

**OMAN WASTEWATER
SERVICES COMPANY S.A.O.C**



**الشركة العمانية
لخدمات الصرف الصحي ش.م.ع.م**

OMAN WASTEWATER SERVICE COMPANY

ELECTRICAL STANDARD SPECIFICATION

SECTION 05

LOW VOLTAGE SWITCHGEARS


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1-0 SCOPE

This specification covers the design, manufacture and testing of factory assembled switchgear of rated voltage up to and including 1kV to be installed within Oman Wastewater Services Company projects.

2-0 STANDARDS SPECIFICATIONS


The design, construction, inspection and testing of the Assembly shall comply with all relevant Statutory Regulations, and the latest editions (current at the time of Tender) of all relevant British and Harmonised European Standards, including:

- BS EN 60439 - Specification of Low Voltage Switchgear and Control Gear Assemblies
- BS EN 60204 - Safety of Machinery. Electrical Equipment of Machines
- BS EN 60947 - Specification for Low-Voltage Switchgear and Control gear
- BS EN 60529 - Specification for Degrees of Protection Provided by Enclosures (IP code)
- BS 7671 - Requirements for Electrical Installations. IEE Wiring Regulations. Sixteenth Edition and Associated Guidance Notes Published by The IEE and
- BS EN 60079 - Code of Practice for the Selection, Installation and Maintenance of Electrical Apparatus for use in Potentially Explosive Atmospheres.
- BS EN 7430 - Code of Practice for Earthing
- All relevant IEC recommendations relating to electric motors.
- Omani Electrical Standards.

The Assembly shall also comply with the particular specification.

Where the particular specification imposes additional requirements to a British or harmonised European Standard, the requirements of the particular specification shall prevail.

Any items not specifically detailed in this Specification, which are necessary to provide a safe and fully operational working system, shall be deemed to be included.

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3-0 SERVICE AND ENVIRONMENTAL CONDITIONS

The Switchgear shall, in all respects, be suitable for operation under service conditions stated on Electrical Standard Specification – Section 01

4-0 ELECTRICAL SYSTEM

4-1 Motor Control Centres – this part shall be read in conjunction with Electrical Standard Specification – Section 06.

4-1.1 Cabled buswired systems shall not be used on MCC's.

4-1.2 Busbar systems shall be Type Tested and Certified within their own steelwork enclosures. The assembly shall be Type Tested in accordance with BS EN 60439-1.

4-1.3 The motor starters shall provide Type 2 Co-ordination to BS EN 60947-4-1.

4-1.4 MCC's shall be of the multi-cubicle construction type. Single cubicle, box and multi-box assemblies shall not be acceptable.

4-1.5 Floor standing front and rear access assemblies shall be provided as standard. The front access shall be for operations and maintenance and rear for cable installation and maintenance. Other arrangements (including front access for mounting against a wall) can only be used with prior written approval from the Engineer.

4-1.6 Assemblies shall conform to Form 4 Type 3 separation as defined in BS EN 60439-1.

4-1.7 The preference shall be to use intelligent components over non-intelligent components.

4-2 Control Panels:

4-2.1 A buswire system or non-fault rated busbar system may be used.

4-2.2 The assembly shall be partially Type Tested in accordance with BS EN 60439-1. The motor starters shall provide Type 2 Co-ordination to BS EN 60947-4-1.

4-2.3 Control panels shall be of the multi-compartment (multi-cubicle if necessary) construction type and shall be suitable for front access only for installation and maintenance. Floor standing assemblies will be standard, wall mounted enclosures can be used when the total number of compartments is nine or less or up to maximum dimensions of 1500mm high by 2500mm wide. All wall-mounted panels shall have external fixing lugs.

4-2.4 Assemblies shall conform to Form 4 Type 3 separation as defined in BS EN 60439-1.

4-3 Wardrobe Panels:

4-3.1 Other Control Panels (generally referred to as Wardrobe Panels) shall comply with the following:

a) Wardrobe panel assemblies shall conform to a minimum separation of Form 2 Type 1 as defined in BS EN 60439-1.

b) Cables (buswire) or insulated busbars may be used.

c) The panel may comprise of one lockable door interlocked Incoming Isolator supplying a number of drives all mounted within the same enclosure.

d) Where more than one door is fitted, these shall be designed to prevent any door from being opened unless the isolator is in the 'Off' position. Similarly, it shall not be possible to close the isolator unless all doors are closed.

e) The construction shall be flush fronted, and may be the single cubicle, or desk type assembly.

f) Wall mounted panels shall have external fixing lugs.

g) Desk type enclosures shall be provided with internal floor fixing lugs.

- h) Panels may be mounted onto proprietary equipment, provided that the control panel is not subject to vibration that might cause maloperation.
- i) Where more than one starter is mounted within one enclosure, then components associated with the same starter shall be grouped together in a logical order. The components of different starters shall be segregated by additional space.
- j) Duty and Standby plant shall not under any circumstances be housed within the same enclosure. Where Duty/Standby plant has been installed on Package Plant, a Motor Control Centre or Control Panel shall be used.
- k) Incoming supply terminals shall be segregated and shrouded from other terminals.
- l) Control supply transformer(s) and fuses shall be provided within the assembly to suit the requirements.
- m) The assembly shall be Partially Type Tested in accordance with BS EN 60439-1.
- n) Panels shall be of suitable IP rating for the environment in which they are to be used.
- o) Wherever practical, the distribution boards for domestic services shall not be provided within the wardrobe panel. Where this is not practical, then the distribution board shall always be supplied off the switched side of the incoming main isolator.
- p) Cable gland plates shall be a minimum thickness of 3 mm. Cable gland or blanking plates shall only be fitted to the bottom of the enclosure.

4-4 Safety Requirements:

4-4.1 When a functional unit is isolated and open, the degree of protection to any remaining live part or to any part which could be energized at above extra low voltage during any test procedure shall be a minimum of IP2X.

4-4.2 Failure of any part of a machine control system or its power supply shall lead to a 'fail-safe' condition and not impede the operation of the stop or emergency stop controls and shall not present an additional risk to health and safety.

- 4-5 The electrical arrangement of the switchgear, protection, metering, control, interlocking, intertripping, etc. shall be as shown on the switchgear single line diagrams.
- 4-6 The switchgear electrical rating (voltage, current, frequency, fault current, etc.) shall be as stated on the switchgear single line diagrams.
- 4-7 The ratings shall be quoted on the basis of the circuit breakers being housed in enclosures under natural ventilation conditions. The ratings of units shall take full account of all heat sources within the enclosures.
- 4-8 The switchgear shall be suitable for operation, without deteriorious effect, with variations of voltage and frequency as stated on the switchgear single line diagrams.
- 4-9 Transient voltage depressions down to 80% of rated voltage shall not affect switchgear performance.

5-0 STRUCTURAL AND MECHANICAL REQUIREMENTS

- 5-1 Switchgear cubicles shall be metal-clad, free standing, floor mounting, flush fronted and arranged to form a single structure with a common busbar assembly.
- 5-2 Switchgear and busbar shall be arranged to permit future extension at either end.
- 5-3 The Switchgear structure shall be provided with barriers to prevent transfer of ionized gases between compartments.
- 5-4 The Switchgear structure shall be self ventilating..
- 5-5 Interlocks, busbar shutters, covers, etc. shall be provided to prevent incorrect or unsafe operation and to prevent access to live parts.
- 5-6 Switchgear shall be designed and constructed to facilitate inspection, cleaning, repair and maintenance and to ensure absolute safety during operation, inspection and maintenance.
- 5-7 Similar parts and components shall be interchangeable wherever practicable.

- 5-8 Enclosure of degree of protection shall be as stated on the one line diagram. When cubicles are open, it shall not be possible to accidentally touch live parts. Terminals on door mounted equipment shall be shrouded.

6-0 INCOMERS:

- 6-1 The Assembly shall be supplied from one or more incoming power supplies and shall be provided with one or more incoming devices as specified in the Particular Specification, of the appropriate type, rating and configuration, as specified in the Particular Specification.

- 6-1.1 An incomer shall be selected from the following:

- a) Air circuit breaker
- b) Moulded case circuit breaker
- c) Switch disconnecter
- d) Fuse switch disconnecter
- e) Changeover device (dual switch disconnecter)
- f) Changeover device (dual fuse switch disconnecter)
- g) Rotary switch disconnecter.

- 6-1.2 Options (c), (e) and (g) shall only apply where the installation incorporates a separate upstream overcurrent protective device.

- 6-1.3 Incomers comprising air circuit breakers, or moulded case circuit breakers shall include, as a minimum, the following basic features:

- a) Mechanical interlock with the compartment door and padlockable in the 'off' position
- b) Integral over current protection.

- 6-1.4 If specified in the Particular Specification, incomers comprising air circuit breakers, or moulded case circuit breakers shall include the following additional features:

- a) Adjustable Overcurrent and earth fault protection, instantaneous hi-set protection, and current transformers as required

- b) Shunt trip circuit
- c) Restricted earth fault protection, and current transformers as required
- d) Phase failure relay for remote indication (e.g PLC/DCS, telemetry)
- e) Undervoltage protection
- f) High voltage intertrip circuit
- g) Solenoid close circuit
- h) Motor operation package
- i) Protection control and monitoring facility integrateable with the control system via a communications link, where specified.
- j) Voltmeter and 7 position selector switch (3 for line to line voltage, 3 for line to neutral voltage, 1 for off), and ammeter, current transformers and 4 position selector switch (3 for line current, 1 for off)
- k) Power factor indicator
- l) Kilowatt hour meter
- m) Power monitoring facility integrateable with the control system via a communications link, where specified.
- n) 2 normally open and 2 normally closed spare auxiliary contacts
- o) Hand/off/auto selector switch
- p) Local/remote selector switch
- q) Key exchange interlock
- r) Electrical interlock
- s) Mechanical interlock and
- t) Handling truck.

6-1.5 Incomers comprising switch disconnectors, fuse switch disconnectors, changeover devices, or rotary switch disconnectors shall include as a minimum the following basic features:

- a) Mechanical interlock with the compartment door and padlockable in the 'off' position.

6-1.6 If specified in the Particular Specification, incomers comprising switch disconnectors, fuse switch disconnectors, changeover devices, or rotary switch disconnectors shall include the following additional features:

- b) Phase failure relay for remote indication (e.g PLC/DCS, telemetry)
- c) Voltmeter and 7 position selector switch (3 for line to line voltage, 3 for line to neutral voltage, 1 for off), and ammeter, current transformers and 4 position selector switch (3 for line current, 1 for off)
- d) Power factor indicator
- e) Kilowatt hour meter
- f) Power monitoring facility integrateable with the control system via a communications link, where specified
- g) 2 normally open and 2 normally closed spare auxiliary contacts
- h) Key exchange interlock
- i) Mechanical interlock
- j) Mobile generator appliance inlet and
- k) Mobile generator connection box.

6-1.7 If specified in the Particular Specification, the incomer shall include the following supervisory control and monitoring functions, wired to the programmable logic controller (PLC/DCS) or to an alternative system.

Wired to PLC/DCS:

- a) Reset
- b) Close
- c) Open
- d) Close/open
- e) Auto available/unavailable

- f) Healthy/tripped and
- g) Closed/open.

Wired to an alternative system:

- a) Reset
- b) Close
- c) Open
- d) Close/open
- e) Auto available/unavailable
- f) Healthy/tripped and
- g) Closed/open.

6-1.8 In both cases the reset, close, open and close/open supervisory control functions shall only apply where the incomer can be remotely operated.

6-1.9 When Earth Fault protection is provided on Incomers it shall incorporate a time delay and suitable current settings to prevent operation prior to faults downstream being cleared by other protection.

6-1.10 Main Power Incomers shall be selected from:

1. 4-pole fixed-pattern ACB having a manually charged spring-assisted operating mechanism.
2. 4-pole withdrawable-pattern ACB having a manually charged spring-assisted operating mechanism.
3. 4-pole isolator (switch disconnectors) having a manually operated spring-assisted operating mechanism.
4. 4-pole fuse switch (fuse switch disconnectors) having a manually operated-spring assisted operating mechanism.

The Standard Module shall include:

- Door interlock (or bolted cover for air circuit breakers) and padlockable in the Opened position (and on the shutters of withdrawable air circuit breakers).
- Phase Failure relay with changeover contacts fitted to the incoming side of the switching device. On the Main Incomers of panels where an automatic fixed standby diesel generator has been fitted, a test switch shall break the Phase Failure relay output.
- Where the incomer rating is 250A or above, a power meter to display as a minimum 3ph Volts, 3ph Currents, kW, kWh, kVAr, kVArH with volt-free pulse/kWh and 4 to 20mA kVA output.
- Where the incomer rating is less than 250A, a 4-position selector switch and voltmeter.

Automatic Main/Standby (or Generator) Incomers shall be selected from:

- Dual 4-pole isolators (switch disconnectors) having manually operated spring-assisted operating mechanisms, and with dual 4-pole contactors of rating equal to or greater than the corresponding isolator and be electrically and mechanically interlocked to prevent simultaneous closure of both contactors.
- Dual 4-pole fuse switches (fuse switch disconnectors) having manually operated spring-assisted operating mechanisms, and with dual four pole contactors of rating equal to or greater than the corresponding fuse switch and be electrically and mechanically interlocked to prevent simultaneous closure of both contactors.

The Standard Module includes for each circuit: -

- For Fuse switch/Contactor or Isolator/Contactor selections, all devices shall be located within a single compartment. Each isolator or fuse switch shall be provided with a door- interlocked operating mechanism, lockable in the 'Off' position.

- Unless written permission is obtained from The Engineer, a suitably rated bypass device, comprising of a Manual Mains/Standby Incomer shall be supplied within a separate adjacent cubicle, to the changeover incomer. The bypass device shall enable the Automatic Mains/Standby (or Generator) cubicle to be isolated, while retaining power to the outgoing circuit.
- All units shall be provided with door interlocking and facilities for applying padlocks in the opened position.
- Phase Failure relay with changeover contacts shall be supplied off the incoming Mains supply, incoming Generator supply and common outgoing circuit.
- Where the incomer rating is 250A and above, a power meter to display as a minimum 3ph Volts, 3ph Currents, kW, kWh, kVAr, kVArH with volt-free pulse/kWh and 4 to 20mA kVA output.
- Where the incomer rating is less than 250A, a 4-position selector switch and voltmeter.
- Automatic Mains failure system (to monitor and automatically switch the incoming supply device to the duty source (if both are live) or the live source (if only one is live).

Mains failure system to include:

- MAINS-MANUAL/AUTO CHANGEOVER/STANDBY (or GENERATOR) MANUAL Selector switch.
- MAIN SUPPLY ON, STANDBY (or GENERATOR) SUPPLY ON, MAIN SUPPLY ON LOAD and STANDBY (or GENERATOR) SUPPLY ON LOAD indication.
- For a Duty/Standby supply (i.e. non-Standby Generator) application, a selector switch to select the duty incomer.

For a Mains/Generator application:

- a) A TEST selector switch to break the Phase Failure Relay output on the Mains incomer.
 - b) GENERATOR ON TEST indication, activated when the TEST selector switch is operated.
 - c) A changeover contact wired to terminals (to provide START and STOP instructions to a standby generator).
 - d) Interlock to prevent the changeover system closing the generator Contactor until the standby generator has run up to speed.
- Timers and control relays, as required, to provide a delay between changing over of supplies (to overcome short duration fluctuations in supply) and for Mains/Generator applications, a generator minimum run timer.

Manual Mains/Standby (or Generator) Incomers shall be selected from:

- Dual 4-pole fuse switches (fuse switch disconnectors) having manually operated spring-assisted operating mechanisms, and being mechanically interlocked to prevent simultaneous closure.
- 3-position (labelled “Mains/Off/Generator” or “Mains/Off/Standby” as appropriate) rotary switch (rotary switch disconnect) with separate Mains and Generator fuses.

The Standard Module shall include:

- Door interlock & padlockable in the opened position.
- Three positions operating handle, door interlocked (labelled “Mains/Off/Generator” or “Mains/Off/Standby” as appropriate) and padlockable in the off position.
- Phase Failure relay with changeover contacts.
- Voltmeter scaled 0–500 volt, and 4-position selector switch.
- Individual control circuit transformer and fuses.

7-0 BUS SECTIONS

- 7-1.1 Busbars and connections shall be manufactured from hard drawn copper.
- 7-1.2 Busbars and connections shall be completely insulated.
- 7-1.3 Busbar vary in cross sectional area shall be adequate for the rating stated on the switchgear single line diagrams.
- 7-1.4 All busbars shall be marked to indicate the phase colouring.
- 7-1.5 Busbars, at bus section switches, shall be arranged to permit safe work on one bus whilst the other remains energized.
- 7-1.6 Busbars and connections shall be adequately sized, braced and supported to withstand the mechanical forces and thermal effects resulting from the switchgear rated short circuit current and carry test certification.
- 7-1.7 Assemblies with two or more incoming power supplies may be provided with one or more bus section devices as specified in the Particular Specification, of the appropriate type, rating and configuration, as specified in the Particular Specification.
- 7-1.8 A bus section device shall be selected from the following:
- a) Air circuit breaker
 - b) Moulded case circuit breaker or
 - c) Switch disconnectors.
- 7-1.9 Bus sections comprising air circuit breakers, or moulded case circuit breakers shall include as a minimum the following basic features:
- a) Mechanical interlock with the compartment door and padlockable in the 'off' position.
- 7-1.10 If specified in the Particular Specification, bus sections comprising air circuit breakers or moulded case circuit breakers shall include the following additional features:
- a) Shunt trip circuit

- b) Solenoid close circuit

Motor operation package:

- a) Control and monitoring facility integrateable with the control system via a communications link, where specified ,
- b) 2 normally open and 2 normally closed spare auxiliary contacts,
- c) Hand/off/auto selector switch,
- d) Local/remote selector switch,
- e) Key exchange interlock,
- f) Electrical interlock,
- g) Mechanical interlock and,
- h) Handling truck.

7-1.11 Bus sections comprising switch disconnectors shall include as a minimum the following basic features:

- a) Mechanical interlock with the compartment door and padlockable in the 'off' position.

7-1.12 If specified in the Particular Specification, bus sections comprising switch disconnectors shall include the following additional features:

- a) 2 normally open and 2 normally closed spare auxiliary contacts,
- b) Key exchange interlock and,
- c) Mechanical interlock.

7-1.13 If specified in the Particular Specification, the bus section shall include the following supervisory control and monitoring functions, wired to the programmable logic controller (PLC/DCS) or to an alternative system.

Wired to PLC/DCS:

- a) Reset
- b) Close
- c) Open
- d) Close/open
- e) Auto available/unavailable
- f) Healthy/tripped and Closed/open.

Wired to an alternative system:

- a) Reset
- b) Close
- c) Open
- d) Close/open
- e) Auto available/unavailable
- f) Healthy/tripped and
- g) Closed/open.
- h)

In both cases the reset, close, open and close/open supervisory control functions shall only apply where the incomer can be remotely operated.

Bus Section Switches shall be selected from:

- 4-pole fixed-pattern ACB having a manually charged spring-assisted operating mechanism.
- 4-pole withdrawable-pattern ACB having a manually charged spring-assisted operating mechanism.
- 4-pole isolator (switch disconnecter) having a manually operated spring-assisted operating mechanism.

The Standard Module shall include:

Door interlock (or bolted cover for air circuit breakers) and padlockable in the opened position (and on the shutters for withdrawable air circuit breakers).

8-0 FEEDERS:

- 8-1.1 The Assembly may supply one or more outgoing power supplies and may be provided with one or more outgoing devices as specified in the Particular Specification, of the appropriate type, rating and configuration, as specified in the Particular Specification.
- 8-1.2 Circuit breakers shall be withdrawable if specified and of the molded case type.
- 8-1.3 Circuit breakers rating and number of poles shall be as stated on the switchgear single line diagram.
- 8-1.4 Circuit breakers of similar rating shall be interchangeable.
- 8-1.5 Tripping, closing, control and indicating supplies for circuit breakers shall be as shown on the switchgear single line diagram.
- 8-1.6 Circuit breakers operating mechanisms shall be as stated on the switchgear single line diagram.
- 8-1.7 Test facilities shall be provided to permit operation of the circuit breaker whilst in the test/isolated position.
- 8-1.8 Circuit breakers shall be provided with two normally open and two normally closed spare, auxiliary contacts wired out to terminals.
- 8-1.9 Circuit breakers shall be interlocked to prevent the following:
 - § The breaker being inserted into the service position unless it is open,
 - § The breaker being withdrawn from service position unless it is open,
 - § The breaker being closed unless it is fully in the service or withdrawn position,

- § Remote operation whilst in the withdrawn position.
- § Padlockable in the “off” position

8-1.10 An automatic shutter mechanism shall be provided to completely isolate the vertical busbars capable of being individually operated by hand.

8-1.11 Isolators and fuse combination units shall:

- a) Be of withdrawable, air break type
- b) Be of the rating and number of poles as stated on the switchgear single line diagrams
- c) Be provided with facilities for padlocking in the “off” position
- d) Be of the fault-make, load-break type, unless specified otherwise.
- e) Be interlocked to prevent the compartment door being opened unless the isolator is in the open position.

8-1.12 A feeder shall be selected from the following:

- a) Air circuit breaker
- b) Moulded case circuit breaker
- c) Moulded case circuit breaker with integral RCD or
- d) Fuse switch disconnecter.

8-1.13 Feeders comprising air circuit breakers, or moulded case circuit breakers shall include as a minimum the following basic features:

- a) Mechanical interlock with the compartment door and padlockable in the ‘off’ position
- b) Integral Overcurrent protection.

8-1.14 If specified in the Particular Specification, feeders comprising air circuit breakers, or moulded case circuit breakers shall include the following additional features:

- a) Adjustable Overcurrent and earth fault protection, instantaneous hi-set protection, and current transformers as required,
- b) Shunt trip circuit,

- c) Phase failure relay for remote indication (e.g PLC/DCS, telemetry),
- d) Undervoltage protection,
- e) Solenoid close circuit,
- f) Motor operation package,
- g) Protection control and monitoring facility integrateable with the control system via a communications link, where specified,
- h) Voltmeter and 7 position selector switch (3 for line to line voltage, 3 for line to neutral voltage, 1 for off), and ammeter, current transformers and 4 position selector switch (3 for line current, 1 for off),
- i) Power factor indicator,
- j) Kilowatt hour meter,
- k) Power monitoring facility integrateable with the control system via a communications link, where specified,
- l) 2 normally open and 2 normally closed spare auxiliary contacts,
- m) Hand/off/auto selector switch,
- n) Local/remote selector switch,
- o) Key exchange interlock,
- p) Electrical interlock,
- q) Mechanical interlock and,
- r) Handling truck.

8-1.15 Feeders comprising fuse switch disconnectors shall include as a minimum the following basic features:

- a) Mechanical interlock with the compartment door and padlockable in the 'off' position.

8-1.16 If specified in the Particular Specification, feeders comprising fuse switch disconnectors shall include the following additional features:

- a) Phase failure relay for remote indication (e.g PLC/DCS, telemetry),
- b) Voltmeter and 7 position selector switch (3 for line to line voltage, 3 for line to neutral voltage, 1 for off), and ammeter, current transformers and 4 position selector switch (3 for line current, 1 for off),
- c) Power factor indicator,
- d) Kilowatt hour meter,
- e) Power monitoring facility integrateable with the control system via a communications link, where specified,
- f) 2 normally open and 2 normally closed spare auxiliary contacts,
- g) Key exchange interlock and,
- h) Mechanical interlock.

8-1.17 If specified in the Particular Specification, the feeder shall include the following supervisory control and monitoring functions wired to the programmable logic controller (PLC/DCS) or to an alternative system.

Wired to PLC/DCS:

- a) Reset
- b) Close
- c) Open
- d) Close/open
- e) Auto available/unavailable
- f) Healthy/tripped and
- g) Closed/open.

Wired to an alternative system:

- a) Reset
- b) Close
- c) Open
- d) Close/open
- e) Auto available/unavailable
- f) Healthy/tripped and
- g) Closed/open.

8-1.18 In both cases the reset, close, open and close/open supervisory control functions shall only apply where the feeder can be remotely operated.

Feeders shall be selected from:

- 3-pole fixed pattern ACB having a manually charged spring-assisted operating mechanism.
- 3-pole withdrawable ACB having a manually charged spring-assisted operating mechanism.
- 3-pole fuse switch (fuse switch disconnecter) having a manually operated spring-assisted operating mechanism.

The Standard Module shall include:

- Bolted Neutral link.
- Door interlock (or bolted cover for air circuit breakers) and padlockable in the opened position (and on the shutters for withdrawable air circuit breakers).
- Adjustable Overcurrent and earth fault protection on items i) to iii) only.

8-2 Contactor Feeders:

- 8-2.1 Contactor feeders shall generally be utilised as a means of switching (either remotely via terminals or automatically via timeswitch) the output of a fuse switch feeder or a distribution feeder.
- 8-2.2 Where specified in the Particular Specification - MCC Schedule, a Contactor feeder shall include a 3-pole contactor of rating equal to or greater than the corresponding fuse switch, installed within the fuse switch compartment to switch the output of the fuse switch.
- 8-2.3 The contactor shall derive its 110V control voltage from the section control power supply, via the auxiliary contacts on the fuse switch. The contactor shall be switched either remotely via terminals or automatically via a timeswitch, as specified in the Particular Specification - MCC Schedule.
- 8-2.4 The timeswitch, if required, shall be installed within the fuse switch compartment, and on the compartment door accessible from the front of the switchboard.

8-3 Motor Starters:

- 8-3.1 The Assembly may supply one or more fixed speed and/or variable speed drives and may be provided with one or more motor starters as specified in the Particular Specification, of appropriate type, rating and configuration as specified in the Particular Specification.
- 8-3.2 As specified in the Particular Specification, a motor starter shall either:
- Form an integral part of the Assembly, or
 - Comprise a separate assembly suitable for floor standing/wall mounting.
- 8-3.3 Motor starters shall include as a minimum the following basic features:
- Switching and isolation device
 - Short-circuit protection
 - Contactor(s)
 - Overload protection and
 - Control relays, terminals and controls.

- 8-3.4 As specified in the Particular Specification, the motor starter switching and isolation device and short-circuit protection device shall be selected from one of the following:
- a) Circuit breaker
 - b) Circuit breaker with integral RCD
 - c) Switch disconnector with separate fuses or
 - d) Fuse switch disconnector.
- 8-3.5 If specified in the Particular Specification, the motor starter shall include the following general features:
- a) Power factor correction
 - b) Control circuit supplies transformers
 - c) Facilities to allow operation of a motor installed in a hazardous area (e.g. barriers) and
 - d) Control circuit test facility.
- 8-3.6 If specified in the Particular Specification, the motor starter shall include the following additional motor protection systems:
- h) Undercurrent
 - i) Underload
 - j) Earth fault
 - k) Thermistor
 - l) Thermostat
 - m) Seal failure and
 - n) Protection control and monitoring device, fully integrateable with the control system via a communications link, where specified.
- 8-3.7 Where reset facilities are specified, they shall be of the latch and manual reset type and the reset(s) shall be provided on the front door of the functional unit.
- 8-3.8 Motor starters for fixed speed drives shall provide Type 2, sub-category C co-ordination to BS EN 60947-4-1.
- 8-3.9 Motor starters for electronic soft start/stop drives shall provide Type 2, sub-category C co-ordination to BS EN60947-4-2.

- 8-3.10 Motor starters for variable speed drives shall provide co-ordination equivalent to the functional requirements of Type 2, sub-category C co-ordination to BS EN 60947-4-2.
- 8-3.11 All faults within the starter shall be contained within the enclosure without danger to personnel and following a fault within the starter, all components within the starter shall be either undamaged or repairable to allow continued operation of the starter.
- 8-3.12 In such a case a declaration (supported by the required tests) confirming compliance with the functional requirements of the type 2 co-ordination tests to BS EN 60947-4-2 will be required.
- 8-3.13 Emergency stop arrangements for machinery applications shall comply with BS EN 418.
- 8-3.14 Where motor starter protection and/or emergency stop arrangements need to be indicated and reset, this shall be achievable without opening the door of the Assembly.
- 8-3.15 Where the starter is provided for use in conjunction with remote plant located in a hazardous area, as defined in BS 5345 or EN 60079-14, the starter shall additionally incorporate facilities in compliance with the requirements schedule in the certificate of conformity for that item of plant.
- 8-3.16 On the restoration of power supplies following a failure, auto control systems shall resume normal operations including, where appropriate, plant restart. These operations shall be carried out in a safe and controlled manner without the need for manual attendance or intervention.
- 8-3.17 Control circuit ‘normal and test’ facilities shall allow the testing of ‘hand’ and ‘auto’ control circuits with the enclosure door open and the switching and isolation device in the ‘off’ or ‘test’ positions as appropriate. The selector shall incorporate auxiliaries to permit full testing and simulation of control gear and supervisory and protection equipment.
- 8-3.18 Any supervisory protection equipment that provides operators with information via a keypad or alphanumeric display shall also function on test.

8-3.19 Controller diagnostic and fault indicators (including serial communications ports) shall be visible and operable without opening the enclosure.

8-4 Fixed Speed Drives

8-4.1 Motor starters supplying fixed speed drives shall be selected from the following:

- a) Direct-on-line
- b) Star delta
- c) Reversing
- d) Two speed
- e) Auto transformer
- f) Rotor resistance
- g) Soft start or
- h) Soft start/soft stop.

8-4.2 Unless specified otherwise in the Particular Specification all motors shall be provided with overload protection as follows:

- a) Up to and including 30 kW, thermal overloads
- b) Above 30 kW and up to and including 110 kW, electronic overloads and
- c) Above 110 kW, digital overloads.

8-4.3 Where there is no cost premium, electronic overloads may be offered in lieu of thermal overloads, and digital overloads may be offered in lieu of electronic overloads.

8-4.4 Where Thermistor motor over temperature protection is specified this may be integrated with the overload protection module.

8-4.5 Where star delta or auto transformer motor starters are specified, they shall be either of the open circuit transition or closed circuit transition type as specified in the Particular Specification.

8-4.6 Auto transformer motor starters shall incorporate transformers with tapings of 50, 65 and 80 % and a thermal protection system to preclude extended starting periods.

8-4.7 If specified in the Particular Specification, direct-on-line motor starters up to and including 18.5 kW, may be provided by the use of integral starters incorporating switching and isolation device, short-circuit protection, contactor and overload protection in a single assembly.

8-5 Variable Speed Drives

8-5.1 Motor starters supplying variable speed drives shall be selected from one of the following:

- a) 6-pulse voltage source inverter using PWM or other equivalent technology
- b) 12-pulse voltage source inverter using PWM or other equivalent technology.

8-5.2 The controller assembly shall be provided with on-board protection, control and monitoring features which shall include, as a minimum, the following:

- a) Overload
- b) Current limit
- c) Over voltage
- d) Speed control
- e) Speed indication and
- f) On-line diagnostics.

8-5.3 Where thermistor motor over temperature protection is provided this may be integrated with the controller assembly.

8-5.4 Harmonic current distortion introduced onto the electricity supply by the Assembly shall be kept within the limits imposed by ht electrical supply company.

8-5.5 If approved by the Engineer, a common rectifier and DC link may be provided to supply two or more inverters.

- 8-5.6 Transformers for phase shifting duties shall, where practicable, be located within the Assembly.
- 8-5.7 The Assembly shall comply with the EMC regulations in respect of emission and immunity to BS EN 50081 and BS EN 50082 respectively.
- 8-5.8 Where required, controller assemblies shall be provided with line reactors to negate the effects of cable capacitance and ensure correct operation of the drive.
- 8-5.9 The Assembly shall permit adequate heat rejection from the inverter compartments, and the Manufacturer shall provide estimates of the total heat rejection from the Assembly.
- 8-5.10 Where harmonic filters are provided to minimise or reduce the effects of harmonics on the supply system, the design of the harmonic filter shall take into account background voltage distortion from other sources which may be present at the time of commissioning, and where required, components of adequate rating shall be provided. The design of the harmonic filter system installation shall also take into account any power factor correction installations connected to the same low voltage power distribution system and the possibility of LC resonance with these and any upstream transformer reactances.

8-6 Motor Starter Facilities

8-6.1 If specified in the Particular Specification, the motor starter shall include the following control systems (a-h), selector switches (i-m) and push-buttons and control devices (n-z):

- a) Restart timer
- b) Protection interlock
- c) Protection operated
- d) Process interlock
- e) Auto control
- f) Available

- g) Contactor operating
- h) Emergency stop.
- i) Hand/off
- j) Hand/off/auto
- k) Local/remote
- l) Local/auto
- m) Remote/auto.
- n) Lamp test
- o) Protection reset
- p) Emergency stop reset
- q) Common reset (applies to all functions i.e. o) and p))
- r) Start forward
- s) Start reverse
- t) Stop (de-energise contactor for fixed speed drives {except soft start/stop}, controlled stop for variable speed drives {including soft start/stop})
- u) Emergency stop
- v) Inch forward
- w) Inch reverse
- x) Raise speed (for variable speed drives)
- y) Lower speed (for variable speed drives)
- z) Speed control potentiometer (for variable speed drives).

8-6.2 If specified in the Particular Specification, the motor starter shall include the following lamps (a-f) and indicators (g-m):

- a) Available
- b) Tripped (common fault)
- c) Individual fault conditions
- d) Running
- e) Stopped
- f) Emergency stop operated.
- g) Ammeter

- h) Ammeter and selector switch
- i) Hours run meter
- j) Number of starts counter
- k) Speed (for variable speed drives)
- l) kWhr meter
- m) Multi-function meter.

8-6.3 If specified in the Particular Specification, the motor starter shall include the following supervisory control and monitoring functions, wired to the programmable logic controller (PLC/DCS) or to an alternative system.

Wired to PLC/DCS:

- a) Protection reset
- b) Common fault reset
- c) Start forward
- d) Stop
- e) Start/stop
- f) Speed control (for variable speed drives)
- g) Auto available/unavailable
- h) Healthy/tripped
- i) Normal/fail
- j) Running/stopped
- k) Speed indication (for variable speed drives).

Wired to an alternative system:

- a) Protection reset
- b) Common fault reset
- c) Start forward
- d) Stop
- e) Start/stop

- f) Speed control (for variable speed drives)
- g) Auto available/unavailable
- h) Healthy/tripped
- i) Normal/fail
- j) Running/stopped
- k) Speed indication (for variable speed drives).

Standard Starter Modules (for all starters) shall include:

- a) 3-pole, 3-position (On-Off-Test) fuse switch.
- b) Contactor(s), and starting sequence relays as required.
- c) Overload relay. Thermal below 22kW, electronic (comprising a memory to prevent overriding resetting of the relay by the removal of power) for 22kW motors and above.
- d) Fuses for control circuit protection.
- e) Lamps for EMERGENCY STOP OPERATED, TRIPPED, RUNNING and AUTO AVAILABLE indication.
- f) Pushbuttons for RESET (resets all functions, protection and emergency stop), START and STOP (effective in hand and local control only) and EMERGENCY STOP (effective at all times).

Control relays, normally a minimum of four relays shall be provided, to carry out the functions of:

- a) Protection Operated Relay (POR), to provide common indication and status signals of any trip conditions. The POR circuit shall latch open following operation of any protective device. The POR shall enable the Start Relay to function. Re-energisation shall be via operation of the Reset pushbutton.
- b) Emergency Stop Relay (ESR), to provide common indication and status signals of any Emergency Stops or Local Isolator operation. The ESR circuit shall latch open following operation

of any Emergency Stop or Local Isolator operation. Re-energisation shall be via the operation of the RESET pushbutton. The ESR shall enable the Start Relay to function.

- c) Auto Available Relay (AR) to provide indication and status signals that no trip conditions exist, that the Emergency Stop has not been operated and that Auto Control has been selected.
- d) Start Relay (SR), to provide sequence starting condition. All Emergency Stops and Local Isolator auxiliaries to be direct acting on the Start Relay.
- e) Restart Timer (operated by incoming control circuit supply provides facility for automatic reset of protection and Emergency Stop circuits)

8-6.4 Dependent on the application, the Emergency Stop Relay or the Start Relay shall be replaced by the relevant Contactor to minimise the provision of duplicate functions. (e.g. the Start Relay could be the Contactor in the case of DOL starters, the ESR could be the line Contactor in the case of inverter drive applications).

- The TEST facility on the fuse switch shall isolate all common feeds for all signals from and to PLCs or telemetry systems.
- Terminals for duplication of all fault conditions to PLC, telemetry or other indication. Allow for cabling to marshaling at one end of MCC if called for in Schedules.
- Earth Fault protection shall be provided on all drives of 22kW and above. Where Earth Fault protection operates into a contactor, the Earth Fault relay shall include a time delay to permit the starter fuse to operate and protect the contactor against breaking fault currents in excess of its designed capability. Separate time delay relays are not acceptable.
- Thermistor relay for motors of 30 kW and above.
- Ammeter.
- Hours run meter.

- kWh meter (with volt-free pulse/kWh) for motors of 45kW and above.

8-7 Star/Delta Starters

8-7.1 Star and delta contactors shall be mechanically and electrically interlocked, such that when changing from the star to delta contactor a current free delay shall be provided to allow the star contactor to open (and arc to clear) prior to the delta contactor closing. This shall be inherent in the design of the starter or shall be achieved by retarding the closing of the delta contactor.

8-8 Variable Speed Drives Starters

8-8.1 Variable speed drives shall comprise of 6 pulse inverters or regenerative inverters.

8-8.2 Whilst inverter drives may be capable of operating up to 60Hz, they shall not be used above 50Hz under normal operating conditions. The motor manufacturer shall be consulted to ensure the proposed drive motor is suitable for the operation from variable speed inverters throughout the whole of the designed speed ranges. VSDs shall as standard be suitable for variable torque applications and shall be suitable for constant torque application upon selection of Option 2.

8-8.3 As well as the features stipulated for motor starters, VSDs shall include:

- Motor speed shall be manually set by a panel mounted membrane keypad or via a potentiometer where a keypad facility is not available. Raise/lower pushbuttons are not required.
- On-board Overload (in place of relay).
- Over voltage protection.
- Speed indication.
- On-line diagnostics.

8-9 Soft Start/Stop Drive (SS) Starters

8-9.1 Soft start/stop drives shall provide controlled start, fixed speed running and controlled stop, utilising a bypass circuit for fixed speed running, and programmable acceleration and deceleration ramps. On-board overload (if fitted) is acceptable in place of an overload relay.

9-0 EARTHING

9-1 Earthing and Bonding:

The electrical system shall be provided with a clearly identifiable and readily accessible Main Earth Terminal (MET) positioned as specified in the Particular Specification.

9-2 The Assembly shall be provided with facilities for connecting to the MET. The Earthing system may take the form of either an earth bar that extends the full length of the Assembly or, for Assemblies with less than 6 functional units and a supply rating of less than 100 A, a stud arrangement.

9-3 Earth bars shall:

- a) be manufactured from high conductivity copper
- b) be located in a safe and easily accessible position
- c) have a minimum number of joints
- d) have facilities for connection to the MET at each end of the bar where the MET is remote from the Assembly and provided by others, or adjacent to the main incomer where the MET is within the Assembly
- e) be rated at a minimum of 60 % of the busbar fault withstand capacity

9-4 Earth bars shall be tinned throughout. The use of pre-tinned copper is acceptable. If specified in the Particular Specification, the Assembly shall have a clearly identified single, bolted, neutral Earthing link.

9-5 Each compartment shall include an earth stud connected to the main earth bar or stud by separate connections or by a common vertical earth tape. Earth conductors shall be sized to withstand the fault level, subject to a minimum CSA of 6 mm².

- 9-6 Each compartment shall have Earthing conductors of 2.5 mm² minimum CSA or braided straps of appropriate CSA for EMC requirements, taken from the compartment main earth stud to the following:
- a) The compartment door
 - b) Component mounting plates and earth terminals
 - c) Equipment mounting rail earth terminals and
 - d) Any removable cover.
- 9-7 Each metal gland plate shall be connected directly to the main earth bar or stud by a separate connection. Earth conductors shall be sized to withstand the fault level, subject to a minimum CSA of 6 mm².
- 9-8 If specified in the Particular Specification, separate earth bars or studs shall be provided for connecting equipment requiring a clean earth or an intrinsically safe earth directly to the MET. Where required, such earth bars or studs shall be located adjacent to the equipment requiring a clean earth or an intrinsically safe earth as appropriate.
- 9-9 Main earth terminal shall be provided remotely by others, unless otherwise stipulated.
- 9-10 All metallic non-current carrying parts of the switchgear shall be bonded together and connected to the switchgear earth busbar.
- 9-11 All doors shall be bonded to the main structure by means of a flexible copper connection arranged so that it cannot be trapped as the door is opened or closed.
- 9-12 Withdrawable parts shall be effectively earthed until they are completely withdrawn with all power and control connections disconnected.
- 9-13 Provision shall be made, adjacent to the cable termination, for earthing cable armouring to the earth busbar.

10-0 SECONDARY WIRING

- 10-1 Secondary wiring within the switchgear shall be securely held in position. Where wiring enters or passes through compartments containing high voltage apparatus then it shall be run in conduit/trunking.

- 10-2 Secondary wiring layout shall permit alterations to individual circuits without requiring shutdown of the complete switchgear.
- 10-3 Bus wires for closing, tripping, control, heaters, etc. shall be run within the switchgear.
- 10-4 Wiring identification shall be by numbered and/or lettered ferrules, of insulating material adjacent to the terminals.
- 10-5 Flexible cables shall be used for connections on door mounted equipment. Wiring shall be loomed, wrapped in flexible PVC conduit and be firmly clamped at both ends to prevent movement at the terminations.
- 10-6 All wiring for external connections shall be brought out to individual terminals on a readily accessible terminal block.
- 10-7 The minimum cross-sectional area of the secondary wiring shall be 1 mm². Wiring with a cross-section of 1.5mm² shall always be stranded.
- 10-8 Plug and socket connections shall be of robust construction and include a location pin or similar device to prevent the interconnection being made incorrectly.

11-0 CABLE TERMINATION

- 11-1 All of the strands forming the conductor shall be connected at the point of termination.
- 11-2 Wiring shall be terminated using crimped cable-ends or lugs which are suitable for the conductor and the type of termination. Cable terminating facilities and terminals shall be suitable for the specified cable type, conductor size and gland.
- 11-3 Terminations shall be made using feed-through, captive screw clamp terminals or other approved type of terminal complying with BS EN 60947-7, mounted on DIN rail. The terminal rails shall be located in a safe and accessible position, with no more than two conductors per termination and with enough space for terminations to be made without undue bending or stress.

- 11-4 All internal wiring, including spare cores, shall be terminated at both ends.
- 11-5 Control circuit terminal rails shall include 10 % spare space.
- 11-6 Horizontal terminals shall be numbered left to right and vertical terminals top to bottom.
- 11-7 Screened signal cables shall be wired directly to and terminated at the device, without compromising the integrity of either conductors or screen by the use of terminal rails.
- 11-8 Screened signal cables shall have the screen solidly connected to earth at the instrument end.
- 11-9 To comply with EMC requirements, it may also be necessary to connect the screen to earth at the non-instrument end. Where this is the case, and such a connection will not compromise safety or performance, the screen shall be solidly connected to earth at the non-instrument end. Where this is the case and such a connection will compromise safety or performance, the screen shall be capacitatively coupled to earth at the non-instrument end.
- 11-10 Where it is necessary to connect the screen to earth, either directly or via a capacitive coupling, a proprietary 360° connection shall be used.
- 11-11 Where it is necessary to isolate the screen from earth, a suitable length of the overall sheath and the screen shall be removed and a 30 mm long silicone rubber oversleeve installed over the point of separation of conductors, screen and overall sheath.

11-12 Cable Termination and Metering Compartment:

The cable termination and metering compartment is intended to receive the supply cable for termination and connection to the electricity supplier's equipment. Where the metering system is directly connected, this shall also be located in this compartment. This compartment shall be located adjacent to the incomer compartment.

The cable termination and metering compartment shall be suitable for the supply cables specified in the Particular Specification. It shall also be suitable for the following, as specified in the Particular Specification:

- a) Copper work, including risers suitable for terminating cables (to be fitted by others)
- b) Double insulated tails, with a minimum of 2 m spare length, coiled in the compartment (to be fitted by others)
- c) Metering fuses and neutral link (to be fitted by others)
- d) Metering fuses and neutral link (to be fitted by Manufacturer)
- e) Current transformer links complete with suitable supports (current transformers to be fitted by others)
- f) Direct connected meter (to be fitted by others)
- g) Backboard made of a material approved by the electricity supplier (to be fitted by Manufacturer)
- h) Gland plate (to be fitted by Manufacturer).

11-13 Cable terminating facilities and terminals shall be suitable for the specified cable type, gland and core size.

11-14 The vendor shall provide the following cable terminating facilities:

- Air insulated terminal box with removable undrilled gland plate or sufficient dimensions to terminate the specified cables using stress relieving type termination kits.
- Direction of cable entry shall be as stated on the switchgear single line diagrams
- Cable termination kits, if stated on the switchgear single line diagrams.

11-15 Positioning of cable terminations shall avoid obstruction of other cable terminations, removable covers, etc. and provide easy access for terminating cables.

11-16 Cable supports shall be provided (where practicable) by the vendor to avoid undue strain on the cable termination.

11-17 Termination of single core cables shall be through an insulating or non-magnetic gland plate.

11-18 Separate compartments shall be provided for the termination of power and control cables.

11-19 All terminal blocks shall be shrouded or provided with transparent covers.

12-0 AUXILIARY SUPPLIES

- 12-1 Auxiliary supplies (closing, tripping, control, indication, heaters etc.) shall be in accordance with the switchgear single line diagram.
- 12-2 Circuit breakers closing, tripping, control and indication power shall be supplied from suitably rated d.c. supply units. Where d.c. supply units are not in the Vendor's scope, then he shall specify his load requirements.
- 12-3 All auxiliaries supply shall be individually fuse protected within each circuit breaker housing.
- 12-4 Anti-condensation heater supplies shall be fed from separate external source for each busbar section.

13-0 INSTRUMENT TRANSFORMERS

- 13-1 Voltage and current transformers of appropriate ratio, output, class and accuracy for protection and metering shall be provided as shown on the switchgear single line diagram.
- 13-2 The vendor shall provide details of ratio, output, class and accuracy for all instrument transformers in his supply.
- 13-3 The secondary windings of instrument transformers shall be earthed at one point, with provision for attaching test links.
- 13-4 Current transformers shall be rated to withstand the thermal and magnetic stresses resulting from through fault currents equal to the switchgear fault rating.
- 13-5 Where current balance protection is specified the Vendor shall provide calculations together with current transformer magnetization curves to **prove** the through fault stability of the protection up to the switchgear fault rating.
- 13-6 Bridging terminals for current transformers shall be provided at the outgoing terminals where external connections are required. Addition terminals shall be provided to permit secondary injection tests on protective relays.
- 13-7 Voltage transformer primary and secondary windings shall be protected by fuses.

13-8 Busbar mounted voltage transformers shall have provision for safety disconnecting the fuses and transformers from the energized busbars.

13-9 Where voltage transformers of the plug-in withdrawable type are used, shutters shall be provided to automatically seal of the high voltage spouts when voltage transformers are withdrawn.

13-10 Voltage and current transformers nameplates shall be fixed in a position so that details can easily be read when fitted in the cubicle.

14-0 METERING, PROTECTION, CONTROL AND INDICATION

14-1 Metering, protection and control shall be provided as shown on the switchgear single line diagram.

14-2 Meters and relays shall be flush mounting and fitted on the front of the switchgear.

14-3 Meters and relays shall be capable of withstanding without damage to the secondary currents associated with the switchgear rated fault current flowing in the primary of current transformers.

14-4 All indicating instruments shall be provided with an external zero point adjustment. Adjustment of the zero point shall be possible without dismantling the instrument.

14-5 Protective relays shall, wherever possible, be of the drawout static type with operation indicator, self monitoring (watchdog) facility and be fitted with test block.

14-6 Voltage free alarm contacts shall be provided for alarms.

14-7 Indication lamps (green-open, red-closed, amber-tripped on fault, white-trip circuit healthy) and mechanical position indicators shall be provided for each circuit breaker. Contacts for remote indication shall be provided.

14-8 Control of circuit breakers shall be carried out at the switchgear. It shall be possible to mechanically trip circuit breakers at the switchgear.

14-9 When the circuit breaker is in the test or withdrawn position, operation shall only possible from the switchgear.

14-10 Current transformer and voltage transformer connections shall be provided at front panel mounted test blocks located on each circuit breaker panel. The test blocks shall enable current, active and reactive power measuring instrument to be connected without open circuiting current transformer secondary circuits.

15-0 ANTI-CONDENSATION HEATERS

15-1 Heaters suitably rated to prevent condensation shall be provided within the switchgear cubicles.

15-2 On-off switches shall be provided.

15-3 Heaters circuits shall be protected with fuses.

15-4 For motors feeders, motor ant-condensation heaters shall be controlled by auxiliary contacts on the circuit breaker. Contacts shall be arranged so that when the motor is energized the heater is off and when the motor is deenergized the heater is on. Additionally, carriage switches shall be provided to energize the heaters when the contactor trucks are withdrawn from their cubicles.

16-0 LABELS AND SAFETY SIGNS

16-1 General:

16-1.1 Labels and safety signs shall be unambiguous, durable and legible. Labels shall be attached directly or adjacent to the electrical equipment to which they refer but not to trunking covers or other easily removable or transferable items.

16-1.2 Labels and safety signs shall be attached using an appropriate number of corrosion resistant, mechanical fixings.

16-1.3 The fixing of labels, safety signs and notices shall not affect the IP rating of the Assembly.

16-2 Labels:

16-2.1 Labels mounted on the outside of the Assembly shall be manufactured from laminated plastic, engraved so as to produce black letters on a white background. Labels for use inside the Assembly shall be to the same standard or may alternatively be printed using an approved proprietary system. Characters shall be upper case and for:

- a) Application labels, be not less than 6 mm in height
- b) Designation labels, be not less than 4 mm height
- c) Component identification labels, be not less than 3 mm in height.

16-2.2 Each Assembly shall be provided with a nameplate giving the following:

- a) Manufacturer's name or trademark
- b) Manufacturer's type designation or identification number
- c) Date of manufacture
- d) Type and frequency of current
- e) Rated operational voltages
- f) Continuous busbar rating
- g) Short-circuit withstand current and time
- h) Degree of protection

16-2.3 Each Assembly shall be provided with an application label as specified in the Particular Specification.

16-2.4 Each compartment shall have an exclusive designation label and for rear access Assemblies a duplicate designation label shall be provided at the rear of each compartment.

16-2.5 All components shall be clearly labelled. Internal components shall be clearly identified by individual labels to indicate the equipment to which they relate and have circuit designations which correlate with the Assembly drawings and documentation. Where this is not

practical, due to space restrictions, common labels (e.g. laminated diagrams) may be used.

16-2.6 A typed circuit chart shall be permanently fixed inside each distribution board cover door or immediately adjacent to the distribution board. The chart shall be laid out in accordance with the physical arrangement of the protective devices such that it is easy to relate the circuit chart details to the appropriate protective device. As a minimum, the chart shall be enclosed in a transparent protective cover attached to the inside of the compartment door. The information to be included shall be as specified in BS 7671.

16-2.7 Labels on starter compartment doors shall carry the motor kW rating as well as the application, the duty and the compartment reference.

16-2.8 Labels on feeder compartment doors shall carry the maximum current rating of the device fitted as well as the application (duty) and compartment reference.


16-3 Safety Signs:

16-3.1 The lettering, colour and layout of safety signs shall comply with BS 5378.

16-3.2 Any hazard for which a standard symbol is not defined shall be identified by simple and appropriate symbols and/or wording.

16-3.3 Signs shall be provided to avoid danger to personnel and to provide compliance with BS 7671 and Statutory Regulations. As a minimum, safety signs shall be fitted to removable covers over busbars and live connections, and to doors of compartments containing:

- Incoming supply cable termination points,
- Incoming supply switching and isolation devices,
- An internal switching and isolation device,
- Functional units incorporating capacitors,
- More than one supply or multiple control circuits originating elsewhere,
- Equipment located within a 'safe area' but associated with certified apparatus located within a hazardous area a sign shall also be fitted at the safe area cable termination rail,

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- Voltages greater than or equal to 230 V exist, where such voltages would not be expected.

16-3.4 Self-adhesive, vinyl safety signs may be used where there is no requirement for a special legend and proprietary safety signs are available.

16-4 Switchgear cubicles and components shall be identified by labels. Cubicle circuit designations and tag numbers (located at front and rear of panel) shall be in accordance with the switchgear single line diagram.

17-0 FINISH

The colour, finish and corrosion protection shall be in accordance with the vendor's specification which has been approved by the Buyer.

18-0 SPECIAL TOOLS

A complete set of any special tools required for operation, maintenance and testing of the switchgear shall be provided.

19-0 SPARES

The vendor shall provide separate lists of recommend commissioning and operating spares.

20-0 INSPECTION AND TESTING

20-1 The vendor shall provide test certificates for each type and rating of switchgear for type and routine tests carried out on the switchgear.

20-2 Tests shall be those listed in the relevant standards.

20-3 Assembly Type Test:

20-3.1 Type-Testing and Partial Type-Testing

20-3.2 As specified/stated in the Particular Specification, the Assembly shall be type-tested or partially type-tested by the Manufacturer in accordance with BS EN 60439-1.

20-3.3 For both cases, documentation, in the form of test certificates, calculations and/or declarations of conformity, shall be provided to confirm compliance with BS EN 60439-1 with respect to the following:

- o) Temperature-rise limits
- p) Dielectric properties
- q) Short-circuit withstand strength
- r) Effectiveness of protective circuit
- s) Clearance and creepage distances
- t) Mechanical operation
- u) Degree of protection

20-3.4 Where a type-tested Assembly (TTA) is specified, the Manufacturer shall provide verification of compliance by type-test, inspection and measurement in all seven areas of BS EN 60439-1, Clause 8.2, confirming that the Assembly is based on a type-tested arrangement, without deviations likely to significantly influence its performance.

20-3.5 Where modifications to the type-tested arrangement are such that calculation and/or extrapolation are required to confirm continued compliance, the Assembly shall be classified as a partially type-tested assembly (PTTA). Where a PTTA is specified, the Manufacturer shall indicate which parts of the Assembly are type-tested and which parts are partially type-tested.

20-3.6 Any modifications to the Assembly that result in the Manufacturer being unable to verify compliance will not be accepted.

20-3.7 With respect to clause 1, item a):

- a) For the Assembly to be classified as a TTA, there shall be no significant deviations from the certified type-tested arrangement. Examples of deviations unlikely to adversely affect the performance of the Assembly may include:
 - An increase in compartment size
 - A decrease in the total power loss produced by the components housed within a compartment

- A decrease in the steady state operating temperature of an adjacent compartment(s) or
 - In the case of a force ventilated compartment, an increase in air flow.
- b) For the Assembly to be classified as a PTTA, it shall be verified by test, calculation and/or extrapolation that any significant deviations from the certified type-tested arrangement will not adversely affect the performance of the Assembly. Examples of such deviations may include:
- A decrease in compartment size
 - An increase in the total power loss produced by the components housed within a compartment
 - An increase in the steady-state operating temperature of an adjacent compartment(s)
 - In the case of a force ventilated compartment, a decrease in air flow or
 - A change in the location of the busbar system within the Assembly.

20-3.8 All test data, calculations and/or extrapolations shall be made available to the Engineer on request to support the Declaration of Conformity.

20-3.9 If the Assembly cannot be classified as a TTA or PTTA, it does not conform to BS EN 60439-1 and is not acceptable.

20-3.10 With respect to clause 1, item b), the Assembly shall, as a minimum, have undergone and passed “Power Frequency Dielectric” tests of the type, voltage and duration detailed in BS EN 60439-1. In addition, where specified/stated in the Particular Specification (that is, the Engineer has requested an Impulse Withstand Capability or the Manufacturer has declared an Impulse Withstand Capability) the Assembly shall have undergone and passed “Impulse” tests of the type, voltage and duration detailed in BS EN 60439-1.

20-3.11 With respect to clause 1, item c), the Assembly shall be type-tested by a NAMAS accredited Test Station, under the observation of ASTA or a member of LOVAG, to the fault withstand capacity specified in the Particular Specification. This type-testing shall be

carried out with the busbar system (comprising main busbars, droppers, risers and all connections to incoming and outgoing protective devices) forming an integral part of the Assembly.

20-3.12 With respect to clause 1, item c) and the short-circuit withstand testing element of item d), verification is not required for:

- a) Assemblies having a rated short-time withstand current or rated conditional short-circuit current not exceeding 10 kA
- b) Assemblies protected by current limiting devices having a cut-off current not exceeding 17 kA at their rated breaking capacity.

20-3.13 With respect to clause 1, item c):

- c) For the Assembly to be classified as a TTA, there shall be no significant deviations from the certified type-tested arrangement.
- d) For the Assembly to be classified as a PTTA, it shall be verified by test, calculation and/or extrapolation that any significant deviations from the certified type-tested arrangement will not adversely affect the performance of the Assembly. Examples of such deviations may include:

- major structural changes to the Assembly
- reductions in busbar cross-sectional area
- changes in busbar profiles and/or spacing
- changes to the type and/or quantity of busbar supports or the support structure
- a change in the location of the busbar system within the Assembly
- Exclusion of, or changes to, major short-circuit protective devices taken account of in the programme of type tests.

20-3.14 All test data, calculations and/or extrapolations shall be made available to the Engineer on request to support the Declaration of Conformity.

- a) The type-test certificate shall include the configuration of the busbar connections between the incomer load terminals and main busbar system and shall also include any copper work installed on the live side of the incoming device. The

configuration of any fishplates and CT links on both sides of the incoming device shall also be included.

- b) The type-test certificate shall include each different arrangement of connection (whether busbars or cables) between the main busbar system and the feed terminals of the outgoing functional units.
- c) Each type of outgoing functional unit which contains a component that has not been type-tested shall be through-fault tested. In respect of fixed speed drives, Type 2 co-ordination to BS EN 60947-4-1 is acceptable as a type-test. In respect of electronic soft start/stop drives, Type 2 co-ordination to BS EN 60947-4-2 is acceptable as a type test. In respect of variable speed drives, a declaration (supported by the required tests) confirming compliance with the functional requirements of the Type 2 co-ordination tests to BS EN 60947-4-2 will be required.
- d) If the Assembly cannot be classified as a TTA or PTTA, it does not conform to BS EN 60439-1 and is not acceptable.

20-3.15 With respect to clause 1, item d):

- e) For the Assembly to be classified as a TTA, there shall be no significant deviations from the certified type-tested arrangement.
- f) For the Assembly to be classified as a PTTA, it shall be verified by test or appropriate design and arrangement of the protective conductor that any significant deviations from the certified type-tested arrangement will not adversely affect the performance of the Assembly. The only acceptable deviation is:
 - g) An earth bar positioned within the Assembly separate from the busbar system and supported in a similar manner to the type tested arrangement.


20-3.16 All test data or design details shall be made available to the Engineer on request to support the Declaration of Conformity. If the Assembly cannot be classified as a TTA or PTTA, it does not conform to BS EN 60439-1 and is not acceptable.

1-2 The buyer reserves the right to witness the following tests:

- 20-3.17 Routine tests on all switchgear/components as specified in the relevant standards.
- 20-3.18 Operational (electrical and mechanical) tests on all components.
- 20-3.19 Primary injection tests to prove current transformer ratios, accuracy of metering and integrity of secondary wiring.
- 20-3.20 Secondary injection tests to prove correct operation of relays unless proved in the primary injection testing.
- 20-4 The buyers reserve the right to inspect switchgear at the manufacturer's works prior to prove compliance with the specifications.
- 20-5 The contractor shall submit from the manufacturer a certified written test certificate in accordance with the requirements of the relevant test procedure.
- 20-6 Wherever possible Site conditions shall be simulated or the tests shall be extended to allow for Site conditions.

21-0 SHIPPING, HANDLING AND STORAGE

- 21-1 Switchgear shall be shipped in sections to suit ease of handling for transportation and installation.
- 21-2 Each shipping section shall be provided with supports in the form of suitable steel sections, lifting eyes, etc. to maintain alignment of parts during shipping, handling and installation. Location of lifting points shall be clearly marked on shipping containers and on drawings. Each shipping section shall have its weight clearly marked on the container.
- 21-3 Withdrawable circuit breakers shall be shipped separately from their housings.
- 21-4 Preparation for shipment shall protect the switchgear auxiliary devices, accessories, etc. against corrosion, dampness, breakage or vibration injury during transportation and handling.
- 21-5 Each shipping container shall be identified with contents, purchase order number and item number.
- 21-6 Instruction shall be provided for reassembly of sections in the field.

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22-0 DRAWINGS AND DATA

- 22-1 The Vendor shall provide drawings and data in accordance with relevant standard.
- 22-2 Devices requiring adjustments shall be fully documented and setting listed.
- 22-3 Full details for installation and setting up shall be included.
- 22-4 Recommended test data shall be stated, covering initial and also regular testing.
- 22-5 Items requiring regular inspection, checking, testing and maintenance shall be listed and the time scale clearly indicated.
- 22-6 Important items shall be cross reference to other parts of the manual as necessary.

23-0 DEVIATIONS

Deviations from this specification are only acceptable where the vendor has listed in his quotation the requirements he cannot or does not wish to comply with and the purchaser has accepted, in writing.
 In the absence of a list of deviations it will be assumed by the purchaser that the vendor complies fully with this specification

24-0 ERECTION AT SITE

It shall be the Vendor's responsibility to check correctness of civil details (steelwork, floor fixing, etc.) before commencement of erection and ensure the installation is carried out in a professional manner.