

**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 03**

**HIGH VOLTAGE SWITCHGEARS**

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## 1-0 SCOPE

This specification covers the design, manufacture and testing of factory assembled switchgear to be installed within Oman Wastewater Services Company projects.

## 2-0 STANDARDS SPECIFICATIONS

Switchgear shall conform in design, materials and performance (except where otherwise specified) with all relevant Statutory Regulations and the latest editions (at time of order) of all relevant British and Harmonized European standards including:

- BS 88, BS EN 60127 Cartridge fuses
- BS 142 Electrical protective relays
- BS 269, BS EN 60439-2 Busbar and connection
- BS 7354, BS EN 60439, BS EN 6094 Electrical power switchgear
- BS 7626, IEC 185 Current transformers
- BS 4794, Pt. 2 IEC 337-2 Control devices
- BS 37 Pt. 1 Electricity meters general
- BS 89, IEC 51 Direct acting indicating electrical measuring instruments
- BS 5685, IEC 521 Electric meters
- BS EN 60529, IEC 529 Degree of protection of enclosures
- BS 4752, IEC 267-1, BS EN 60439 Switchgear and control-gear
- BS EN 60947-3, IEC 408 Air break switches
- BS EN 60947-4 IEC-1 & 1A Contactors

- BS 6231 PVC insulated cables for switchgear
- All relevant IEC recommendations relating to electric motors
- Omani Electrical Standards

**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 The electrical arrangement of the switchgear, protection, metering, control, interlocking, intertripping, etc. shall be shown on the switchgear single line diagrams.
- 4-2 The switchgear electrical rating (voltage, current, frequency, fault current, etc.) shall be stated on the switchgear single line diagrams.
- 4-3 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.
- 4-4 The switchgear shall be suitable for operation, without deteriorious effect, with variations of voltage.
- 4-5 Transient voltage depressions down to 80% of rated voltage shall not affect switchgear performance.

**5-0 STRUCTURAL AND MECHANICAL REQUIREMENTS**

- 5-1 The equipment shall be designed for operation from the front, except where necessary for the isolation of voltage transformers. Where rear access is required. L.V. and H.V. compartments shall be completely segregated. All HV switchgears have to be operated as part of the normal running of the plant will also be capable of being switched remotely.

- 5-2 Switchgear cubicles shall be metal-clad, free standing, floor mounting, flush fronted and arranged to form a single structure with a common busbar assembly.
- 5-3 It shall be possible to extend the board safely by installing additional units at either end and cabling up with existing units live except when making the busbar connections.
- 5-4 Automatic safety shutters shall be provided to cover the busbar and circuit spouts during isolation. They shall be positively driven in each direction and padlocked in the closed position. A self-cancelling latch shall be included in each shutter mechanism for testing and maintenance purposes.
- 5-5 The Switchgear structure shall be provided with barriers to prevent transfer of ionized gases between compartments.
- 5-6 The Switchgear structure shall be self ventilating.
- 5-7 Interlocks, busbar shutters, covers, etc. shall be provided to prevent incorrect or unsafe operation and to prevent access to live parts.
- 5-8 Switchgear shall be designed and constructed to facilitate inspection, cleaning, repair and maintenance and to ensure absolute safety during operation, inspection and maintenance.
- 5-9 Similar parts and components shall be interchangeable wherever practicable.
- 5-10 Enclosure of degree of protection shall be stated on the single line diagram. When cubicles are open, it shall not be possible to accidentally touch live parts. Terminals on door mounted equipment shall be shrouded.
- 5-11 Isolating mechanisms and unit withdrawal facilities shall be suitable for operating by one man.
- 5-12 All materials shall be of the “self extinguishing” type.

## 6-0 CIRCUIT BREAKERS

- 6-1 Circuit breakers shall be of the vacuum or SF<sub>6</sub> type to comply with the relevant British or harmonised European Standards.
- 6-2 Circuit breakers shall be capable of clearing any fault condition, which may occur in the system without damage to equipment or personnel.
- 6-3 Circuit breakers shall be of the vertical isolation, horizontal draw out pattern, complete with carriage earthing contact. The isolating contacts shall comprise of an appropriate number of individually spring loaded fingers. Fixed Pattern (unable to withdraw) Circuit Breakers, having integral Circuit Earth facility, may be used subject to written permission from the Engineer.
- 6-4 Where draw out pattern Circuit breakers are of the same pattern and rating they shall be interchangeable.
- 6-5 Vacuum circuit breakers shall comprise separate vacuum interrupters, which are designed to prevent welding of contacts and sharp current chopping during fault interruption and switching of motor loads, transformers and capacitors.
- 6-6 Sulphur hexafluoride (SF<sub>6</sub>) circuit breakers shall comprise an assembly of SF<sub>6</sub> gas filled interrupters which are designed to prevent welding of contacts and sharp current chopping during fault interruption and switching of motor loads. They shall be fitted with a gas filling device and low pressure detector with facilities for alarm and lockout initiation.
- 6-7 Operating mechanisms shall be as detailed in the Particular Specification and selected from the following:
- Independent manual spring
  - Hand charged spring with manual release
  - Motor charged spring with electrical release
- 6-8 All operating mechanisms shall have mechanical 'ON' and 'OFF' indicators and a manual trip device fitted with means for locking. Hand charged and motor charged spring mechanisms shall have mechanical indicators to show 'SPRING CHARGED' and 'SPRING DISCHARGED'.

- 6-9 Operating mechanisms of the hand charged and motor charged spring types shall be arranged so that release of the springs to close the circuit breaker can only be achieved by a deliberate action. It shall not be possible for vibration or mechanical shocks to release the charged springs. Motor spring mechanisms shall be arranged so that charging is initiated automatically following a discharge. The necessary limit stops and switches for the automatic control of the charge, once initiated, shall form an integral part of the mechanism. It shall be possible to hand charge a motor charged spring mechanism.
- 6-10 Spring operated mechanisms shall be provided with volt-free contacts to give indication that the springs are charged. The closing solenoids of the solenoid operated mechanisms shall be suitable for operation at a minimum of 80% of the nominal supply voltage. They shall not malfunction or cause excessive vibration when energised at the rated voltage, or when energised from a full wave rectified source designed for multiple simultaneous operations. Unless otherwise agreed, the maximum operating voltage shall be taken as 120% of the nominal supply voltage.
- 6-11 To facilitate maintenance and adjustment of contacts, it shall be possible to 'slow-close' the circuit breaker but this operation shall only be possible in the fully withdrawn position. Any necessary operating handle or lever shall be supplied.
- 6-12 All circuit breakers shall be provided with interlocks to ensure that:
- The circuit breaker cannot be plugged in or isolated whilst it is closed; attempted isolation shall not trip a closed circuit breaker
  - The circuit breaker cannot be closed until it is fully plugged in or completely isolated
  - The circuit breaker cannot be closed in the service position without completing the auxiliary circuits between the fixed and moving portions
  - The circuit breaker cannot be 'slow-closed' except in the fully withdrawn position
- 6-13 With hand charged or motor charged spring mechanisms, the springs cannot be discharged until they have been fully removed and disconnected
- 6-14 With the circuit breaker plugged into an earthing location, tripping shall only be affected by a lockable manual device on the operating mechanism. All electrical interlocks and protection shall be disabled.

- 6-15 Where mechanical key interlocking is employed, tripping of a closed circuit breaker shall not occur if any attempt is made to remove a trapped key from the mechanism.
- 6-16 Circuit breakers duty and rating shall be stated on the switchgear single line diagram.
- 6-17 Circuit breakers of similar rating shall be interchangeable.
- 6-18 Circuit breakers shall be electrically operated but shall be also supplied with manual trip.
- 6-19 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.
- 6-20 Control of circuit breakers shall be carried out at the switchgear. It shall be possible to mechanically trip circuit breakers at the switchgear.
- 6-21 When the circuit breaker is in the test or withdrawn position, operation shall only possible from the switchgear.
- 6-22 Tripping, closing, control and indicating supplies for circuit breakers shall be as shown on the switchgear single line diagram.
- 6-23 Test facilities shall be provided to permit operation of the circuit breaker whilst in the test/isolated position.
- 6-24 Circuit breakers shall be fully tested to the specifications and carry test certification.
- 6-25 Circuit breakers shall be provided with trip circuit supervision to monitor trip circuit continuity and trip circuit supply. Alarm and indication facilities shall be provided.
- 6-26 Circuit breakers shall be provided with two normally open and two normally closed spare, auxiliary contacts wired out to terminals. Any additional contact equipment shall be as detailed on the switchgear single line diagram. Control and auxiliary switches shall comply with the requirements of BS EN 60947-5-1, with a minimum of two spare contacts. They shall be readily accessible and enclosed in a transparent plastic cover.

6-27 Withdrawable Circuit breakers shall:

6-27.1 Be fitted with busbar and cable circuit shutters:

- a) Labeled “Busbars” and “Circuit”,
- b) Of metal construction and effectively earthed to the main housing,
- c) Of the positively driven type, gravity drop shutters are not acceptable.

6-27.2 Circuit breakers shall have provisions for padlocking in the test and isolating positions.

6-27.3 Anti-pumping facility shall be provided in the circuit breaker closing circuit.

## 7-0 BUSBARS

7-1 Busbars and connections shall be manufactured from hard drawn copper.

7-2 Each busbar shall be completely insulated with a flame retardant material. The insulation shall be non-hygroscopic and rated at the system voltage.

7-3 No busbar shall vary in cross sectional area along its length.

7-4 Busbars, at bus section switches, shall be arranged to permit safe work on one bus whilst the other remains energized.

7-5 An earthing busbar shall be provided along the full length of the switchgear structure with provision for earthing cable connections at each end.

7-6 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.

## **8-0 EARTHING**

- 8-1 Each unit of H.V. switchboards shall include integral earthing facilities for both busbars and circuit. Each unit of motor control gear shall include a motor circuit earth switch. A positive earth connection shall be provided to all enclosure doors on which electrical components are fitted. Earthing via the door hinge shall not be accepted.
- 8-2 All metallic non-current carrying parts of the switchgear shall be bonded together and connected to the switchgear earth busbar.
- 8-3 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.
- 8-4 Withdrawable parts shall be effectively earthed until they are completely withdrawn with all power and control connections disconnected.
- 8-5 Provision shall be made, adjacent to the cable termination, for earthing cable armouring to the earth busbar.

## **9-0 SECONDARY WIRING**

- 9-1 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.
- 9-2 Secondary wiring layout shall permit alterations to individual circuits without requiring shutdown of the complete switchgear.
- 9-3 Bus wires for closing, tripping, control, heaters, etc. shall be run within the switchgear.
- 9-4 Wiring identification shall be by numbered and/or lettered ferrules, of insulating material adjacent to the terminals.
- 9-5 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.

- 9-6 All wiring for external connections shall be brought out to individual terminals on a readily accessible terminal block.
- 9-7 The minimum cross-sectional area of the secondary wiring shall be 1 mm<sup>2</sup>. Wiring with a cross-section of 1.5mm<sup>2</sup> shall always be stranded.
- 9-8 Plug and socket connections shall be of robust construction and include a location pin or similar device to prevent the interconnection being made incorrectly.

## **10-0 CABLE TERMINATION**

- 10-1 HV terminal boxes shall be designed for dry type cable joints and sized appropriately for the cables to be terminated.
- 10-2 Auxiliary circuits shall be terminated in a segregated terminal box.
- 10-3 Facilities shall be provided for padlocking against each individual position of the switchgear operating mechanisms, against closure of control gear isolation, and against access to cable test terminals and high voltage fuses.
- 10-4 Padlocks shall be provided for each padlocked facility. The padlocks shall be identifiable with their associated keys and shall be suitable for the duty as approved by the switchgear manufacture.
- 10-5 A volt-free changeover contact shall be wired to the auxiliary circuit terminal box for each circuit breaker and switch on/off state, service and earth position, and fault trip.
- 10-6 Cable terminating facilities and terminals shall be suitable for the specified cable type, gland and core size.
- 10-7 The following cable terminating facilities shall be provided:
  - 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.

10-8 Cable supports shall be provided (where practicable) to avoid undue strain on the cable termination.

10-9 Termination of single core cables shall be through an insulating or non-magnetic gland plate.

10-10 Separate compartments shall be provided for the termination of power and control cables.

#### 11-0 AUXILIARY SUPPLIES

11-1 Auxiliary supplies (closing, tripping, control, indication, heaters etc.) shall be in accordance with the switchgear single line diagram.

11-2 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.

11-3 All auxiliaries supply shall be individually fuse protected within each circuit breaker housing.

11-4 Each switchboard shall be provided with a self contained and dedicated battery backed auxiliary 30V D.C. power supply unit for switchgear operation, installed within the substation. It shall be energised from the local 230 volts A.C. power supply.

11-5 The batteries shall be of the nickel-cadmium alkaline, sealed lead acid or other appropriate type designed for long life, minimum maintenance and continuous floating across a constant voltage supply without emitting corrosive fumes.

11-6 The battery charger shall be an automatically controlled unit designed to maintain the batteries in a state of full charge. It shall incorporate a current limiting device for protection against low battery volts and short circuit, and reverse battery protection.

11-7 Anti-condensation heater supplies shall be fed from separate external source for each busbar section.

## 12-0 INSTRUMENT TRANSFORMERS

12-1 Current transformers (C.T.'s) and voltage transformers (V.T.'s) for protection and instrumentation shall be designed in accordance with the British Standard recommendations appropriate for the application.

12-2 The accuracy class of the C.T.'s and V.T.'s shall be suitable for the type of measurement or protective loads supplied. The rated voltage, current and frequency shall be stated. Separate C.T.'s shall be used for protection and for instrumentation.

12-3 Voltage transformers shall be protected by HRC primary fuses, to BS EN 60282-1 and by secondary fuses to BS88 in each relay and metering circuit. The secondary circuits shall be kept as short as possible and separate leads used to connect the transformer to each relay and metering burden. A means of isolation of the primary shall be included and lockable safety shutters shall cover the fixed isolating contacts when the transformer is isolated.

12-4 The vendor shall provide details of ratio, output, class and accuracy for all instrument transformers in his supply.

12-5 The secondary windings of instrument transformers shall be earthed at one point, with provision for attaching test links.

12-6 Current transformers shall be rated to withstand the thermal and magnetic stresses resulting from through fault currents equal to the switchgear fault rating.

12-7 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.

12-8 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.

12-9 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.

12-10 Busbar mounted voltage transformers shall have provision for safety disconnecting the fuses and transformers from the energized busbars.

12-11 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.

12-12 Voltage and current transformers nameplates shall be fixed in a position so that details can easily be read when fitted in the cubicle.

**13-0 METERING, PROTECTION, CONTROL AND INDICATION**

13-1 Metering, protection and control shall be provided as shown on the switchgear single line diagram.

13-2 A voltmeter and ammeter shall be fitted to each feeder circuit breaker and motor starter arranged to monitor phase and line voltages and line currents on the load side in conjunction with selector switches. Ammeter switches shall be make-before-break type to avoid open circuits in the C.T. circuits.

13-3 Meters and relays shall be flush mounting and fitted on the front of the switchgear.

13-4 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.

13-5 All indicating instruments shall be provided with an external zero point adjustment. Adjustment of the zero point shall be possible without dismantling the instrument.

- 13-6 All circuit breakers and switches, including isolating switches, shall have a positively driven mechanical indicator to show the on/off/earth state of the switch as applicable.
- 13-7 Protective relays for circuit breakers shall, unless otherwise specified, be the electronic type installed in draw-out cases mounted in an instrument cabinet above the circuit breaker on the front of the panel, self monitoring (watchdog) facility and be fitted with test block.
- 13-8 Over current and Earth Fault Protection shall be provided on all circuits. The protection shall be inverse, extremely inverse, definite time, instantaneous, directional or non-directional as appropriate to the circuit or circuits being protected. The discrimination shall extend to all points on the system down to the final sub-circuit.
- 13-9 Protection relays shall be mounted on the front of the switchgear or relay panel in such a position that operation and maintenance can be conveniently carried out. Auxiliary relays may be mounted internally and shall be located to be readily accessible.
- 13-10 Protection relays shall be contained in a dust-proof case with a clear front cover providing a minimum protection classification IP52 to BS EN 60529.
- 13-11 Relays shall have provision for testing the operation and calibration without disconnecting the permanent wiring by means of integral or separately mounted plug-in test terminal assemblies.
- 13-12 Relays shall be flush, draw-out type. Each relay shall have an indicator device to show the relay has operated and its specific operating function. Each indicator shall be able to be reset by hand. Re-setting devices shall not require the removal or opening of the relay. It shall not be possible to operate or adjust the relay settings without opening the case.
- 13-13 Multiple-function modular relays shall incorporate plug board or similar approved function and characteristic changing devices.
- 13-14 All relay protection elements shall have controls for protection set point and time setting adjustment. Relay characteristics, functions and settings shall be clearly indicated on the relay element front plate.

13-15 Protection relays shall comply with BS 142.

13-16 Where required for instrumentation and control, electrical signals shall be derived from transducers. These shall be connected to C.T.'s, V.T.'s, and tachometers or direct to the power system to derive the relevant parameters.

13-17 The output from the following transducers shall be 4mA to 20mA:  $\cos \Phi$ ;

- Current (I);
- Frequency (Hz);
- kVA;
- kVAr;
- Motor speed (rpm);
- Power (kW);
- Voltage (V).

13-18 The following shall have transducers to give pulse outputs:

- kVAh;
- kWh.

13-19 Transducers with 4mA to 20mA output(s) shall have easily accessible potentiometers for adjustment of zero and span. Transducers with pulse outputs, which may operate into computer systems, shall have easily accessible adjustments for the number of pulses equivalent to kVAh and/or kWh and also the pulse duration (width). This is to permit the transducer's outputs to be matched to the scan rate of the computers.

13-20 The complete transducer system shall have accuracy suitable for the purpose.

13-21 Where local indication of electrical parameters derived from transducers is also required on the switchgear/starter panel, a repeater display meter operated from the transducer shall be provided. This shall use a separate circuit from the transducer's 4mA to 20mA output to the instrumentation system and be detailed in the Particular Specification.

13-22 Transducers shall be calibrated by voltage and current injection before installation in the switchgear/control gear. Their operation shall also be demonstrated during the factory testing of the switchgear and control gear. The transducers shall be finally calibrated on Site.

13-23 Stop/start pushbuttons, supply on, motor running and tripped indicator lights, an auto/off/manual selector switch as appropriate, an hours run counter, and other components as necessary shall be included on the front panel to provide the method of control required. Volt free contacts shall be provided for output to SCADA.

13-24 Voltage free alarm contacts shall be provided for alarms.

13-25 Active (kWh) and reactive (kVArh) meters shall be provided on each circuit breaker panel.

#### 14-0 HIGH VOLTAGE MOTOR STARTERS

14-1 High-voltage motor starters at 3.3kV or 6.6kV shall be of the metal clad totally-enclosed pattern in accordance with BS 5227, and with construction and general component standards in accordance with those specified for AC switchboards and control gear.

14-2 High-voltage starters shall be of single-tier withdrawable truck-mounted or fixed pattern and compliant with BS 5856.

14-3 Fixed housings shall be provided with automatic safety shutters on the busbar-isolating spouts for motor or single end circuit control. Feeder-isolating spout shutters shall be fitted when specified.

14-4 Contactors shall be operated by 110V dc derived from a transformer-rectifier in each starter.

14-5 Each starter shall have low-voltage and high-voltage equipment fully segregated.

14-6 Contactors, high-voltage HBC fuses, control transformers and associated components shall be mounted on the starter withdraw-able truck providing safe maintenance access to all main active equipment.

14-7 Truck-mounted low-voltage equipment shall be segregated from the high-voltage circuit by an earthed metallic screen.

- 14-8 Contactor auxiliary switches shall comply with the requirements of BS EN 60947-5-1. They shall be readily accessible and enclosed in a transparent plastic cover. A minimum of four spare auxiliary switches, two normally open and two normally-closed, shall be provided.
- 14-9 Separate segregated low-voltage compartments shall be provided accessed by separate hinged doors.
- 14-10 Contactors shall comply with BS 775 Part 2 and shall have utilization category AC-3 and duty of Class 0.03 unless otherwise specified.
- 14-11 Contactors shall be of the vacuum type. Operation of vacuum contactors shall be such that current is broken at, or very near to zero, to minimise current chopping.
- 14-12 High-voltage HRC fuses shall comply with BS EN 60282 and BS 2692 and shall be of the striker-pin pattern. Fuse protection shall be fully co-ordinated with the contactor performance throughout the range of operation of all starter components under voltage over-current and earth-fault conditions. Striker-pin operation shall ensure contactor opening under single-phase fault conditions.
- 14-13 Comprehensive interlocking and padlocking shall be provided to ensure correct operation and operator safety.
- 14-14 High-voltage starters shall incorporate an integral fully interlocked manual/automatic feeder-circuit earthing switch. The switch shall be mounted on the starter fixed housing and its operation shall be fully interlocked with the operation of the contactor isolating truck. Earth-switch operation shall be from the front of the starter and operable only with the starter in the isolated position. Earth-switch automatic operation shall be as follows:
- § Automatic opening when moving the contactor truck from the 'isolated' to 'service' position;
  - § Automatic closing upon the full withdrawal of the contactor truck from the fixed housing.
- 14-15 Viewing facilities shall be provided permitting visual checking of the position of the switched position of all earth-switch contacts with the cubicle door closed and the truck in the isolated position.

14-16 Earth switches shall comply with BS EN 60129, and shall have performance rating fully co-ordinated with the starter service application. For motor starter control duty, the earth switch shall have a short-circuit making capacity compatible with the maximum potential stored energy of a rotating machine of output rating consistent with the AC3 rating of the contactor, or 10kA peak and a short-time rating of 4kA rms for 1 second, whichever is greater.

14-17 The earth-switch mechanism shall have padlocking facilities and means of opening the switch to permit feeder circuit testing.

14-18 Starter control, protection, instrumentation, and metering facilities shall be as specified.

#### 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 anti-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

16-1 Each ring main unit, switchboard and control board shall bear an identification label with letters of minimum size 12mm. Additionally, each individual switch shall bear an identification label at both the back and front of the unit where applicable with the switch name and number, with minimum lettering size 8 mm.

16-2 Conspicuous notices shall be fixed to the outside and inside of each substation and provide information as given in the following:

- External
  - Outside the substation the notices shall state: the name of the substation; the voltage; a warning against unauthorised entry; how to raise the alarm in case of emergency; and a contact telephone number
- Internal
  - a) Inside the substation the notices shall state: electric shock instructions; a warning against working without a permit; and any other applicable routine instructions
  - b) Single-line Diagram
  - c) A single-line diagram of the power distribution system shall be provided in a glazed frame fixed to the wall of each substation.

16-3 A wall mounted tool cupboard shall be provided, in each substation, to store all operating handles and any special attachments for testing etc.

16-4 A wall mounted cupboard with a drop down writing surface shall be provided in each substation to house the substation logbook. This cupboard may be combined with the tool cupboard.

16-5 There shall be a minimum of two key safes provided within each substation

16-6 One empty key safe shall be capable of being locked by two padlocks (minimum shackle diameter of 6mm).

16-7 Further key safes, as necessary, shall be provided to store keys and padlocks within the substation.

16-8 One set of operating handles not integral with the switchgear shall be supplied for each substation. Each handle shall be labelled with details of the substation to which it belongs and an instruction notice prohibiting its removal shall also be provided.

16-9 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.

16-10

16-11 A main label shall be affixed in a prominent position on each switchboard giving the following information:

- § Manufacturer name and type
- § Switchboard designation
- § System voltage, phases, wires and frequency.
- § Rate fault current

§ Year of manufacture.

16-12 Each circuit shall be fitted with a label giving the following information:

- § Current and voltage rating
- § Rated fault making and breaking current

16-13 Labels shall have black characters on a white background and made of a non-corrodible material.

16-14 Labels shall be affixed means other than adhesive.

### **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 The buyer reserves the right to witness the following tests:

20-3.1 Routine tests on all switchgear/components as specified in the relevant standards.

20-3.2 Operational (electrical and mechanical) tests on all components.

20-3.3 Primary injection tests to prove current transformer ratios, accuracy of metering and integrity of secondary wiring.

20-3.4 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.

## 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.

## 23-0 DEVIATIONS

23-1 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.

23-2 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.

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