



ABU DHABI SEWERAGE SERVICES COMPANY (ADSSC)

GENERAL SPECIFICATION FOR ELECTRICAL WORKS

DIVISION 16 ELECTRICAL

SECTION 16140 11kV SWITCHGEAR

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1. GENERAL REQUIREMENTS

All items described within this section shall comply with the provisions of Section 15001: General M&E Requirements.

1.1 SCOPE AND CERTIFICATION REQUIREMENTS

- a) This specification covers the design and manufacture of 11kV metalclad switchgear for ring main applications, complete with all accessories.
- b) Switchgear shall be designed and manufactured to IEC 62271-200 or other approved standards to meet the latest Abu Dhabi Distribution Company (ADDC) specifications.
- c) It is mandatory for manufacturers to have valid ISO 9000 series Certification issued by an internationally-recognised agency in Western Europe, USA or Japan, and should have been tested in a "Recognised Independent Testing Laboratory" as per the relevant IEC standards, including "Short Circuit Withstand Tests".
- d) The Manufacturer shall have documented supply record of similar switchgear working satisfactorily in the same climatic and service conditions for the last five (5) years as a minimum prerequisite to submit their offer.
- e) Evidence of type testing, together with copies of test certificates from a recognised independent short-circuit testing station covering the equipment offered, shall be submitted. The type-test evidence shall show that the circuit breakers have been tested in their cubicles and that all current carrying parts of these cubicles (busbars, isolating connections, current and voltage transformers, cable termination chambers, etc.,) have been included for all tests required by the relevant IEC standard.
- f) If additional independent type testing is required to fully comply with IEC recommendations, the additional time required for full type testing shall not relieve the Contractor of his obligations to complete the Works within the Contract time for completion. Additional type testing, if required, shall be performed at no extra cost to ADSSC and the Contractor shall in addition bear all costs in connection with the witnessing of such tests by ADSSC.
- g) The switchgear shall be installed in a non-air-conditioned room without any forced ventilation duty at the ambient conditions specified in Section 15001: General M&E Requirements.

1.2 SYSTEMS AND FAULT LEVELS

The characteristics of the ADSSC System are defined in Section 15001: General M&E Requirements.

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1.3 TEMPERATURE RISE

- a) Each current carrying component of the equipment supplied shall be capable of continuous operation at the specified ratings without exceeding the maximum temperature rises stated in the appropriate IEC recommendations, based on the site ambient conditions.
- b) The Contractor shall submit the Technical Data Sheets duly filled and certified stating permissible overload rating for the switchgear operating under emergency conditions, together with the duration and ambient temperature for which it applies.

1.4 GENERAL ARRANGEMENT AND CONSTRUCTION

1.4.1 TYPE OF SWITCHGEAR

- a) All switchgear shall be of the metalclad (compartmental design) air-insulated indoor type complying with IEC 62271-200, unless specified to the contrary in the Specification.
- b) The switchgear shall be of the self-supporting bolted construction type with all equipment installed inside vertical steel structures, suitably subdivided into individual compartments for:
 - i. Busbars.
 - ii. Circuit Breaker.
 - iii. Cable Connection.
 - iv. VT.
 - v. Low Voltage, Local Control, Protection and Metering Compartment.
- c) The 11kV switchgear shall be equipped with one set of three phase-insulated busbars. The circuit breakers shall be "VACUUM" and have approved means of isolation and circuit and busbar earthing. It shall also incorporate earthing facilities for each set of busbars, achieved by either suitably interlocked earthing switches/devices or other approved method.
- d) The equipment shall be dust-proof, rodent- and insect proof. It shall be capable of robust operation in the ambient conditions of Abu Dhabi.
- e) Provision shall be made for electric heaters to prevent condensation, particularly when the equipment is out of service. The IP class of enclosure protection shall be IP4W.
- f) The switchgear shall be designed for automatic pressure relief in case of pressure build up due to arcing, at the same time ensuring that escaping gases are clear off the operating personnel in the front and rear of the switchgear. Any device for pressure relief shall, under normal service,

shall be absolutely vermin-, dust- and damp-proof. Test evidence to verify the design will be required.

- g) Complete protection shall be provided against approach to live parts or contact with internal wiring parts. Particular attention shall be paid to drive linkages, bushings, earth bars and the like to ensure that the enclosure classification is not reduced when these 'pass through' compartments.
- h) Cast iron shall not be used for any part that may be subjected to mechanical shock. Materials, wherever possible, shall be non-hygroscopic and non-flammable. Insulating materials shall have a high resistance to tracking.
- i) The switchgear shall be suitable for mounting on a concrete floor. All necessary fixing bolts and rails shall be provided with the switchgear.
- j) Circuit breakers shall be mounted in moving portions in the form of wheeled carriages with horizontal isolation from the fixed busbars and outgoing circuit connections. It shall be possible to remove the circuit breaker completely from the panel without using any external device.
- k) Circuit breakers of the same type and current rating shall be interchangeable, electrically and mechanically, but it must be impossible to interchange equipment of different current ratings.
- l) Adequate clearances and surface creepage distances shall be provided to ensure satisfactory performance under service conditions.
- m) In order to make the type of switchgear compatible with the arrangements familiar to ADSSC, the switchgear shall incorporate a set of busbars which shall be contained in a separate busbar chamber positioned physically above the cable box. The plug and socket contacts of the unit shall therefore be:
 - i. Busbar contacts uppermost.
 - ii. Circuit contacts lowest.
- n) Suitable potential indicators shall be provided on the cable side to indicate live cable conditions. Details of the indicators provided shall be furnished in the technical proposal for acceptance/approval of ADSSC.

1.4.2 BUSBARS

- a) Busbars shall be air-insulated, hard-drawn, high-conductivity copper bars.
- b) Busbars shall be arranged in sections to permit future extensions and/or deletion. The method of extension is to be clearly defined and shown on

suitable drawings. Provision shall be made for extending the busbar at either end without any need for cutting or drilling of the busbar.

1.4.3 LOW VOLTAGE, LOCAL CONTROL, PROTECTION AND METERING COMPARTMENT

a) General Arrangement

The low voltage equipment compartment, provided as part of the switchgear and mounted on the feeder switchgear panels, shall be completely metal enclosed and provided with a separate front access door suitable for installation of indicators and control devices, including protective relays for 11kV switchgear. If protective relays are mounted inside this compartment, it shall have a door with a window to allow the observation of relays provided within. Wiring to door-mounted equipment shall be run inside flexible conduit, suitably mounted to prevent stressing of the conductors when opening the door to its extreme stop.

Relays shall be of approved type and comply generally with the requirements of IEC 60255, or other approved standard, and be contained in dustproof, moisture-proof, flush-mounted cases with transparent fronts and semi-gloss black bezels. They shall be provided with breathers.

Two test plugs to suit each different type of relay case or test socket shall be provided for each switchboard or suite of relay panels. The test plugs shall have terminals for both the relay and wiring side connections, which shall accept both wires and plug connectors, and be complete with lengths of flexible cable for connection to a portable relay test set. These plugs shall be stored in the key cabinet specified elsewhere in this document.

All relays shall be so arranged that any dust that may have collected in or upon the case shall not fall on the relay mechanism when opening the case.

Auxiliary relays shall also be mounted in dustproof cases.

All protective relays shall be provided with a name and data plate to approved standard, which shall include the ratios of the associated current and/or voltage transformers.

All metal bases and frames of relays shall be earthed, except where the latter must be insulated for special requirements, and an earth terminal shall be provided on the back of the relay case.

Each relay that initiates tripping shall be provided with a trip isolation facility, which shall be integral with the relay such that the tripping has to be isolated prior to withdrawal of the relay from its case.

All relays which are connected to complete either the tripping circuit of a circuit breaker or the coil circuit of an auxiliary tripping relay shall be provided with approved operation indicators, which, whenever possible, shall be of the mechanically-operated type. Indicators shall also be provided on such additional relay elements as will enable the phase of the fault condition to be identified.

Each indicator, whether of the electrically-operated or mechanically-operated type, shall be capable of being reset by hand without opening the relay case and it shall not be possible to operate the relay when resetting the operating indicator. Each indicator shall be so designed that it cannot show before the relay has completed its operation. Indicators shall not reset during a failure of auxiliary power to the relay.

It shall not be possible to operate any relay by hand without opening the case.

Unless otherwise specified, the current circuit for the relays shall be suitable for 1A 50Hz and voltage circuit shall be rated for 63.5V 50Hz (phase to neutral) or 110V, 50Hz (phase to phase).

The maximum ac fault voltage across any two points of a current circuit shall not exceed 3,000V peak and non-linear resistors shall be included, if necessary, to achieve this limitation.

If bolts or nuts are so placed as to be inaccessible with an ordinary spanner, not less than 2 suitable special spanners shall be provided.

All calculations to determine relay settings and adequacy of CT and VT rating shall be submitted to ADSSC for approval. In the event that the rating of the VT or CT proposed is insufficient to accommodate the connected burden in accordance with this specification, the Contractor shall supply the CT and VT with the necessary increased capacity at no extra cost.

The Contractor shall install only protection relays and equipment that are supported by guaranteed works routine test certificates issued by the manufacturers.

The Contractor shall provide electrical protection relay schedules to include manufacturer, type designation, characteristic details and ranges and actual protection settings to be used, on a per circuit basis.

All relays offered shall have been fully type tested in accordance with the appropriate standards and shall have had satisfactory operational service. Full data relating to these requirements shall be submitted with the specification. Unless otherwise stated, it will be assumed that relay equipment offered, has been type tested, or if not tested, that the tendered price includes for such tests.

- b) Flag Indicator Relays
Trip flag indication relays shall be current operated and operate in series with the appropriate tripping relay.
- c) Alarm flag indication relays shall be shunt operated.
- d) Indicating Lamps
Normally-energised indicating lamps shall be employed for 'ON', 'OFF' and 'TRIP' indications of a circuit breaker. They shall be energised from the 50V dc supply for switching station switchgear.

A common switch shall be provided in an approved location so that all 'normally lit' indicating lamps can be switched off.

Indicating lamps fitted into the fascias of switch and instrument cubicles or panels shall be adequately ventilated. They shall be easily removed and replaced from the front of the panel by manual means not requiring the use of extractors.

The bezel of metal or other approved material holding the lamp glass shall be of an approved finish and be easily removable from the body of the fitting to permit access to the lamp and lamp glass. The lamps shall be clear and fit into an accepted standard form of lamp holder. The rated lamp voltage should be 10% in excess of the normal running auxiliary supply voltage, whether a.c. or d.c. Alternatively, low voltage lamps with series resistors will be acceptable.

Indicating lamp glasses shall, unless otherwise specified or approved conform to the following standard colour code:-

Colour	Class of Indication	Examples
Red or Operative	Closed position	Circuit Breaker or contactor energised
Green	Opened position	Circuit Breaker or contactor unenergised
White	Lamp normally alight	Healthy or normal condition e.g. voltage healthy, trip supply healthy and equipment in normal service. Also safe conditions i.e. busbar or circuit dead in synchro schemes.
Amber	Action necessary	Alarm indication on which faulty or abnormal condition e.g. transformer over temperature, charger fail, circuit breaker tripped due to fault etc.
Blue	Indication of operation of circuit breaker closing, other equipments and those, which operates intermittently.	Springs charged, tap changer in progress etc.
Yellow	Local or remote control	Position of selector switch, circuit breaker etc

The colour shall be in the glass and not an applied coating. The different coloured glasses shall be interchangeable. Transparent synthetic materials may be used instead of glass, provided it can be shown that such materials have fast colours and are completely suitable for operating in Abu Dhabi.

Fuses shall be provided in indication circuits.

The variety of indicating lamps provided shall be rationalised to reduce maintenance and spares requirements.

e) Fuses and Links

Fuses and links shall be in accordance with Section 16060: Disconnect Switches and the following:

- i. Fuses shall be of the high rupturing capacity cartridge type (rewireable type fuses will not be accepted). Fuse holders shall be designed to lock the cartridge firmly into position without the use of screw clamping devices.
- ii. Carriers and bases for 16A fuses shall be coloured green and those for 6A fuses shall be black. Link carriers and bases shall be white or another distinctive colour. Miniature Circuit Breakers may be offered in lieu of fuses in ac circuits. All colours shall be subject to the approval of ADSSC.

1.4.4 CIRCUIT BREAKER

a) Circuit Breaker Making and Breaking Capacities

Each circuit breaker shall be capable of making and breaking short-circuits faults as specified in the specification, specification schedules and all in accordance with IEC 62271-200.

b) Vacuum Circuit Breaker

Vacuum Circuit Breakers with totally enclosed and maintenance-free contact systems will be accepted. They shall incorporate contacts designed to ensure a long contact life at all currents up to the rated making and breaking current switching conditions.

Contact material having low current chopping levels is preferred to minimise the occurrence of excessive over-voltages when switching. If additional devices are required to limit over-voltages caused during switching to a safe level, these shall be supplied and the details given in the Schedule of Particulars.

Contact material properties shall be such that the specified dielectric strength across opened contacts is obtained at all times.

Transmission of high mechanical stresses to the vacuum enclosure during operation shall be reduced to the minimum possible by the use of resilient mountings. Features to prevent the application of abnormal stresses to the flexible seals shall be incorporated.

Means for measurement of contact wear without major dismantling shall be incorporated and an appropriate gauge provided.

The details of any vacuum monitoring facilities shall be stated in the Schedules of Particulars.

It shall be possible to remove any one vacuum bottle from any one phase without having to remove the vacuum bottle on other two phases.

c) Circuit Breaker Operating Mechanisms

Circuit breaker operating mechanisms shall be of the 240V ac motor wound-spring type.

It shall be possible to charge the spring with the circuit breaker in either the "Opened" or "Closed" positions. It shall not be possible for the circuit breaker to close unless the spring is fully charged. A visual indicating device, preferably mechanical, shall be provided to indicate the state of the spring. The device shall indicate "SPRING CHARGED" when the spring is in a condition to close the circuit breaker and "SPRING FREE" when the spring is not in a condition to close the circuit breaker. If a charged spring is released when the circuit breaker is closed, the circuit breaker shall not open and neither shall such operation result in

damage. Indication lamps to indicate spring charged shall be provided where specified.

The mechanism shall be fitted with a local manual spring release, preferably a push button, shrouded to prevent inadvertent operation and provided with means for padlocking.

Operation counters shall be fitted to all circuit-breaker mechanisms.

Motor charging of the spring mechanism shall be fitted with an a.c. motor. Recharging of the mechanism operating spring shall be commenced immediately and automatically upon completion of each circuit breaker closure. An emergency hand-operated charging device shall be supplied.

A contact shall be provided to initiate a "Breaker Alarm" if the operating spring is not recharged within a predetermined time.

The operating mechanism shall be designed so that the circuit breaker is free to open immediately the trip coil is energised. A direct acting mechanical trip via an emergency button shall be provided on each breaker.

Means shall be provided for the manual operation of all circuit breakers for maintenance purposes.

An approved, positively-driven, mechanically-operating indicator shall be provided to show whether the circuit breaker is opened or closed.

In the event of failure to latch in the closed position, it shall not be possible for the circuit breaker to open except at normal speed. Means shall be provided for slow closing of the circuit breaker for maintenance purposes. It shall not be possible to use this device when the circuit breaker is in the service position. An approved arrangement shall be provided to prevent repeated reclosures in the event of a permanent 'close' signal being present.

It shall not be possible, without the use of tools, to gain access to the tripping toggle or any part of the mechanism, which would permit defeat of the mechanical tripping feature.

It shall not be possible to render the electrical protection-tripping feature inoperative by any mechanical locking device.

It shall be possible to complete the closing, tripping and interlock circuits when the circuit breaker is isolated in order to permit operation for tests purposes. The interlocks of the circuit breaker when in the isolated position shall be arranged to prevent interference with associated interlocks on circuits in service.

d) Circuit Breaker Isolating Features

The circuit breaker shall be connected to the busbars and feeder circuit through plug and socket type isolating devices. The devices shall be 'off load' type but be suitable for operation whilst the busbars or feeder circuits are live.

The following circuit breaker positions shall be provided:

- i. Isolated (or Maintenance).
- ii. Test.
- iii. Service.

Mechanical indication shall be provided to show the position of the circuit breaker. Such indications shall be visible from the front of the equipment at all times.

In each operating position, the circuit breaker shall be positively registered in its housing before the circuit breaker can be closed or opened.

e) Interlocks

All mechanical interlocks shall be of the preventive type and be arranged to prevent maloperation of the equipment if the interlock is defeated. The interlock shall be effective at the point where hand power is applied so that stresses cannot be transferred to parts remote from that point.

Electrical interlocks shall also function to prevent the closing operation of the circuit breaker.

Clearly labelled mechanical interlocks shall be provided which are designed to prevent:

- i. A closed circuit breaker from being withdrawn from or inserted into the isolating contacts.
- ii. Tripping by attempted isolation.
- iii. The closing of a circuit breaker except when correctly located in the service or test positions.
- iv. A circuit breaker being closed in the service position when the secondary circuits between the fixed and moving portions are not completed.

Additional operational interlocking shall be to the approval of ADSSC.

All interlocking associated with circuit or busbar earthing shall be mechanical.

f) Main Earthing Devices

Each item of switchgear shall be provided with means for connecting the circuit and the busbars to the main earth bar of the equipment for maintenance purposes.

The earthing connections and devices shall have instantaneous peak and short time current ratings equivalent to that of the circuit breakers.

In addition to any other requirement, one portable earthing device for each panel shall be provided. The cost of these earthing facilities shall be included in the price of the respective switchgear.

Full details of the method of earthing shall be submitted by the manufacturer.

Such earthing shall be achieved by the following means:

- i. For cable feeder circuit earthing: By fixed earthing switches fitted into the cable box portion of the panel. The earth switch shall be mechanically interlocked to prevent closure unless the circuit breaker is fully withdrawn from the unit or secured into the isolated position. It shall not be possible to move the circuit breaker into the service position with the earth switch closed.
- ii. For busbar earthing and transformer circuit earthing: By earthing trucks fitted with circuit breakers or approved earthing switches. Interlocks shall be provided such that it shall not be possible to install an earthing truck into the panel unless all circuit breakers associated with the busbar or circuit to be earthed are withdrawn from their units or secured onto the isolated positions.

It shall not be possible to move the circuit breakers associated with the earthed busbar into their service position with the busbar earth switch closed.

One busbar earthing truck and one transformer circuit earthing truck shall be provided for each busbar voltage specified.

When the earthing truck device is in use, the automatic features of the appropriate shutter shall be maintained and it shall be possible for the other shutter to remain locked closed.

Busbars could be alternatively earthed by the use of circuit breaker.

When a circuit breaker is used for earthing, means other than locking shall be provided to ensure that the electrical tripping of the circuit breaker is rendered inoperative when closed. It shall not be possible to return the equipment to the service location and to reclose the circuit breaker without first cancelling the means provided to render the electrical tripping inoperative.

g) Safety Shutters

A set of mechanical shutters shall be provided to cover each three-phase group of isolating contacts. The shutters shall be fully closed when the circuit breaker is in the isolated position.

Each set shall be capable of being individually operated and individually padlocked in the closed position.

The shutters shall open automatically by means of a positive drive initiated by the movement of the circuit breaker or voltage transformer carriage.

The closing operation shall also be automatic, either by positive drive or by two independent means, each capable of operating the shutter alone.

When padlocked closed, the shutter shall completely shroud the stationary contacts and it shall not be possible to force the shutters, or part of the shutter, to gain access to the stationary contacts.

To facilitate testing, means other than locking shall be provided for securing the shutters in the opened position. However, such means shall be automatically cancelled and the automatic operation of the shutters restored upon reconnection of the circuit breaker or voltage transformer to the fixed isolating contacts.

It shall not be possible to touch by bare hand the busbar and cable circuit contacts even if the shutters are removed manually. This is essential to accord adequate protection for the operator against accidental contact with live parts.

Busbar shutters shall be painted signal red, colour 537 in BS 381C and shall be clearly and indelibly labelled "BUSBARS" in large white letters. The circuit shutters shall be painted lemon colour 355 in BS 381C but shall not be lettered.

On bus section and bus coupler units, both sets of shutters shall be painted signal red and labelled "BUSBARS". In addition, an arrow shall be painted in white on each shutter pointing towards the busbar with which the shutter is associated.

Voltage transformer spout shutters shall comply with the above depending on the connection (busbar or circuit) of the VT.

Provision or access shall be made for lubricating the mechanical linkages.

All shutters shall be metallic and of an approved thickness and shall be effectively earthed.

h) Isolating Contacts for Secondary Circuits

Means shall be provided for connecting the secondary circuit on the moving portion with those on the fixed portion of the equipment. These connections shall be maintained for all positions of the circuit breaker. A set of self-aligning contacts shall be provided in the secondary

connections between the fixed and moving portions to permit ready disconnection in the event of complete withdrawal of the moving portion of the equipment.

Secondary circuits on the moving portions of circuit breaker equipment of equal current rating shall be identical in order to permit interchangeability.

i) Locks and Padlocks

Padlocks shall be provided on the switchgear for locking the withdrawing gear of the circuit breaker, the safety shutters (locks to be coloured red) and the access doors to marshalling compartments or other live parts of the switchgear regularly opened during maintenance. All locks shall be of approved type and every lock shall be a different change. Locks and keys shall be permanently identified with details to the approval of ADSSC. Three ordinary keys for each lock shall be supplied.

Each circuit shall be provided with a lock for each of the following functions:

- i. Locking the circuit breaker in the isolated position.
- ii. Locking the circuit breaker control switch.
- iii. Locking each of the circuit and busbar shutters.

Six (6No.) master keys shall also be provided for the substation where applicable. Circuit breaker control and control selector switches shall be provided with integral locking devices of approved design complete with 3 keys per each switch. Control switches shall be lockable in the neutral position only.

Suitable, wall-mounting, metal-cased key cabinets shall be included in the Contract, one for each item of switchgear. They shall have labelled hooks or other receptacles and be of sufficient size to house all keys and padlocks supplied with the switchgear. The cabinets shall be wall mounted and shall match the switchgear in colour and finish. Provision shall also be made in each key box for storage of permit books and danger boards. There shall be four danger boards each 250x200mm provided under the Contract. The inscriptions shall be approved by ADSSC.

1.5 FLOOR INSERTS

- a) Where metal inserts or rails are required in the floors for constructing the switchboard or guiding the circuit breakers into position, they shall be included in the Contract.
- b) It shall be possible to remove/install the circuit breakers from/into the fixed portion without the aid of special portable ramps or the like.

1.6 VOLTAGE AND CURRENT TRANSFORMERS

1.6.1 VOLTAGE TRANSFORMERS (VTS)

All voltage transformers shall be single-phase units and be of the 'withdrawable' carriage-mounted type with plug-in contacts. Means shall be provided for locking the voltage transformers in the service or withdrawn position. Shutters shall be fitted to the spouts, which shall open and shut automatically by the insertion or withdrawal of the voltage transformer. The secondary winding and carriage earth connection shall be made before it is possible to make the primary connections.

1.6.2 CURRENT TRANSFORMERS (CTS)

- a) It is intended to use ac series tripping for the circuit breaker to eliminate the need for a substation battery. Consequently, the current transformers supplied must be closely matched to the protection relays and breaker trip-coils to ensure satisfactory overall performance. Tenderers/The Contractor shall submit detailed calculations to prove that the equipment can operate over the whole ranges of possible fault currents and relay settings. The electrical relays shall be designed in accordance with IEC 60255.
- b) CTs shall comply with BS EN 60044-1 (IEC 60044-1), be cast resin insulated, and be so rated and designed that they shall not sustain any damage due to through fault currents expected on the system.
- c) The secondary of all CTs shall be 1A.
- d) Each CT shall be as follows:
 - i. Ratio: As specified.
 - ii. Rated Continuous Thermal Current: The current transformer shall be carrying twice the maximum rated primary continuously.
 - iii. Rated Output: Outputs shall be matched to the requirement of relays, ammeters and trip coils selected.
 - iv. Accuracy Class: 1 or better (as appropriate).
 - v. Rated Accuracy Limit factor: 20.
 - vi. Rated Short Time Thermal Current: 25kA.
 - vii. Rated Time: 1 second.
 - viii. Quantity: One per phase.

1.6.3 VOLTAGE TRANSFORMER AND CURRENT TRANSFORMER SECONDARY TERMINALS

- a) VT and CT secondary wiring shall be routed via local isolation and short-circuiting links which can either be separately mounted or be integral with terminal blocks. These links shall facilitate isolation of the VT secondary circuit and short-circuiting of CT secondary circuits. The outgoing side of these links shall have a disconnecting feature to allow

isolation of the burden for testing purposes. It shall not be possible to disconnect the VT/CT secondary earth connections via these links. The links shall also allow ratio change of dual-ratio current transformers.

- b) The above features shall all be possible without disconnecting any wiring from the terminal blocks and links and without isolation of the primary circuit and shall be in addition to any testing features required on relay panels.

1.7 CABLE BOXES

- a) Cable boxes shall be adequately sized to accommodate air-insulated heat-shrinkable type terminations.
- b) The minimum distance between the lower end of the cable socket and the inner face to which the gland is bolted shall be that required to effect the necessary clearances in compliance with the requirements of the heat shrink cable terminations used and in any case not less than 450mm. Above this face, there shall be no projection that restricts the spreading of the cores of the cable.
- c) The cable box shall be positioned below the busbar chamber and shall completely enclose the cable above the switchgear room floor.
- d) Cable glands shall be suitable for 11kV, 3-core, XLPE, Double Steel Tape Armour, PVC-served cables, of size range 95 to 240mm² copper.
- e) Gland plates, unless otherwise specified, shall have glands pointing vertically downwards.
- f) Each panel shall be supplied complete with a suitable heat shrinkable termination kit of an acceptable make; including cable lugs, support glands, etc. The kit shall be suitable for 95mm² for Transformer Control Panel and 185/240mm² for Feeder Control Panel.

1.8 EARTHING OF METAL PARTS

- a) All metal parts of the switchboard and integral earthing features shall be directly connected to a copper earth bar, which shall run along the full length of the switchboard.
- b) The cross sectional area of the earth bars shall be as specified and sufficient to carry the rated short time withstand current of the switchgear for the time specified.
- c) The frame of draw-out circuit breakers and earthing trucks shall be automatically connected to the switchboard earth bar through substantial plug type contacts.

1.9 HEATER

Each compartment shall be provided with a suitably rated heater for operation from 240V ac supply and arranged for cutting in when the breaker is "OFF" or "ISOLATED". This is to prevent condensation on breaker bushing, spout insulations, etc. An additional Hygrostat relay shall also be provided in the cable compartment.

1.10 INSTRUMENTS

Dial type, switchboard pattern, flush-mounting, moving-iron voltmeters and ammeters shall be provided.

1.11 SMALL WIRING

- a) All wiring shall be 2.5mm² Copper Conductor, 600V tropical grade PVC-insulated heat-resistant type. All small wiring shall be suitably terminated with circuit numbers.
- b) Trip circuit shall have an additional ferrule coloured red and marked "TRIP". Each circuit identification number shall be suffixed with the panel identification letter.
- c) All terminals shall be provided with suitably-rated terminal studs. Exposed terminals shall be suitably enclosed by detachable covers.
- d) The trip circuit cables shall be coloured BLACK. Current transformer secondary wires shall be adequately sized for the burden involved in each case.

1.12 LABELS

The panel of each item of switchgear shall have a blank circuit label approximately 300x80mm mounted on the front of the panel in a prominent position. The labels shall be made of suitable engraving material approximately 2mm thick, white surfaces with black engraving. Small black labels of similar material shall be mounted on the rear of the panels. The circuit names will be engraved at site to the approval of ADSSC.

1.13 SECONDARY MCBS

- a) LV Control Circuit shall be protected by MCBs. All necessary MCBs shall be supplied and they shall be fitted with clearly legible labels indicating the circuit. They shall be grouped according to their function.
- b) Labels shall indicate the current rating of the MCB and code symbols.

1.14 11KV VOLTAGE DETECTOR

Each feeder control panel shall include One 11kV single-phase voltage detector with two glow discharge lamps to indicate circuit "ALIVE". The voltage detector (capacitor type) to be connected in the L2 (Black) phase on the circuit side. The glow discharge lamps shall be located on front of the panel.

2. SPECIFICATION FOR 11KV, 4 PANEL SWITCHGEAR

2.1 CONFIGURATION

- a) 4-panel switchgear for a ring main application shall comprise of two Transformer Control Panel and two Feeder Control Panels. The first and the last panel shall be for Feeder Control and the centre panels for the transformer. The protection relays shall use an ac series tripping.
- b) Indication shall be supplied from the station auxiliary supply through a single-phase 240V 50Hz step down transformer. The transformer circuits shall be equipped with Protective Relays. No protection shall be provided for Feeder Circuits, but one feeder panel shall be equipped with a Through Fault Current Indicator.

2.2 FEEDER CONTROL PANEL

- a) Each Feeder Control Panel shall include, as a minimum:
 - i. One 11kV/25kA, 3-phase Vacuum Circuit Breaker of the rating specified.
 - ii. One 11kV Voltage Detector connected in L2 (Black) phase on the circuit side, with two glow discharge circuit ALIVE, indicating lamps mounted on front panel.
 - iii. One cable box for 11kV, 3-core XLPE, double steel tape armoured, PVC sleeved cable size as specified with a heat shrinkable cable termination kit.
 - iv. Dry type heat shrinkable termination complete with cable lugs, glands and accessories.
 - v. One set of core balance transformer and through fault indicator relay. (Applicable for one panel only.)

2.3 TRANSFORMER CONTROL PANEL

Each 11kV/433V transformer control panel shall include, as a minimum:

- i. One 11kV/25kA, 3-phase Vacuum Circuit Breaker of the rating specified.
- ii. Three current transformers of current ratings specified.
- iii. One cable box for 11kV, 3-core XLPE, double steel tape armoured, PVC sleeved cable size as specified.

- iv. Dry type heat shrinkable termination complete with cable lugs, glands and Accessories.
- v. One set of over current and earth fault relays.
- vi. One ammeter of specified scale connected on L2 (Black) phase.

2.4 PROTECTIVE RELAYS AND AMMETERS

2.4.1 FEEDER CONTROL PANEL

- a) No protective relays or ammeters are to be provided on feeder circuits. 'Through Fault' Current Indicator, energised from a core-balance CT, shall be provided on the outgoing feeder circuit. The indicator shall be mounted on the front of the panel.
- b) The indication shall re-set manually, when the ac supply is restored to the substation.

2.4.2 TRANSFORMER CONTROL PANEL

- a) The transformer to be protected shall be rated 11/0.433kV, Dyn11.
- b) Two over-current and one centre-element earth fault relays shall be provided which have normal inverse definite-minimum time lag (IDMT) characteristics complying with BS EN 60255 (IEC 60255) and their curves shall be such as to give tripping after three seconds for ten times current setting, when a time multiplier setting of 100% is applied.
- c) The over-current relay shall have IDMT current settings ranging from 50% to 200% in steps of 25%. The earth fault relay shall have an IDMT current setting range from 20% to 80% in steps of 10%. The time setting ranges for both over-current and earth fault IDMT relays shall preferably be continuously variable from 0 to 1.0 or as an alternative, with steps of at least 0.01 from 0.05 to 1.0.
- d) Each over-current and earth fault relay shall be supplemented with an instantaneous element, which shall be capable of tripping in less than 40ms, when twice the current setting is flowing.
- e) The over-current instantaneous element shall have pick-up setting range of 8 to 32 times nominal. The earth fault instantaneous element shall have a pickup setting range 4 to 16 times nominal.
- f) Operations indicators shall be fitted to each relay. The instantaneous elements and IDMT elements shall have separate indicators.
- g) No dc control voltage shall be used. Consequently, ac series tripping is to be performed under fault conditions. With this series tripping arrangement, it is common to require three trip coils. It is essential that the performance of the CT relay circuit and trip coils are co-ordinated, so that the scheme operates satisfactorily. Auxiliary equipment such as

resistors and chokes shall be provided where necessary to limit over-voltage and over-current effects.

- h) The Contractor shall submit calculations to prove that the relay scheme is adequately designed. They shall take into account the variation of trip coil impedance with plunger position and that the relay scheme is capable of operating over the range from minimum earth fault relay setting to circuit breaker fault rating.
- i) Type tests shall be carried out in the presence of ADSSC for the performance of the relay/CTs./trip coil under full fault condition (The test is exempted if performed already on a similar unit). Any limitations on the operating range of the relay shall be clearly stated.
- j) One ammeter, connected to the centre phase, shall be provided on these panels. It shall have one pointer, which is activated by a thermal element, and another acting instantly. The thermal pointer shall move a resettable maximum demand indicator. The ammeter shall be scaled to suit the applications requirements and be capable of taking twice rated current continuously without suffering damage.

2.5 ADDITIONAL EQUIPMENT

2.5.1 EARTHING GEAR TO BE SUPPLIED WITH SWITCHGEAR

- a) Each item of switchgear shall be provided with 3-phase set of earthing gear required for the earthing of switchgear through the circuit breaker of the circuit being earthed. All extensions plugs shall be fully insulated.
- b) The earthing device shall be fully interlocked to prevent danger to personnel and damage to equipment. The earthing devices shall be supplied separately in suitable wooden cases, with fixing and operational instructions permanently fixed in the lids of the cases. Full details of the earthing equipment shall be submitted with the tender.

3. SPECIAL TOOLS

- a) All special tools, levers, removable door handles, portable earthing devices, test plugs and the like which are required for operational purposes to 'rack in' or remove circuit breakers, voltage transformers and to facilitate earthing, testing and day-to-day operations of the works shall be provided in a lockable cabinet.
- b) All cabinets shall be wall-mounted with one provided for each switchboard. Each tool shall be secured within the cabinet in a fully labelled manner and identified such that it will be obvious it a tool or device has been removed from the cabinet.
- c) Full lists of special tools and devices shall be to the approval of ADSSC and shall include any special operational tool and devices listed

elsewhere in the specification. These shall include in the main, but not necessary be limited to the following:

- i. 1 set of 3-phase primary test plugs, fully insulated to facilitate insulation and primary injection testing.
- ii. 1 portable manually-attached flexible clamp-on type earthing device for each of switchgear. (Feeder, transformer, bus section).
- iii. 1 set - Manual slow closing device.
- iv. Special removable door keys as appropriate.

4. INSPECTION AND TESTING

- a) The equipment will be subject to inspections by Inspector appointed by ADWEA and the representative of ADSSC during manufacture and after completion in accordance with Section 15001: General M&E Requirements.
- b) The inspections may also be carried out by an ADWEA approved independent inspecting authority nominated by ADSSC.
- c) All required materials for the inspection and testing, as well as all testing equipment shall be supplied by the Contractor and shall be included in the unit prices.

4.1 TYPE TESTS

- a) The Contractor shall submit type test certificate from an internationally recognised authority acceptable to the client as evidence that the circuit breaker with panel has been successfully tested to relevant IEC Recommendation, BS EN on its own structure, complete with isolating features, with vent outlets forming part of the unit and with the main connected and busbars. The certificate shall include the test results and circuit breaker performance during the tests.
- b) Full type test certificate shall be made available to ADSSC at the time of inspection. ADSSC may require certain type tests to be repeated at the Supplier's expense, if it is found that the offered equipment substantially differs in design and construction with the type test unit. Such tests shall be performed at Supplier's expense.
- c) The following type tests shall be carried out in accordance with BS/IEC on one complete Switchboard in the presence of ADSSC's representative:
 - i. Power Frequency Voltage Tests.
 - ii. Mechanical Operation Tests.
 - iii. Voltage Tests on Auxiliary Circuit.
 - iv. Polarity Tests.
 - v. Sequence Tests.
 - vi. Temperature Rise Tests.

4.2 ROUTINE TESTS

Routine tests shall be carried out in accordance with the relevant BS/IEC standards in the presence of ADSSC's representative.

5. ENGINEERING DATA

The following shall be submitted with the offer:

- a) All technical schedules duly completed and signed.
- b) All drawings and information called for by this Inquiry, including:
 - i. General arrangement of the switchgear showing all important dimensions, together with mountings/accessories.
 - ii. Details of Circuit Breaker(s).
 - iii. Details of HV Cable Box with Bushing.
 - iv. Details of LV Cable Box with Bushing.
 - v. Earthing Arrangement.
 - vi. Details of all the CTs and relays included.
 - vii. Single Line Diagram of the completed switchgear.
- c) Detailed summary of deviations from the tender specification (if any).
- d) Brochures and catalogues for standard equipment.
- e) Applicable design specifications.
- f) Lists of accessories included in the bid.

END OF SECTION