.2 Construction

a) The switchboard shall be of free standing, metal-clad type and shall be built to the Supplier's latest verified design in accordance with AS/NZS 61439, the Drawings and Data Sheet.

b) The switchboard shall consist of modules arranged in vertical sections or tiers. The tiers shall be configured in an arrangement suitable for free standing installation on a concrete pad for outdoor installation and plinth mounted for indoor installation. The switchboard shall provide front access and front connection unless otherwise specified. Doors shall open 120º.

Escutcheon plates shall be provided to effectively shroud all live parts in panels when the access door is open.

c) Individual functional units shall be of demountable or withdrawable design and shall be a uniform width and depth with a combination of modular heights permitting new modules to be installed and interchange of existing modules post installation.

d) The switchboard height shall not exceed 2200mm.

e) The various compartments of the switchboard shall be designed and tested for arc fault containment in accordance with AS/NZS 61439.1 Appendix ZD.

f) Equipment and terminals shall be readily accessible in the cubicles and shall require a minimum of disturbance of associated and adjacent equipment for access.

g) Form of internal separation to AS/NZS 61439 shall be Form 3B. Form 3Bih will not be accepted.

h) Terminals, busbars and any components carrying voltages greater than extra low voltage shall be protected against accidental contact by personnel to an IP rating of IP2X to AS 60529. This shall be achieved by fitting proprietary shrouds or fabricating clear barriers. Shrouds shall be used on cable terminals in the cable zones.

i) Test certificates for the assemblies shall be submitted for review before construction commences.

j) The complete switchboard shall be vermin and insect proof.

k) Facilities shall be provided for lifting transportable sections without distortion.

6.2.1 Indoor Switchboards

Switchboards designated on the Data Sheet as indoor service, which will be installed within a dedicated electrical switchroom building shall be constructed from powder coated mild steel at least 1.6mm thick and shall have a minimum degree of protection of IP52.

6.2.2 Outdoor Switchboards

Switchboards designated on the Data Sheet as outdoor service, which will be installed external to a building or within a corrosive and/or wet environment shall be constructed from powder coated 316 stainless steel at least 1.6mm thick or marine grade aluminium at least 3mm thick, and shall have a minimum degree of protection of IP56. In addition, outdoor switchboards shall also incorporate the following features:

a) Full height outer doors covering all functional units and controls. Doors shall be provided with lift of pintle hinges. Hinges shall permit the door to move through an arc of at least 120°.

b) Outer doors shall be lockable and fitted with a stainless steel 3 point locking mechanism, with either 1 or 3 Dirak 207-9295 Swing Handles or equivalent with lock No. 92285.

c) Roof heat shields mounted on 50mm C section supports.

d) Side heat shield mounted on 20mm stand-offs.

6.3 Busbars

6.3.1 Main Busbars

The busbar system shall consist of a horizontal 3 phase set of rectangular hard drawn, high conductivity copper bars, air insulated and supported by suitable insulators. The busbars shall be bolted with high tensile, corrosion resistant steel bolts. Bolted busbar joints shall be tensioned in accordance with the manufacturer's recommendations. Flexible busbar connections are not

acceptable. Each section of busbar shall be colour coded at regular intervals and at termination points. Busbars shall be continuously rated for the maximum full load current per phase.

The busbars and support system shall be a tested and verified design able to withstand the prospective fault level as indicated on the Data Sheet. A physical barrier shall isolate live busbars from other sections.

Busbar temperature rise at full load shall be limited to 50°C with an ambient temperature of 40°C. Busbar temperature shall not exceed 90°C under full load conditions.

6.3.2 Vertical Busbars

Each tier shall have a 3 phase copper vertical busbar for the distribution of power from the main busbar to the individual modules. The busbar shall be designed to permit the connection of individual modules. The capacity of the vertical busbar shall not be less than 300A.

6.3.3 Neutral Busbars

A vertical neutral busbar shall be provided within each cable zone of the switchboard and shall provide adequate connection facilities for each incoming and outgoing circuit. The neutral busbar rating shall be 100% of the phase busbar rating. The switchboard shall be designed so that effects of eddy currents around neutral busbars are minimised.

6.3.4 Earth Busbars

A continuous, separate earth busbar shall be provided along the full length of the switchboard and shall provide adequate connection facilities for each incoming and outgoing circuit, with vertical droppers in each cable zone. Connections shall be provided at each end of the earth bar for earth cables to the site earth grid.

6.3.5 MEN Link

A removable MEN link of full size of the neutral shall be provided. The MEN link shall be easily accessible in the switchboard.

6.4 Earthing of Assemblies

All metal components of the assemblies shall be effectively earthed. Special attention shall be given to earthing of those components which are hinged, withdrawable or demountable.

All hinged doors shall have an earthing stud. Doors with electrical equipment installed on the door shall have an earthing cable installed from the earth stud on the door to an earth connection on the body of the main assembly.

6.5 Switchgear Assemblies

6.5.1 Functional Units

Functional units shall be of demountable or withdrawable design and shall be a uniform width and depth with a combination of modular heights permitting interchange, and shall be in accordance with the following requirements:

a) Functional units shall include equipment shown on the Drawings. All equipment shall be in accordance with the relevant clauses of this Engineering Standard. Equipment shall be arranged within functional units to permit easy access and removal of all components without interference to the structure, other components or cable entry.

b) Functional unit power connection to main vertical busbars shall be via clamp or spring contact devices.

c) It shall not be possible to come into contact with any live wiring or components when the circuit breaker or isolator is in the "Off" position and module door is open, without deliberately removing covers. A fully insulated and shrouded installation is required.

6.5.2 Main Incomer Sections

The specific requirements for the incomer sections will be shown on the Drawings. Typical requirements shall include:

a) The main incomer section shall be equipped with a withdrawable air circuit breaker for switchboards rated greater than 800A or an MCCB for switchboards rated 800A or less, with a certified breaking capacity not less than the specified fault level. The circuit breaker shall have the following features:

- Integral solid state protection relay incorporating time delayed overcurrent, instantaneous overcurrent and earth fault protection
- Manual spring charge
- Shunt trip
- Manual Open Pushbutton
- Manual Close Pushbutton
- Lockable safety shutters
- Isolation Padlock facility

b) The incomer section shall incorporate a digital power meter with metering CTs to provide indication for volts, amps, watts, apparent power, power factor and voltage harmonic content.

c) The incomer front panel shall have a cut away section such that the circuit breaker controls and indication are exposed.

d) The incomer section shall incorporate a surge diverter as specified on the Drawings.

6.5.3 Supply Authority Metering

If required on the Drawings, the switchboard shall incorporate a provision for a separate CT chamber and a panel for external supply authority metering equipment in accordance with the requirements of the latest version of the Queensland Electricity Connection and Metering Manual.

6.5.4 Emergency Generator Transfer Switches

If required on the Drawings, the switchboard shall incorporate either a manual or automatic transfer switch arrangement for switching an emergency generator.

The preferred transfer switch arrangement is to use dual circuit breaker incomers, with a mechanical interlock ensuring that only one of the incomer circuits can be closed.

a) The Emergency Generator incomer shall be identical to the Main incomer circuit, and shall also include the following:

- 4 pole circuit breaker of the same size and rating as the main incomer
- Phase rotation meter

b) Where a transfer switch is required, a separate Main Isolator shall be installed on the line side of the Main Incomer and Supply Authority metering CTs. The Main Isolator shall be the same size and rating as the incomer circuit breaker.

c) Where an automatic transfer switch is required with a permanent generator installation, a separate Generator Isolator shall also be installed on the line side of the Generator Incomer. The Generator Isolator shall be the same size and rating as the generator incomer circuit breaker.

6.5.5 Control Power Supply

The motor control centre shall incorporate a separate Control Power Supply module including the following:

a) Dual 24VDC switchmode power supplies with a minimum size of 20A per power supply.

b) The 24VDC power supplies shall incorporate an appropriate redundancy module allowing parallel operation.

c) The 24VDC power supplies shall be supplied separately from the plant UPS distribution board.

d) If there is no UPS supply available, a single 20A 24VDC battery backed power supply may be used, supplied from the motor control centre.

e) The power supplies shall incorporate voltage free contacts for fault status indication to the plant PLC system.

6.5.6 Motor Starter and Feeder Modules

The specific requirements for each motor starter and feeder module will be shown on the Drawings.

a) Moulded Case Circuit Breakers are the approved disconnect device on all motor starter and feeder modules. Fuses shall not be used.

b) Circuit breakers shall comply with AS 60947 with respect to construction and performance requirements. They shall be of the independent manual or stored-energy closing, air break type. Circuit breakers shall have a rated short circuit breaking capacity not less than the specified main busbar short-circuit current rating.

c) A rotary handle fitted to the front panel of each module shall be used to operate the circuit breaker. On and Off positions shall be clearly marked on the handle. The handle shall be padlockable and shall provide an interlock that prevents the module door being opened when the circuit breaker is in the On position or the circuit breaker is in the Off position and a padlock is fitted.

d) Main contactors for combination motor starters shall be air break type, 3 pole, 415VAC. Contactors shall conform to the requirements of AS 60947.4.1 with respect to both uninterrupted duty and Class 1 of intermittent duty (120 operating cycles per hour) with rated operational current and shall have a mechanical endurance level of one million no-load operating cycles. The condition for making and breaking shall be to utilization category AC3.

e) Auxiliary contacts shall be provided as required and the facility to field fit additional auxiliary contacts shall be a feature of the contactor.

f) Unless otherwise indicated on the drawings, each motor starter circuit shall incorporate conventional thermal overload protection (TOL). The trip class of the overload shall be suited to the starting characteristics of the motor/load combination. The TOL device shall have a minimum of 1 N/O and 1 N/C auxiliary contact.

g) Thermistor or RTD protection shall be provided for all motors larger than 37kW as indicated on the drawings.

h) The combination of short circuit protection device, contactor and thermal overload used in each motor starter circuit shall provide Type 2 co-ordination in accordance with AS 60947.4.1.

6.5.7 Variable Speed Drives

The specific requirements for each variable speed drive starter circuit will be shown on the Drawings.

a) Variable speed drives shall be installed within the motor control centre for all installations designated as outdoor service on the Data Sheet.

b) Variable speed drives up to 110kW shall be installed within the motor control centre for all installations designated as indoor service on the Data Sheet, where the MCC will be installed within a dedicated electrical switchroom building.

c) Variable speed drives larger than 110kW may alternatively be installed outside the motor control centre within the switchroom building and shall be rated to IP54.

d) Where variable speed drive units are installed within the MCC, care should be taken to ensure that adequate cooling is maintained in accordance with the manufacturer's recommendations. A heat load calculation for each variable speed drive shall be provided.

e) Each module containing a variable speed drive unit shall incorporate a suitable ventilation fan and filter to draw in cooler external air and a corresponding filter to vent hot air out. The ventilation fan shall be started and stopped by an adjustable thermostat.

f) Variable speed drive HMI units shall be installed on the MCC module door where the variable speed drive is installed within the MCC.

g) Where the variable speed drive is installed external to the MCC, the HMI unit shall be installed on the IP54 enclosure such that the HMI unit can be accessed without opening the enclosure.

h) Variable speed drive starter circuits shall incorporate a line side contactor controlled by the emergency stop and LCS isolator circuits as indicated on the Drawings.

i) Variable speed drives shall incorporate a load side filter to comply with manufacturer cable length specifications if required.

j) Variable speed drives shall incorporate harmonic filtering to limit harmonic distortion to within the supply authority requirements for the specified site. Harmonic filtering shall consist of either passive or active filtering devices. Harmonic modelling calculations shall be provided to demonstrate compliance with supply authority requirements.

k) Where no supply authority requirements for harmonic distortion are provided, as a minimum all variable speed drives 22kW or larger shall incorporate passive filtering to provide <5% THID at rated load.

l) Where the Drawings indicate line or load side filters are required on the variable speed drive, the filter(s) shall be installed within the same enclosure as the variable speed drive unit.

6.6 Control and Indication Devices

The following devices shall be selected in accordance with Engineering Standard GRC-ES002 – Preferred Electrical Components.

6.6.1 Control Relays

General purpose control relays shall be Finder 55.34 series plug-in type. Relays shall have 240VAC or 24VDC coils as indicated on the Drawings. Each relay shall have a sufficient number of N/O and N/C contacts and incorporate flag indication and built in suppression for DC coils.

6.6.2 Indicating Lights

Indicating lights shall be 22mm in diameter, LED flush mount type suitable for 24VDC.
The functions of the indicating lights shall be:

- Green – closed, running, ON
- Red – open, stopped, OFF
- Amber – tripped, fault

6.6.3 Control Switches

Control switches shall be 22mm diameter flush mounted type with an IP rating not less than the IP rating of the equipment upon which it is mounted.

6.6.4 Meters

Meters shall be provided as indicated on the Drawings and shall be positioned adjacent to the unit with which they are associated.

Analogue meters shall be accuracy class 1.5, have a 96mm casing and have insulated terminals. Analogue ammeters shall be 5 times over-scaled. CT operated ammeters shall be 5A with 5 times over-scale.

6.6.5 Current Transformers

Current transformers shall be fully encapsulated and shall comply with AS 60044.1 and the following:

a) Metering transformers shall have accuracy class and secondary output as specified on the Drawings.

b) Current transformers shall be installed in the circuit module and fitted with a nameplate that can be read from the front of the opened module.

6.6.6 Terminals

a) “Top Hat” type DIN rail mounted moulded terminal blocks shall be provided for termination of all control wiring. Terminals shall carry a numeric designation in accordance with the Drawings and shall be segregated according to function and voltage.

b) Terminal groups for the termination of control wiring external to the switchboard shall be arranged vertically and located within the vertical cable zone adjacent to their respective functional units. The terminal groups shall be spaced to facilitate easy connection of wiring and cables.

c) Access to individual terminals shall not be impeded by power cable connections.

d) A separate terminal shall be provided for the connection of each individual wire. Bridging links as supplied by the terminal manufacturer shall be used to interconnect 'common' terminals. Bridging links shall be recessed within the terminal strip with no part, bridging link or screws, being proud of the terminal strip.

6.6.7 Fuses and Test Blocks

a) All fuses used for protection of power and control circuits shall be G class to AS/NZS 60269.

b) Fuse holders shall be of the all insulated type with shrouded contacts.

c) Test blocks shall be as specified on the Drawings.

6.7 PLC Section

Unless specified otherwise, each Motor Control Centre shall incorporate a full height PLC section with a minimum width of 600mm and minimum depth of 400mm to accommodate PLC and communications equipment as shown on the Drawings.

Typically, the PLC section shall consist of remote I/O modules connecting to all PLC inputs and outputs within the motor control centre with a communications network connection to the plant PLC system. All PLC and communications hardware shall be selected in accordance with Engineering Standard GRC-ES002 – Preferred Electrical Components.

Unless specified otherwise on the Drawings, the PLC section shall include the following equipment:

a) Allen-Bradley 1794 Flex IO modules and terminal bases to suit the quantity of I/O required. A minimum of 20% spare capacity for each I/O type used shall be allowed.

b) Allen-Bradley 1794 Flex IO Ethernet/IP communications adapter for each Flex I/O rack.

c) DIN rail mount Ethernet switch.

d) 24VDC power distribution to each Flex I/O module.

e) PVC slotted cable ducts adjacent to each Flex I/O rack to accommodate control wiring.

6.8 Cable Zones

a) Vertical cable zones shall be provided adjacent to each tier of functional units and shall extend the full height of the tier. Zones shall be of sufficient size to accommodate terminal blocks as shown on the drawings and shall allow front entry via hinged doors. Vertical cable zones shall be located on the right-hand side of the modules to which they provide access.

b) Provision shall be made on the side of vertical cable zones furthest from the module entry points to secure incoming cables in place at intervals of 300mm. This shall be in the form of galvanised admiralty pattern perforated tray as wide as the cableway is deep installed for the full height of the cableway.

c) Horizontal cable zones shall be provided across the top and bottom of the entire motor control centre with removable bolted covers and shall connect with the vertical zones. The cable zone shall be fully accessible from the front of the switchboard.

d) Cable zones shall have provision for supporting cables between their point of entry and point of termination.

e) Cable zones shall be of sufficient size to accommodate the required power and control cables in one layer on the cable support provisions. Cable Zones for power cabling shall be a minimum of 300mm wide.

f) Cable zones shall be sized to allow power cables to be terminated whilst maintaining at least the minimum bending radius of the cabling as recommended by the cable manufacturer.

g) Slotted PVC wiring ducts shall be provided in the cable zones to neatly distribute control and communications wiring throughout the MCC.

6.9 Gland Plates

Undrilled brass gland plates of at least 5mm minimum thickness shall be provided within cable zones and shall be of sufficient size to accommodate all glands necessary for the termination of all power and control cables at the switchboard.

Gland plates shall be fixed by means of captive nuts and screws and shall have a suitable gasket fitted between the gland and the fixing surface. Gland plates shall be bonded to earth with a minimum 6mm^2 earth conductors.

6.10 Cable Entry and Termination

6.10.1 Power Cables

Cable entry into the switchboard and switchgear assemblies will be from the bottom unless otherwise specified. The Supplier shall ensure that cable entry and termination areas are adequate for the number and size of cables to be accommodated.

Power cables shall be terminated to devices using copper compression type crimp lugs or pins as appropriate. Lugs and pins shall be applied using overall crimping hexagonal dies. Lugs or pins applied using a single indent crimp are not acceptable.

Power cables shall be identified at both ends by applying phase coloured heat shrink sleeving over adjacent insulation and the barrel of the cable lugs.

6.10.2 Control Wiring

Control wiring for digital signals shall be PVC insulated, V90, 0.6/1kV, multi-stranded copper conductor with a minimum cross sectional area of 1.5mm^2.

Current transformer secondary wiring shall be PVC insulated, V90, 0.6/1kV, multi-stranded copper conductor with a minimum cross sectional area of 2.5mm^2.

Control wiring for analogue signals shall be PVC insulated, V90, multi-stranded copper conductor, twisted pair or triples with overall and individual screen and a minimum cross sectional area of 1.0 mm^2.

Wire colours shall be as follows:

Voltage	*Active Conductor*	*Common Conductor*	*Earth Conductor*
415/240V AC	Red/White/Blue	Black	Green/Yellow
12/24V DC Supply	Brown	Grey	-
12/24V DC Switched	Violet	-	-
CT Wiring	Red/White/Blue	Black	Green/Yellow

a) All wires shall be identified at both ends by wire numbering ferrules, with wire numbers as shown on the Drawings. The same number shall appear at both ends of the wire.

b) Wiring shall be identified using a transparent sleeve that fits over the wire with provision for characters to be loaded into a second sleeve moulded with the first sleeve. The Grafoplast or Brady Multi-Mark systems shall be used.

c) All wires shall be terminated at both ends with a pre-insulated crimp lug, crimp pin or bootlace ferrule. No more than one wire shall be connected to any one terminal screw.

d) Terminals blocks shall be DIN rail mounted clip-on type. Barriers shall be installed between terminals at which cables of different voltages are terminated. There shall be 20% spare (unused) capacity on DIN rails to allow for future terminals and relays etc.

e) Terminal blocks shall be numbered as shown on the Drawings. Each terminal shall be numbered along with the group via a Marker Carrier.

f) Control wiring shall be installed in a neat and orderly fashion and shall be loomed or enclosed within slotted PVC wiring duct. The method of installation shall allow wires to be traced without removing cleats and ties. Wiring duct shall not be filled to more than 60% capacity.

6.11 Identification Labels

Labels shall be provided in accordance with the requirements of Engineering Standard GRC-ES008 – Electrical Equipment Identification Labels.

6.11.1 Nameplate

The motor control centre shall have one stainless steel nameplate fixed to the front of the switchboard with stainless steel screws. The switchboard nameplate shall have black paint filled letters and shall be engraved with the information specified in AS/NZS 61439.1.

The nameplate shall include the following information:

- Manufacturer
- Model or equipment designation
- Year of manufacture
- Compliance standards
- Testing approvals
- Ratings

6.11.2 Equipment Labelling

Identification labels shall be fixed to the exterior of each panel or module of the motor control centre. The label shall be engraved with the name and equipment number or function of that panel or module.

Equipment protruding through the front of the panels or doors shall have an identification label mounted on the panel or door below the piece of equipment. This label shall be engraved with the name and number of the equipment and any additional information required to explain the use of the equipment.

A second label shall be mounted inside the door or panel through which the device protrudes carrying the equipment number only.

Each piece of equipment mounted inside a panel shall have an identification label mounted as close as practicable to the piece of equipment. Interior labels shall typically carry the equipment or component identification number only. The interior labels shall be white traffolyte type labels engraved in black.

In addition, warning and danger labels shall be provided as per the requirements of AS/NZS 61439.1 and AS 1319.

Busbar chamber covers shall have warning labels as per the requirement of AS/NZS 61439.1.

6.12 Bolts and Nuts

Bolts, nuts, screws and washers shall be stainless steel in accordance with AS 1111. Spring and flat washers shall be fitted under all nuts and flat washers under bolt heads.

6.13 Hinges

Hinges shall be lift off pintle type manufactured from chrome plated brass or stainless steel with two fixing bolts. Where the motor control centre is designated as outdoor service on the Data Sheet, stainless steel shall be used.

6.13.1 Doors

Pan type doors shall be used for all modules and future spaces. Doors shall be hinged to the structure with pintle type hinges mounted on the left hand side of the door. Each door shall be connected to the main structure with a flexible earth lead.

6.14 Handles and Latching Mechanisms

Latching mechanisms on all doors and hinged panels shall be of the recessed quarter turn type with 7mm square operating mechanisms. The Supplier shall supply a minimum 2 tools for operating the latch mechanism with each motor control centre. Where the motor control centre is designated as outdoor service on the Data Sheet, stainless steel mechanisms shall be used.

6.15 Gaskets and Seals

Formed in place polyurethane, neoprene or rubber shall be used to seal fixed sections of the switchboard and doors, to provide sealing to the required IP rating.

6.16 Accessories

The Supplier shall provide a complete set of all special spanners, tools and appliances including special slings and lifting equipment necessary for installing, adjusting and maintaining the equipment. All items supplied under this clause shall be new and shall not be used during manufacture, testing, or installation of the equipment without prior approval from the Purchaser. All such spanners, tools, and appliances shall be supplied prior to take-over of the work.

7 INSPECTION AND TESTING

7.1 Verification Testing

Test certificates shall be supplied for all tests that have been carried out on representative assemblies, sub-assemblies or components as applicable in accordance with the requirements of AS/NZS 61439.1.

7.2 Routine Testing

The switchboard supplier shall carry out all routine tests or any tests required to prove compliance with this specification, the drawings and the relevant standards. The testing shall include the following as a minimum:

a) Standard 50Hz high voltage withstand test on the complete assembly including the circuit breakers. Megger insulation before and after test.

b) Standard 50Hz insulation test on all small wiring, including switchboard and instrument transformer secondary wiring, at 2000V to earth for one minute.

c) Continuity and polarity tests on all coils and circuits.

d) Verification of current transformers; terminal markings, determination of errors, magnetising curve, CT polarity test and CT ratio test using primary current injection.

e) Functional tests on all relays, control circuits and interlocks.

f) Checking of electrical and mechanical interlocks.

g) Mechanical operation of circuit breakers, draw-out mechanisms, interlocks, auxiliary switches, manual devices, etc.

The switchboard supplier shall have suitably qualified labour readily available to rectify any defects or errors identified during testing, such that there is no delay in testing.

The switchboard supplier shall provide instructions for final installation inspection and tests after the switchgear has been installed. The instructions shall include a schedule of recommended site tests to establish correct operation, procedures for any adjustments to obtain correct operation, instructions for final inspection and putting in service.

7.3 Test Certificates

The supplier shall provide test certificates for all routine testing carried out. These shall be forwarded to the purchaser within 7 days of completion of the tests.

7.4 Witnessing

In addition to the Routing Testing outlined above, the switchboard manufacturer shall make allowance for factory acceptance testing (FAT). These tests shall be carried out to the satisfaction of, and if necessary, in the presence of the purchaser's representative. The supplier shall provide 7 days' notice to enable the purchaser's representative to witness such tests.

8 TRANSPORTATION AND STORAGE

After completion of all testing, the switchboard supplier shall ensure that the switchboard sections and all components are suitably packed in separate crates for transportation to site by road transport and the unloading on site by a crane or forklift.

Packaging shall ensure that no dust or water enters the equipment during transportation or temporary storage outdoors. Silica gel desiccant shall be placed in individual sections of the switchboard. No loose items shall be transported in any part of the switchboard. Items packed in separate crates should be identified and a list provided to the Purchaser, for each individual crate. The Supplier shall provide suitable notice to the Purchaser for gaining access to site.

Upon arrival on site, the Supplier shall confirm with the Purchaser, the exact location(s) for offloading of the equipment.

9 PAINTING AND SURFACE PROTECTION

Steelwork surface preparation, anti-corrosion protection and the surface coating system shall be to Australian Standards. Evidence shall be provided that these items meet Australian Standards.

The painting system used for the motor control centre shall be powder coated to a total thickness of 70 microns. The standard painting system of the switchboard supplier may be used provided details of the system are submitted and approval for use is received from the Purchaser.

a) The colour and finish of Motor Control Centres for indoor service shall be X15 Gloss Orange.

b) The colour and finish of Motor Control Centres for outdoor service shall be X15 Gloss Orange.

c) Escutcheon panels and other interior surfaces shall be Gloss White.

10 MANUALS AND DRAWINGS

The Supplier shall provide full drawings and documentation for the equipment. This shall include:

a) General arrangement drawings showing the overall dimensions and MCC arrangement.

b) Module layout drawings showing the location of all equipment within each module, including an equipment list identifying each item of equipment, its part/model number and quantities.

c) Single line diagram.

d) Circuit diagrams and schematic drawings consisting of:
   - Individual schematic diagram for each motor and feeder circuit
   - Incomer schematic diagram
   - Control power distribution schematic

e) Recommended spares list.

f) Internal and External label drawings.

g) Certified Inspection and Test Plans and results.

h) All verification test certificates.

i) Equipment data sheets and manuals.

j) Installation, Operating and Maintenance Manuals.

Final copies of all documentation shall be provided within two weeks of Factory Acceptance Testing.

The Supplier shall provide 2 paper copies of all documentation in hardbound folders, plus an electronic copy on CD in a structured folder arrangement.

All drawings shall be provided in AutoCAD electronic file format (.dwg) and in PDF format.

11 DATA SHEETS

This Engineering Standard shall be read in conjunction with the attached Motor Control Centre data sheet. The Purchaser shall complete an individual data sheet for each Motor Control Centre. Each Motor Control Centre data sheet shall be provided to the Manufacturer in Microsoft .xls format for completion.