

UNITED ARAB EMIRATES

FEDERAL ELECTRICITY & WATER AUTHORITY

TECHNICAL SPECIFICATION

11KV SWITCHGEAR

SUBSECTION - A
TECHNICAL SPECIFICATION - 11KV SWITCHGEAR

CONTENT

- 1.0 Scope
- 2.0 Manufacturer/Supplier
- 3.0 Design criteria
- 4.0 General Requirements
- 5.0 General Arrangement and construction
- 6.0 Current Rating
- 7.0 Connections To Outgoing Circuits
- 8.0 Circuit-Breakers
 - 8.1 Vacuum Circuit-Breakers
 - 8.2 SF6 Circuit-Breakers
- 9.0 Circuit-Breaker Operating Mechanism
- 10.0 Isolating Features
- 11.0 Local Control
- 12.0 Earthing Switches
- 13.0 Interlocking
- 14.0 11kV Switchgear Interlocks
- 15.0 Auxiliary Switches And Contactors
- 16.0 Current Transformers
- 17.0 Voltage Transformers

- 18.0 Cable boxes
- 19.0 Earthing System
- 20.0 Locking Devices
- 21.0 Anti-Condensation Heaters/Lights
- 22.0 Bus ducts
- 23.0 Safety shutters
- 24.0 Isolating contacts
- 25.0 Locks and Padlocks
- 26.0 Floor Inserts
- 27.0 Corona
- 28.0 Circuit Labels
- 29.0 Special tools
- 30.0 Erection, Operation and maintenance manual
- 31.0 Spares and accessories
- 32.0 Installation
- 33.0 Tests
 - 33.1 Type tests
 - 33.2 Routine tests
- 34.0 Ratings
- 35.0 Applicable Standards
- 36.0 Name Plates / Rating Plate
- 37.0 Drawings/documents

11KV SWITCHGEAR

1.0 SCOPE

This section details the requirements for 11kV Switchgears to be supplied for 33/11kV Substations and it shall be read in conjunction with control and protection requirements, scope of work, schedule of requirement etc.

2.0 MANUFACTURER/SUPPLIER

The 11kV Switchgear Manufacturer shall satisfy the following minimum requirement to supply 11kV Switchgear under this contract.

- a) The country of origin for manufacturing & testing shall be in Europe, North America or Japan only.
- b) The offered type and make shall have minimum three years satisfactory record in UAE/GCC.
- c) The offered switchgear with same type, rating shall be fully type tested as per the requirement of relevant IEC standards (IEC 60298, IEC 62271-100, 102, IEC-60044-1, 44-2 etc). The standards used shall be those last published prior to the date of opening of tenders. Type test certificates older than six years are not acceptable.
- d) The Manufacturer shall have an ISO certification.

3.0 DESIGN CRITERIA

The switchgear shall be designed to ensure satisfactory operation under the site and system operating conditions as per the design criteria described in tender document.

4.0 GENERAL REQUIREMENTS

The switchgear shall be single busbar, air insulated suitable for accommodation within a building and capable of continuous operation under the climatic conditions existing at the site.

The design of the switchboard shall be such as to enable bay extensions at either end with the minimum of disturbance to the installed equipment and without complete shutdown of the switchboard. The design shall allow high voltage testing of the extended busbar section and bays while the other busbar sections and bays are in normal operation.

The equipment offered shall be adequately protected from all types of system voltage surges and any equipment necessary to satisfy this requirement over and above what is specified, shall be included.

The design shall include all facilities necessary to enable the performance of the specified site checks and tests to be carried out. The Contractor shall state the test facilities provided and indicate any attachments or special equipment provided for this purpose.

Switchgear dimensions, opening etc shall be co-ordinated with existing civil building layout, floor opening and beam locations etc. Any additional dummy panels as required to suit the civil layout, opening and beams shall also be supplied within the overall quoted price of switchgear.

All grounding system, special tools and tackles, O & M manuals etc required for erection, operation, testing and maintenance of switchgear shall be supplied within the quoted price. The embedded plates and channels for the switchgear foundations and maintaining floor tolerances shall be provided by switchgear supplier. Anchoring bolts for fixing switchgear shall also be supplied by the switchgear supplier.

5.0 GENERAL ARRANGEMENT & CONSTRUCTION

All switchgear shall be of the extensible metal clad (compartmental design), air insulated, indoor, and drawout type complying with IEC 62271-200 unless specified to the contrary in the Specification. All materials, components used and the switchgear itself shall conform to the relevant IEC standards. In case of the equipment offered is to any other equivalent international standard, the acceptance of such equipment will be subject to the approval of Authority. One copy of such standards shall be furnished along with the Tender.

The enclosure degree of protection to IEC 60529 shall be min. IP-41. The degree of protection between sections shall be IP 4X. The switchgear shall be painted. The colour of painting shall be RAL 7032.

The 11kV switchgear shall be equipped with single set of three phase insulated busbars which shall comply with relevant IEC standards. The busbars shall be clad with solid insulation throughout. The busbar joints shall be insulated by preformed insulation and shall be detachable type suitable for inspection of bolt tightness at joints. The insulating material used shall be capable of withstanding the heating effects of the rated short time current without permanent deformation or deterioration.

The circuit breakers shall be SF6/VACUUM type and have approved means of isolation and circuit and busbar earthing.

The equipment shall be dust-proof, rodent and insect proof. It shall be capable of operating in tropical and humid conditions shall be equipped with electric heaters with on-off switch and humidistat control to prevent condensation particularly when the equipment is out of service.

The external effects of internal arc shall be limited by a suitable design to prevent any danger to an operator during the time he is performing his normal duties. Test evidence to verify the design will be required.

Complete protection by covers and partitions 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. The protection category in these aspects shall be not less than IP 4X to relevant IEC standards.

Cast iron shall not be used for any part, which may be subjected to mechanical shock. Materials shall wherever possible, be non- hygroscopic and non-flammable. Insulating materials shall have a high resistance to tracking.

The switchboards shall be suitable for installation in a building with a cable basement and mounting on a concrete floor. All necessary foundation bolts/fixing bolts and rails shall be provided and the cost included in the Tender Price. Equipment foundation requirement details consistent with the switchgear design offered are to be provided at an early stage in order for these to be incorporated in the civil works design.

The 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. The main disconnection contacts shall be silver plated, self cleaning type and shall be mounted in porcelain or cast resin bushings.

Circuit breakers of the same type and current rating shall be interchangeable, electrically and mechanically, but necessary interlocks shall be provided to avoid interchanging of equipment of different current ratings.

The main 110V DC and 415V AC auxiliary supply shall be connected through isolating MCB's of adequate rating.

The LV compartment is to be provided with fluorescent lamp controlled with electrical ON/OFF switch in addition to a door limit switch.

All normal operations in the switchgear room on a live cubicle are to be carried out by one person only from the front of the cubicle and shall be possible only with the cubicle door closed, ensuring complete safety. It is preferable that earth switches to be operated ON/OFF from the front of the cubicle.

Adequate clearances and surface creepage distances shall be provided to ensure satisfactory performance under service conditions.

Pressure relief devices shall be provided in the cubicles for various compartments.

Caution against live parts shall be provided (Wherever applicable) using permanent labels.

Suitable potential indicators shall be provided to indicate live circuit conditions.

6.0 CURRENT RATING

Every current-carrying part of the switchgear including CB, current transformers, conductors, busbars, connections and joints shall be capable of carrying its specified rated normal current continuously and in no part shall the temperature rise exceed the values specified in relevant IEC Standards at ambient temperature. Assistance from any forced cooling to maintain IEC rating is not allowed.

Every part of the switchgear shall also withstand, without mechanical or thermal damage the instantaneous peak currents and rated short-time currents (3 sec.) pertaining to the rated breaking capacity of the circuit breaker. The primary rating of the current transformers shall not differ from that of the associated circuit breakers unless specified otherwise.

The design of sliding type current carrying connectors and joints shall be such that they meet the aforementioned conditions over the full permitted range of movement. Where such joints may be made or adjusted on site, full details of alignment procedure, together with any necessary alignment tools or gauges shall be described in the maintenance manual and included in the scope of supply of special tools.

7.0 CONNECTIONS TO OUTGOING CIRCUITS

The switchgear shall be so arranged that all outgoing main and auxiliary cables shall be taken from the bottom.

All outgoing feeders shall be suitable for connecting 2 Nos. 11kV XLPE cable per phase with heat shrinkable terminations. The incomer feeder shall be suitable for connecting 3 Nos. 11kV single core 630 sq.mm Cu. XLPE cable per phase.

The outgoing compartment dimensions shall be enough to accommodate the required number of cable cores per phase and shall be easily accessible to allow maintenance works and/or quick replacement of the cable.

Where required to reduce local heating when single-core cables are adopted, non-magnetic gland plates shall be provided or alternatively, non-magnetic inserts.

Sealing ends shall be provided with all fittings including flexible connections where necessary. Stress cones or other approved means for grading the voltage stress shall be provided for insulating the cable within the sealing end. Glands shall be insulated from the chamber.

The insulation between cable and the switchgear enclosure shall be capable of withstanding a dry high voltage test of 2 kV a.c. for one minute and 5 kV d.c. for one minute.

8.0 CIRCUIT-BREAKERS

Circuit breakers shall preferably be Vacuum type. SF6 breakers will also be considered and these shall use the SF6 gas conforming to IEC or other approved standard as the insulating medium as well as for arc quenching. The circuit breakers shall be suitable for an operating sequence of O-0.3 sec.-CO-3 min-CO. Circuit breakers shall comply with IEC standard 62271-100 and IEC 60298. The Circuit breakers shall have valid type test report based on the above standard conducted on an independent test lab or witnessed by independent observers. Evidence of type test report as per the standard shall be submitted along with offer. The capacitive current switching, line charging and cable charging current, restrike performance, mechanical & electrical endurance, making and breaking current etc. shall be as per IEC 62271-100. The circuit breakers shall have first pole to clear factor of 1.5. The transient recovering voltage performance shall be as per IEC. All circuit breakers whether cable or others shall be suitable for auto reclose duty and the requirements of pole discrepancies during closing and opening operation shall comply with IEC 62271-100.

The circuit breakers shall be complete with high integrity operating and isolating mechanisms, primary and secondary disconnecting devices, auxiliary contacts, manual tripping facilities, operations counter, mechanical position indicator, control wiring, auxiliary relays and contactors as required.

The offered circuit breakers along with operating mechanism shall be type tested for mechanical endurance class M2.

If the circuit breakers are not type tested as per the IEC 62271-100, the new type tests shall be conducted preferably in an independent test laboratory. If tests are performed on manufacturer's premises, the tests shall be witnessed by independent observers. The above tests shall be conducted without any cost implication to FEWA.

8.1 Vacuum Circuit-Breakers

Circuit breakers employing the vacuum interruption principle shall incorporate vacuum bottles of declared and established manufacturer. Each interrupter shall be capable of individual adjustment for correct operation and easy removal for

maintenance or replacement. Full instructions for monitoring the state of vacuum and contact life shall be provided to the approval of the Authority.

Vacuum bottles shall not require the addition of insulation or stress shielding to achieve the necessary dielectric strength externally and shall not be mechanically braced by components, which may reduce the integrity of the insulation across the open gap.

Circuit breakers of the vacuum type shall incorporate contacts designed to ensure a long contact life at all currents up to the rated making and breaking current switching conditions. Contact materials having low current chopping levels are preferred to minimize 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 open 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 shall be provided.

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

If possible, any one vacuum bottle should be able to be removed without having to remove any of those on the other two phases.

8.2 SF6 Circuit-Breakers

Circuit breakers employing SF6 gas as an interrupting medium shall operate on the principle of self-generated gas pressure or rotating arc for arc extinction. Means of confirming the existence of adequate gas density in the circuit breakers shall be available without removing the unit from service. The system of gas monitoring shall be temperature compensated and with sufficient contact for alarm and lockout.

Absorption of moisture and the decomposition products of the gas shall be achieved by integral filters.

The circuit breaker shall be of the single pressure puffer type. The circuit breaker shall be of the phase segregated design where each phase is enclosed in its own gas compartment. Circuit breakers of the single pressure puffer type or rotating arc will be considered.

All materials used shall be carefully chosen to ensure that they will not deteriorate in the presence of the by products of arcing and will not absorb moisture. A suitable absorbent shall be fitted into the enclosure of each phase adequately sized to ensure that the moisture content of the gas is maintained below guaranteed values for the service life of the unit or between maintenance periods as applicable. Interrupters incorporating separate main and arcing contacts shall be arranged such that any re-ignition or restrikes always occur in the arcing zone between the arcing contacts.

Static and moving gas seals shall be designed to prevent the leakage of gas or ingress of moisture throughout the service life of the interrupting module. The leakage rate of gas shall not exceed one percent per annum by weight for each module. If SF6 circuit breakers are sealed for life they shall be guaranteed for a minimum of 10 years normal duty.

The gas system shall be monitored by a temperature compensated pressure switch, which shall give an alarm for abnormal pressure within any part of the circuit breaker. The alarm shall be received before the gas pressure has reached a level preventing safe interrupting of faults up to the design level of the circuit breaker.

A second pressure switch shall be provided to prevent electrical operation of the circuit breaker when the gas pressure drops below the level for safe interruption of faults up to the design level of the switchgear. At this pressure the insulation properties of the circuit breaker shall not be reduced.

A means shall be provided of evacuating and refilling the circuit breaker with SF6 gas and the circuit breaker shall be provided with a pressure gauge, which shall be clearly visible from the front of the cubicle when the circuit breaker is in the service position.

The gas enclosures and all gas pipe work, gauges valves and the like shall comply with the relevant clauses of the specification and be of approved material and securely fixed so as to withstand the maximum forces sustained during the circuit breaker operation and gas evacuation/refilling procedures. Over pressure relief devices shall be provided and shall be proved to be capable of allowing the safe discharge of any excess pressure that may arise in service however caused.

The circuit breaker shall be delivered to the site filled with SF6 gas at the correct operating pressure but an additional quantity of SF6 gas shall be provided sufficient to facilitate checks to the gas pressure switch. Gas removed from the circuit breakers on site shall not be re-used. The external coupling for gas evacuation and filling shall be of an approved type which shall be self sealing when external coupling hoses are removed. In addition the gas system shall be equipped with a hand operated isolation valve between the self sealing coupling and the circuit breaker gas system. The prices for all such gas filling accessories and sufficient quantity of gas for filling at site including two spare bottles with SF6 gas, gas filling plant etc shall be deemed to be included in the tendered price and shall be supplied for each substation switchboard separately.

All contacts shall be easily and quickly replaceable. Separate arcing contacts or contacts with replaceable arcing tips shall be provided to protect the main contacts from burning during operation. The design of the arc control devices and the material used in them shall be such that erosion caused by the arc during the operation of the circuit breaker shall be as little as possible. Means for measurement of contact erosion without major dismantling shall be incorporated and an approved gauge shall be provided.

9.0 CIRCUIT-BREAKER OPERATING MECHANISM

The circuit-breaker operating mechanism shall be of the motor wound spring type.

Operation will normally be from a "Remote" position but facilities shall be provided for operation locally by electrical release and by direct manual release from stored energy devices. It shall be possible to lock each local control function when circuit breaker is in the open position. Operation counters of non-resettable type shall be fitted to all circuit-breaker mechanisms.

The mechanism and its control scheme shall be such that, in the event of an electrical tripping pulse being applied to the circuit-breaker during the closing stroke, or of the mechanism failing to latch in the closed position, the circuit-breaker shall open fully and in such a manner as to be capable of interrupting its rated breaking current.

The mechanism and its control scheme shall be such that the mechanism shall not make repeated attempts to close the circuit- breaker when the control switch is held in the CLOSE position in the event of failure to latch on the first closing attempt or in the event of a trip signal being given to the circuit-breaker.

The electrical closing and tripping devices, including direct acting solenoid coils, solenoid operated valves and motors shall be capable of operation over the ambient temperature range when the voltage at their terminals is any value within the specified auxiliary voltage range.

The circuit breaker shall be driven by a single mechanism coupled to the three phases and suitable for rated operating sequence O-0.3Sec-CO-3min-CO.

Spring operated mechanisms shall have the following additional features:-

- (a) If the circuit breaker is opened and the springs charged, the circuit breaker can be closed and then tripped.
- (b) If the circuit breaker is closed and the springs charged, the stored energy shall be sufficient energy to trip, close and then trip the circuit breaker following loss of supply to the charging motor.
- (c) Mechanical indicators shall be provided to indicate the state of the spring. This indication shall be clearly visible from the front of the breaker. 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 condition to close the circuit breaker. In addition, suitable contacts shall be provided which may be used for remote indication.
- (d) 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.
- (e) 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.
- (f) Motor charged mechanisms shall be fitted with an d.c. motor suitable for 110V, DC supply. An emergency hand operated charging device shall be supplied. The mechanism shall have an interlocking arrangement to disconnect the motor gear when manual spring charging handle is inserted.
- (g) Under normal operation, motor recharging of the operating spring shall commence immediately and automatically upon completion of each circuit-breaker closing operation. The time required for spring recharging shall not exceed 30 seconds. A contact shall be provided to initiate a "Circuit breaker inoperative alarm" if the operating spring is not recharged within a predetermined time.
- (h) It shall not be possible to close a circuit breaker, fitted with a motor charged closing mechanism, whilst the spring is being charged. It shall be necessary

for the spring to be fully charged and the associated charging mechanism fully prepared for closing before it can be released to close the circuit-breaker.

- (i) It shall be possible to charge the spring with the circuit breaker in either the "Open" or "Closed" position.

All operating coils for use on the d.c. supply shall be connected so that failure of insulation to earth does not cause the coil to become energised.

Tripping and closing circuits shall be provided with MCBs on each unit and shall be independent of each other and all other circuits. The MCBs shall be equipped with auxiliary contacts for remote signalling.

Auxiliary switches shall be provided in circuit-breaker tripping circuits to interrupt the tripping supply as soon as the circuit-breaker has completed the tripping operation, and to interrupt the closing supply as soon as the circuit breaker has completed the closing operation.

Approved mechanically operated indicating devices shall be provided to indicate whether the circuit-breaker is in the "open" or "closed" position and whether the circuit-breaker is in the "service", "test", "isolated" or earthed position.

Locking facilities with padlocks shall be provided so that the circuit breaker can be prevented from being closed when it is open. These facilities shall not require the fitting of any loose components prior to the insertion of the single padlock required. It shall not be possible to lock mechanically the trip mechanism so as to render inoperative the electrical tripping. A direct acting mechanical trip via an emergency button shall be provided on each breaker.

10.0 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 shall be suitable for operation whilst the busbars or feeder circuits are live. The isolators shall comply with IEC 62271-102 standards.

The following circuit breaker locations shall be provided and the description of each position shall be as per relevant IEC standards. The following positions shall be provided as a minimum:

ISOLATED (OR MAINTENANCE)

TEST

SERVICE

Mechanical and lamp indications shall be provided to show the location of the circuit breaker (ie. CB in test position, service position etc). Such indications shall be visible from the front of the equipment at all times.

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

11.0 LOCAL CONTROL

Each circuit-breaker shall be provided with local control facilities including local control switches and a mimic diagram for the operation and status indication of the circuit-breaker and all associated earth switches together with selector switches to prevent local, remote controls being in operation simultaneously.

Local manual release facilities shall be provided for closing and tripping the circuit breaker. The operation of both releases shall be subject to lockout if insufficient stored energy is available. Local manual releases shall be provided with locking off facilities.

Sufficient electrical terminals shall be provided for the termination and interconnection of all cabling associated with remote control, alarms, indications, protection and local ring main supplies.

The LV compartment shall have sufficient space to accommodate all components, relays, wiring, terminals, MCBs, aux. Relays, control switches and position indicators etc.

The terminals of CT circuits, VT circuits etc. shall be wired upto LV compartment from CTs and VTs etc. for external cabling.

The terminal block for each application ie, CT circuits of each function, VTs, control, status and alarms, SCADA circuits, AC supplies, DC supplies, bus wires etc. shall be properly segregated and labelled to suit the application.

The CT terminal blocks shall have shorting, isolation and injection test facilities whereas VT terminals shall have isolation and injection test facilities ie, two separate types complying the above requirement shall only be applied for CTs and VTs. VT terminal blocks shall not have any provision for shorting. Ferrule Nos. shall be provided for all wiring as per the specifications of small wiring and termination. The control switches to be provided for local operation of CBs, shall be lockable, spring return to neutral position type i.e., 3 positions 'close - neutral - open'. However the Local/Remote selector switch shall be supplied with two positions type, lockable, key free in Remote positions only. LV compartment shall have door limit switches and panel illumination. Also a heater controlled by humidistat and heater on/off switch, 'heater on' indication lamp etc. shall be provided in the LV compartment. A separate lamp test push button (black colour) for testing all the indication lamps shall be provided. All CT/VT and AC circuit wiring of the LV compartment shall be with minimum 2.5 sq.mm colour coded wires (red, yellow, blue, black) whereas other DC wiring shall be 1.5 sq.mm grey colour wires. Also the specification for electrical small wiring and terminations enclosed in tender document are applicable for all wiring in switchgear, LV compartment etc.

12.0 EARTHING SWITCHES

Earth switches shall have valid type test report as per IEC 62271-102 conducted on an independent test lab or witnessed by independent observers. Evidence of type tests as per IEC 62271-102 shall be submitted along with tender.

Earthing switches shall be arranged to permit safe maintenance of any section of the equipment when the remainder is live.

Earthing devices shall be designed for full fault making capability during closing operation of the device. After the device has been closed the device is only required to carry fault current with duration as specified separately.

The earthing devices shall be fault making switches designed to satisfy the following conditions.

- (a) The operating mechanism shall be a spring-operated manual device. The closing speed of the switch is independent of the operator.

- (b) It shall not be possible to have the switch in partially open or closed position and it shall be possible to close and immediately open the switch.
- (c) It shall be possible to lock the switch in closed position.
- (d) The location of the Earthing blades shall preferably be visible through a window with switched background lighting if required. If this is not possible visual mechanical indication must be provided which is positively driven in both directions. The material used for earthing blades shall be copper.

The Earthing function shall form part of the integral design of the equipment. The manufacturer shall submit full details of the method of Earthing.

Mechanical interlock shall be provided such that when the cable is live the line earth switch shall not close. Local Electrical/Mechanical position indicators shall be provided on all switches and shall be visible from the front side of the panel. The field contacts used for electrical indicators shall be contacts of limit switch which shall be actuated at the instant of earthing blades set at final position of operation.

13.0 INTERLOCKING

An interlocking scheme shall be provided which takes into account the following basic requirements. All interlocking shall be submitted to FEWA approval before submitting the schematic diagrams.

- (a) To safeguard maintenance personnel who may be working on one section of the equipment with other sections live.
- (b) To prevent incorrect switching sequences that could lead to a hazardous situation to plant, equipment and personnel.
- (c) To prevent earthing of live circuit/ live bus.

The interlocking scheme shall be electrical for all operational interlocks and preferably of the mechanical type for maintenance safety interlocks but shall be effective when the equipment is being controlled locally, under emergency hand operation or from a remote position.

All mechanical interlocks shall be applied at the point at which hand power is used so that stress cannot be applied to parts remote from that point.

All electrical interlocks shall so function as to interrupt the operating supply and a system of interlocks shall be provided which shall cover the emergency hand operation of apparatus which is normally power operated. Failure of supply or connections to any electrical interlock shall not produce or permit faulty operation. Electrical bolt interlocks shall be energised only when the operating handle of the mechanism is brought to the working position. Visible indication shall be provided to show whether the mechanism is locked or free. Means, normally padlocking, shall be provided whereby the bolt can be operated in the emergency of a failure of interlock supplies.

Where key interlocking is employed tripping of the circuit breaker shall not occur if any attempt is made to remove the trapped key from the mechanism. Any local emergency-tripping device shall be kept separate and distinct from the key interlocking.

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

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

Capacitive divider neon type indication shall be provided per phase for all outgoing and incoming circuits to indicate the status of the circuits, when it is energised.

The neon indicators shall be located in the same side of earth switch operation and additionally the failure of this device shall not affect the primary circuit.

Clearly labeled mechanical interlocks shall be provided which are designed.

- a) To prevent a closed circuit breaker from being withdrawn from or inserted into the isolating contacts.
- b) To prevent tripping by attempted isolation.
- c) To prevent the closing of a circuit breaker except when correctly located in the 'service' or 'test' positions.
- d) To prevent a circuit breaker being closed in the 'service' position when the secondary circuits between the fixed and moving portions are not completed.
- e) To prevent withdraw completely out of the circuit breaker truck before auxiliary circuit plug and socket have been disconnected.
- f) To prevent uncoupling of the auxiliary circuit plug and socket when the breaker unit is in 'service' (connected) position.
- g) To prevent moving breaker unit from the 'disconnected' position to the 'service' (connected) position while the earthing switch is closed.
- h) To prevent closing the earthing switch when the breaker unit is in the 'service' position or not in fully 'disconnected'/'test' position.
- i) For busbar earthing it should be possible to close the earth switch only when all the breakers on the respective side of the bus are in fully 'disconnected' position including bus section breaker.
- j) If either of the bus-section earth switch is in 'ON' position or earth truck for busbar earthing is in the inserted position, no breaker on the respective side of the bus and the bus section breaker can be moved to 'service' position.
- k) It should not be possible to close the earth switch on live parts.
- l) It should not be possible to close the transformer breaker in 'service' position in case power transformer neutral(s) is not earthed.
- m) Additional operational/safety interlocking system shall be provided as required and to the approval of the Authority.

14.0 11KV SWITCHGEAR INTERLOCKS

A. General

The following electromechanical interlocks shall be provided for the 11kV switchgear to be supplied under this contract.

- 1.0 The main door opening shall be prevented when the circuit breaker is in 'service' condition and while racking in/racking out of the circuit breaker.
- 2.0 The auxiliary plug of circuit breaker shall not be removable when the circuit breaker is in closed condition or in service condition.
- 3.0 Rear door (if any) can be opened only when earthing switch is closed.

B. Circuit Breaker Truck

For Racking in the circuit breaker truck from test/isolated position to service position the following conditions must be satisfied.

- 1.0 The earth switch must be in 'open' position.
- 2.0 The circuit breaker must be in 'open' condition.
- 3.0 The associated busbar earth switch must be in open condition.
- 4.0 33kV side earth switch off (for incomers).

C. Circuit Breaker Operation

Following electromechanical interlocks shall be provided for closing the circuit breaker.

- 1.0 The circuit breaker must be either in test position or in service position.
- 2.0 The circuit breaker auxiliary plug must be fixed into proper position.
- 3.0 The anti pumping relay must be in de-energized condition.
- 4.0 Trip circuit must be healthy.
- 5.0 The associated trip relays must be in reset condition.
- 6.0 SF6 gas pressure must be sufficient for SF6 breakers.
- 7.0 33kV side earth switch off (for Incomers).
- 8.0 Both sides of the 11kV Busbar earth switches shall be in "open" condition (For Bus sections).
- 9.0 LVCB open (for Aux. transformers.).

D. Earth Switch Operation

Following electromechanical interlocks are to be provided for closing the earth switch.

- 1.0 Circuit breaker must be in test/isolated position.
- 2.0 VT MCB must be 'ON' and VT supply shall be absent.

- 3.0 VT truck must be in service position.
- 4.0 The cable circuit must be dead.
- 5.0 33kV side busbar disconnecter off (for Incomers).
- 6.0 LV side CB open (for Aux. transformers).
- 7.0 The earth switch locking key must be turned/locking push button must be pressed for energizing the interlocking coil of earth switch.
- 8.0 Other additional safety interlocks as per manufacturer recommendations.

E. Busbar Earth Switches

The following electromechanical interlocks to be satisfied for closing the earth switch.

- 1.0 All CBs associated with relevant busbars including bus section CB must be in test/Isolated position.
- 2.0 The bus VT truck must be in service position.
- 3.0 The VT supply absent and bus VT MCB must be ON.
- 4.0 The earth switch locking key must be turned/locking push button must be pressed for energizing the interlocking coil of earth switch.

15.0 AUXILIARY SWITCHES AND CONTACTORS

Auxiliary switches shall be provided on all circuit breakers and earthing switches for local & SCADA indication, control and interlocking. With each circuit-breaker, disconnecting device, and earthing device, there shall be supplied all necessary auxiliary switches, contactors and mechanisms for indication, protection, metering, control, interlocking, supervisory and other services. All such auxiliary switches shall be enclosed in dust free housing. Not less than four spare auxiliary switch ways shall be provided with each circuit breaker, disconnectors and earthing switches. All auxiliary switches shall be wired up to a terminal board on the L.V compartment of the switchgear whether they are in use or not in the first instance and shall be arranged in the same sequence on all equipment.

Switches shall be provided to interrupt the supply of current to the tripping mechanisms of the circuit breakers directly, once the operation of the latter has been completed. All such switches and mechanisms shall be mounted in approved accessible positions clear of the operating mechanism and shall be adequately protected. The contacts of all auxiliary switches shall be strong and shall have a positive wiping action when closing and where necessary, discharge resistors shall be provided to prevent arcing when breaking inductive circuits.

Direct acting auxiliary switch contacts shall be used in conjunction with busbar protection schemes in case of duplicate busbars.

If sufficient aux. Contacts are not available, the contacts shall be multiplied by using suitable bistable relays so that the failure of DC supply shall not cause a mal-operation or undefined position of circuit breakers, disconnectors or earth switches.

If any discrepancy between the aux. Contacts and bistable relay contacts, this shall be monitored and alarmed locally and for remote indication.

All repeat relays are subject to approval of FEWA.

16.0 CURRENT TRANSFORMERS

Current transformers shall be located on the feeder side of the circuit breaker and on both sides for bus section CB and shall be part of panel assembly. CTs shall be encapsulated and protected from the adverse effect of atmospheric conditions.

Current transformers shall be supplied as detailed in the Schedule of Requirements and as per single line diagram and comply with the requirements of IEC 60044-1 as appropriate and as per the metering/protection and supervisory requirement as called for in the specification. Generally, the cores for measuring instruments shall have accuracy class of 0.5% or better and saturation factors below five (5). Cores for relaying shall have accuracy class of 5P as required. For unit protection schemes, the C.Ts shall have class PX accuracy class according to IEC 60044-1.

The requirements of C.Ts are shown in the Substation single line diagrams and in the typical control and protection diagrams for various feeders.

The C.Ts shall have the same short-circuit ratings as that of the switchgear.

Current transformer ratios shall be chosen according to the requirement of protection/metering requirements and as shown on the schedules/drawings. Final determination of ratios and VA burden requirements shall be coordinated by the Contractor to the approval of the Authority.

All secondary shall be wired to terminal block in LV compartment to facilitate easy ratio changing. Adequate interposing CT's are to be provided in case protection/measurement/SCADA are fed from the same CT core.

Any increase in accuracy class/VA output or change in C.T. ratio to that shown in the Tender proposal drawings/technical particulars, based on the final approved calculations shall be met with by the Contractor without any additional cost.

The accuracy class/VA output/knee point voltage, magnetizing current, secondary winding resistance...etc., shall meet the protection requirement (at any tap (C.T.ratio) selection possible, in case of multi-ratio C.Ts).

Facility and accessories, if any shall be provided to facilitate easy primary injection testing.

The rated short-time thermal current shall not be less than the through fault capacity of the associated circuit breakers.

The characteristics of current transformers shall be submitted to FEWA for approval together with detailed calculation, details of the protection, instrumentation and measuring equipment with which each current transformer is to be used. Each current transformer shall be capable of providing the necessary output to operate the related devices satisfactorily at the connected burden and accuracy class.

Each current transformer shall have a rated continuous thermal current of at least 120% of the rated primary current of the associated equipments.

The characteristics and capacities of current transformers used for protective circuits shall be calculated by the manufacturer who shall prove by calculation the suitability of the CT's provided in conjunction with the relay/BCPU manufacturers requirements for the relays and equipment offered.

Where multi-ratio secondary windings are specified a label shall be provided at the secondary terminals of the current transformer indicating clearly the connections required for each ratio. These connections and the ratio in use shall also be shown on the diagram of connections. The secondary windings shall be earthed at one point through a removable link, which shall be in the relay/control compartment. All different CT ratios terminals shall be wired upto terminal block in LV compartment to facilitate easy selection. The CT ratio selection shall be possible without disturbing CT wires and on load.

Terminal boards shall have shorting, disconnecting and injection facility to allow testing with the circuit in service and on load.

It shall be possible to carry out primary injection testing of the CTs when the switchgear is fully assembled, or retesting of the CTs during the service life of the switchgear without interruption of supply to adjacent circuits.

The secondary windings of each set of current transformers shall be capable of being open circuited for one minute with the primary winding carrying the rated current.

All current transformers shall be installed with the P1 terminals adjacent to the busbars. The polarity of the primary and secondary windings of each transformer shall be clearly indicated at the respective terminals and in addition labels shall be fitted in a readily accessible position to indicate the ratio, class and duty of each transformer.

The current transformer particulars as specified in IEC 60044-1 shall be given on an accessible plate mounted external to the current transformer and on the switchgear cubicle.

17.0 VOLTAGE TRANSFORMERS

Voltage transformers shall be of electromagnetic type.

All voltage transformers shall be supplied as detailed in the Schedule of Requirements and as per single line diagram. All voltage transformers shall be single-phase inductive type dry units and they shall 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 and means shall be provided for locking the shutters in open and in closed position. The secondary winding and carriage earth connection shall be made before it is possible to make the primary connections. The spout shutters shall be pointed YELLOW or RED depending on whether they are connected to the circuit side or the busbar side the circuit breaker. The Voltage transformer truck, if provided for withdrawable type, shall be earthed separately.

All voltage transformers shall have windings of required (but with min. specified) VA output,

Voltage transformers shall be suitably designed for connected relay, protection, BCP, Instrumentation and meters and shall be approved by the suppliers of such equipment. Design calculations and parameters shall be submitted to FEWA for approval at an early stage, prior to manufacture of voltage transformers.

The neutral point of the Primary star connected windings shall be solidly earthed in an accessible position and shall be easily isolated for insulation testing.

The neutral point of the secondary star connected windings shall be earthed separately via approved removable links mounted in accessible positions.

Voltage transformers shall have a rated voltage factor of 1.2 continuous 1.9 for 8 hours.

The primary windings shall be connected to the busbar (for busbar VTs) or feeder side (for line VTs) of the circuit-breaker as specified through withdrawable fuses of adequate breaking capacity with current limiting features which can be replaced with the circuit alive. These shall be so placed as not to be accessible to unauthorized persons. Calculations for selection of primary fuse rating shall be submitted.

The primary windings fuses shall comply with IEC 60282; secondary winding fuses if applicable shall comply with IEC 60269.

Labels of approved type shall be provided showing make, serial no., type, ratio, accuracy class, output, max. Continuous thermal current. Suitable measures shall be provided to ensure protection against ferro-resonance effects.

The VA burden indicated in the Tender drawings shall be the minimum and it shall be the Contractor's responsibility to ensure that the VA output fully meets the requirement of total connected burden considering the future requirement as necessary. If required, in the opinion of the Authority, to increase the VA output value to that shown in the Tenderer's proposal drawing, based on the calculations, then such increase in requirement shall be met with by the Contractor without any cost implication.

Facility and accessories, if any, shall be provided for easy disconnection of voltage transformers during HV DC testing of the cables.

It shall be arranged that replacement of one or all the voltage transformers can be carried out in situ, without complications. If, any handling devices or fixtures are required for this purpose, then one set shall be supplied within the quoted price of the switchgear.

The VTs shall be a part at the panel assembly. The VTs shall be capable of discharging the capacitance of line, cables and switchgear, which may remain connected to them during switching operations. The Contractor shall declare any limitations of the equipment for this duty.

The neutral side of all voltage transformers shall be earthed.

Voltage transformer secondary miniature circuit-breakers shall be provided as close to each voltage transformer as possible and shall be labelled to indicate their function, phase identification, etc. For single-phase voltage transformers, secondary windings shall be brought out to insulated links. Each neutral lead shall be connected together at a single earth point in the LV compartment. Earthing of the VT HV winding shall be through a link separate from the LV winding.

Separate MCB's of adequate rating shall be provided at the VT secondary for protection schemes, Instruments and BCPU

The ratio and phase angle errors of voltage transformers shall not exceed the permissible limits prescribed in the relevant Standard.

Connections to the voltage transformer primary fuses shall be capable of carrying the circuit breaker rated short-time withstand current.

Voltage transformers shall be capable of carrying continuously without injurious heating 50% burden above their rated burden and shall withstand 1.9 times rated voltage for 8 hours.

Terminal boards shall have disconnecting facility feature that will allow isolation of the burden for testing purposes with the circuit in service and on load. The above features shall all be possible without disconnecting any wiring from the terminal blocks and links.

When meters are provided with voltage signals for VTs not connected directly to the same circuit, as the current transformers then the voltage signals shall be wired through auxiliary contacts to break the circuit automatically when the circuit breaker is open.

The VT shall meet the requirements as per IEC-60044-2.

18.0 CABLE BOXES

Cable boxes shall be supplied for terminating the XLPE cables as specified separately and shall be suitable for air insulated heat shrink type termination. They shall be designed for ease of access for jointing and for connecting the cable, preferably by removing half of the box and cable gland separately.

The cable boxes shall be designed and constructed to minimize the danger of fragmentation; cast iron boxes should not be used.

Draining holes protected by 1mm aperture mesh shall be incorporated at the base of the box to ensure drainage of any condensation.

Cable sockets shall be secured and arranged so as to permit alignment with the cable core. The dimensions shall be such as not to infringe the clearance specified in the design criteria.

Gland plates for single core cables shall be made from non magnetic material. The cable box with all cable terminations in place shall withstand the specified BIL. However; any need of additional insulation barrier between phases or between phase and earthed enclosure shall be subject to FEWA approval.

The dimensions of cable boxes for three core cables shall be adequate to permit crossing of cable cores without damage to the insulation.

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 450 mm. Above this face there shall be no projection which restricts the spreading of the cores of the cable.

The cable box shall be of such a design as to prevent ingress of moisture.

Where gaskets are used they shall be of synthetic rubber/cork composition or approved material. All gaskets unless otherwise approved, shall be in one continuous piece without joints. Gaskets shall not be compressed before use.

Cable boxes for XLPE insulated multi core wire armoured power cables shall be fitted with suitable means to clamp the armour wires.

Provision shall be made for earthing the cable box.

19.0 EARTHING SYSTEM

All metal parts other than those forming part of any electrical circuit shall be earthed to the earthing system. Any necessary terminals on any part of the equipment required for this purpose shall be provided by the Manufacturer.

Earthing conductor cross section shall be in accordance with the manufacturer standards which shall be proved with necessary type test reports. However, for 11kV switchgear minimum 300 mm² cross section copper bar shall be employed for earthing. The copper earth bar shall run along the full length of the switchboard and earthing studs shall be provided at not less than two points. The frame of the draw-out circuit breaker earthing truck shall be automatically connected to the switchgears bar through substantial plug type contact when the circuit breaker is in disconnection, service and test position.

20.0 LOCKING DEVICES

Locking devices shall be provided for securing each control switch/selector switches as specified in the schedule of requirements.

Generally, minimum requirement is that locking facilities shall be applied on points of isolation and points of earthing to prevent inadvertent operation. Disconnecter and earthing switch devices shall be locked either in "open" or "closed" position and the withdrawable truck shall be locked in disconnected position.

All access doors and gates to circuit enclosures shall be locked.

21.0 ANTI-CONDENSATION HEATERS/LIGHTS

Anti-condensation heaters of an approved type shall be provided inside each control cubicle, cable boxes etc. They shall be shrouded and located so as not to cause injury to personnel or damage to equipment. The heaters shall have humidistat/hygrostat control and shall be arranged to cut off when the cubicle internal temperature/humidity exceeds safe value. 'Heater on' indication shall be provided. Also, door limit switch and internal lighting shall be provided for LV compartment.

22.0 BUS DUCT (Normally Not Applicable to this contract)

The bus duct shall be build-up on rigid supports and structures, which shall be designed under consideration of easy access and maintenance and safe operating. Busbars shall consist of electrolytic drawn copper material of sufficient strengths to withstand all operational and faulty conditions. The busbars shall be clad with solid insulation throughout. The busbar joints shall be insulated by preformed insulation and shall be detachable type suitable for inspection of bolt tightness at joints. The insulating material used shall be capable of withstanding the heating effects of the rated short time current without permanent deformation or deterioration.

Bus duct shall be pre-fabricated, sectionalised and metal enclosed to limit the effects of faults to a minimum of possible parts. The proposed busbar arrangement shall be subject to approval of FEWA.

Appropriate adapters, including flexible transition links, all necessary bolts, nuts washers and spring washers (all made of stainless steel only), for connection of the bus duct to the switching panels, etc. shall be supplied. Appropriate grounding studs with bolts and washers of stainless steel shall also be provided.

Bus ducts enclosure shall be made of aluminium and shall be dust rodent and vermin-proof and provisions shall be made against condensation, particularly if the load is switched off.

Gaskets used for the various parts of flange connections shall be heat and pressure resistant and shall be of such a material that no deterioration will occur under service conditions. Gaskets of any kind of impregnated/bonded cork are not acceptable.

Bus duct housings shall be earthed through an appropriate earth bar or equivalent to be connected along the full length of the bus-work and to be suitably connected to the earthing grid.

The bus duct shall be arranged at a suitable height, however suitable provisions shall be foreseen for cleaning, maintenance, etc., e.g. step ladders or walking platforms.

Thermal expansion of bus ducts and enclosure parts shall be compensated for with suitable bellows and fittings.

Appropriate pressure relief devices shall ensure that impermissible pressure is not built-up in case of short circuits to prevent destruction of the enclosure.

The supplies shall also include all necessary supports, structures, bushings, post insulators, conductors, etc.

The erection of the bus-duct work shall avoid any cutting, welding or drilling of material at Site.

The complete installation shall match the specified safety requirements and regulations.

Creepage distances of busbar supporting bushings shall meet requirements as specified in the Technical Data Sheets.

The bus duct length shall be as per the substation layout. The manufacturer shall supply the complete bus duct with all accessories required for the satisfactory installation of 11kV switchgears in two rooms as per the layout.

23.0 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 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 shutter, to gain access to the stationary contacts.

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

Busbar shutters shall be painted signal red, colour 537 in BS 381C and shall be clearly and indelibly labeled "BUSBARS" in large white letters. The circuit shutters shall be painted lemon colour 355 in BS 381C shall be lettered "CIRCUIT".

On bus section and bus coupler units both sets of shutters shall be painted signal red and labeled "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.

24.0 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 locations of the circuit breaker other than in the isolated condition. 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 and accessible for maintenance.

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

25.0 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 marshaling compartments or other live parts of the switchgear regularly opened during maintenance. Padlocks shall be provided as listed below. All padlocks shall be of approved type and every lock shall have unique key. Locks and keys shall be permanently identified with details to the approval of the Authority. (Three ordinary keys for each lock shall be supplied).

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

Locking the circuit breaker in the 'isolated' position.

Locking the VT in service or 'withdrawn' position.

Locking the circuit breaker control switch, ON/OFF pushbutton on the circuit breaker operating mechanism, local/Remote switch, Synchronizing selector switch etc.

Locking each of the circuit, busbar and VT shutters.

Six (6 Nos.) master keys shall also be provided for the substation. Circuit breaker control and other 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. All locks shall have unique key except for synchronizing selector switch.

Suitable wall-mounting metal cased key cabinets, complete with an approved locking method on the access doors, shall be included in the Contract, one for each switchboard. These shall have labeled hooks or other receptacles and shall be of sufficient size to house all keys and padlocks supplied with the switchgear. The cabinets shall be wall mounted in the switch rooms and should 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 25 x 20 cm. provided under this Contract. The inscriptions to be agreed later.

The cost of the cabinets, locks etc. shall be included in the cost of the switchgear.

26.0 FLOOR INSERTS

Where metal inserts or rails are required in the floors for constructing the switchboard or guiding the circuit breakers into position, these rails shall be included in the Contract and it shall be supplied in advance during building construction. 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.

27.0 CORONA

Equipment shall be designed so as to minimize corona or other electrical discharge and radio interference. Tests for corona and radio interference shall be carried out by the Contractor at his works as required by the Authority.

28.0 CIRCUIT LABELS

The switchgear shall be adequately labeled at the front and rear of the fixed portion of the equipment both in English and in Arabic, and on moving portions in a clear and concise manner. Each switch-board shall be fitted with main label in a prominent position. Circuit labels shall not be fitted on detachable doors or covers.

All circuit labels shall be engraved with white lettering on a black background, and shall have circuit names as designated in the schedule of requirements and comply with the requirement of specification.

If the internal surface of the instrument compartment is provided with white shade all the labels shall be engraved with white lettering on black background. Otherwise, the labels shall be engraved with black lettering on white background.

29.0 SPECIAL TOOLS

A detailed list shall be provided for the special tools/ accessories included in the offer. The special tools/accessories shall include all necessary items required for operational and maintenance purposes and include such items as mobile gas filling equipment with associated accessories, set of special equipment, if any, to facilitate C.T. primary injection and high voltage testing of switchgear/cables, test plugs, manual operating handles for circuit breaker, disconnect, gas monitoring systems, necessary to check gas leakage, gas density, special keys/handles etc. and any other items necessary for efficient operational and maintenance requirements. These shall be to the approval of the Authority. All such necessary items shall be deemed to be included in the contract price. Upon commissioning, these special tools and accessories shall be handed over to the Authority in good condition.

30.0 ERECTION, OPERATION & MAINTENANCE MANUALS

A comprehensive manual covering all aspects of erection, operation and maintenance of 11kV switchgears panel shall have to be submitted before two months of actual delivery of equipments. The manual shall include manufacturer's catalogues, technical data for all equipments and components, such as circuit breakers, earth switches, BCPUs, CTs, VTs, protection relays, auxiliary relays, switches, measuring and indicating instruments, interposing CTs, lamps, lamp holders, terminal blocks, resistors, thermostats, cable glands, lugs, fuses, etc. List of spares with manufacturer's code number for different equipment and components shall be included in these manuals.

A separate volume shall cover all tests reports including routine test reports for complete switchgears, CTs and VTs, relays and other accessories and other tests reports witnessed by FEWA Engineers.

31.0 SPARES & ACCESSORIES

Recommended spares and accessories shall be listed in the enclosed schedule for 11kV switchgears and control gears for satisfactory operation of the switchgears and control gears for three years after commissioning.

32.0 INSTALLATION

The installation/commissioning of the switchgear is to be supervised by original manufacturer from switchgear factory. Providing the manufacturer's specialist for the above shall be in the scope of main contractor without any contractual implication to FEWA.

33.0 TESTS

33.1 Type Tests

Type tests shall have been carried out on the switchgear components in accordance with the relevant IEC standards preferably in an independent test laboratory. Type test reports older than 6 years will not be acceptable.

Tests for internal faults as per IEC 60298 annex AA are required.

The performance of the components of the switchgear shall be substantiated by test data relevant to the particular designs offered. The type test certificates issued by Test Laboratories for the type of equipment offered or similar design shall be tabulated in the schedule enclosed with the tender.

Evidence of valid type tests shall be submitted with the Tender and shall include dielectric tests, temperature rise tests, short-time current tests and mechanical endurance tests together with evidence of tests to verify the making and breaking capacity of the included switching devices and other primary components. All other test certificates as per relevant IEC standard shall also be included.

Evidence of Type Tests should be provided, including the hydraulic system, for ambient temperature of 50°C and 100% humidity.

No additional costs will be allowed for type testing to meet specified requirements and should deficiencies in existing type test evidence occur then the cost of such additional or repeat tests as may be required by the Authority shall be deemed to be included in Contract Price, including the costs for witnessing the inspection/testing. FEWA reserves the right to ask for repetition of those type tests conducted in the

manufacturers works (if such tests are not witnessed by independent observer from internationally accredited test lab) in presence of FEWA representatives and all the cost towards testing and witnessing by FEWA is deemed to be included in the tender price.

Clause reference of type tests are listed below. Any other tests specified by the referred standard (current and future issues) but not listed shall be applicable as well.

33.1 (a) Metal enclosed switchgear.

IEC 60298

Clause

- 6.2 Dielectric tests
- 6.4 Measurement of the resistance of the circuit
- 6.5 Temperature-rise test
- 6.6 Short time and peak withstand current tests
- 6.7 Verification of the protection
- 6.8 Tightness tests
- 6.9 Electromagnetic compatibility (EMC)
- 6.10 Additional tests on aux. & control circuits
 - 6.10.3 Electrical continuity of earthed metallic parts tests
 - 6.101 Verification of making and breaking capacities
 - 6.102 Mechanical operation tests
 - 6.104 Tests on non-metallic partitions & shutters
 - 6.106 Internal arcing tests (As per IEC 62271 – 200)

33.1 (b) Circuit Breaker

IEC 62271-100

Clause

- 6.2 Dielectric tests
- 6.4 Measurement of the resistance of the main circuit
- 6.5 Temperature-rise tests
- 6.6 Short-time and peak withstand current tests
- 6.7 Verification of the degree of protection
- 6.8 Tightness tests
- 6.9 Electromagnetic compatibility (EMC) tests

- 6.101 Mechanical and environmental tests
- 6.102 Miscellaneous provisions for making and breaking tests
- 6.103 Test circuits for short circuit making and breaking tests
- 6.104 Short-circuit test quantities
- 6.105 Short-circuit test procedure
- 6.106 Basic short-circuit test-duties
- 6.107 Critical current tests
- 6.108 Single-phase and double-earth fault tests
- 6.110 Out-of-phase making and breaking tests
- 6.111 Capacitive current switching tests
- 6.112.2 Special requirement for making and breaking tests on class E2 circuit breakers

33.1 (c) Current Transformers IEC 60044-1

Type tests for Measuring Current Transformers & Protective Current transformers shall be done as per specified standards IEC 60044-1.

33.1 (d) Voltage Transformers IEC 60186 & 60044-2

Type Tests for all Voltage transformers shall be done as per specified standards.

33.2 Routine Tests

The routine tests on switchgear and accessories shall be carried out as per the latest edition of relevant IEC standard. The complete routine test report including switchgear, CTs, VTs, etc. arranged section wise for each circuit shall be submitted to FEWA approval.

The switchgear and accessories are subject to routine witness test and inspection at manufacturer's works in presence of FEWA inspectors. All the switchgear bays, BCPU's and accessories shall be offered for routine witness tests and inspection in presence of FEWA representatives. During inspection by FEWA representatives at manufacturer's works, the quantity of switchgear are ready and offered for inspection with their internal routine test report shall only be considered as inspected by FEWA. The balance items not ready during the inspection shall be subject to further inspection by FEWA. Total quantity as per BOQ may also be offered for routine witness test in different lots subject to approval of FEWA but minimum complete quantity of each substation shall be included in each lot of inspection.

The manufacturer shall submit the routine test procedure of complete switchgear, CTs, VTs, protection etc. at least 3 months before the inspection, for FEWA approval.

Also 2 sets of inspection packages (which shall include technical schedule approved set of drawings, test procedure, copies of relevant standards, day wise test program etc.) shall be submitted at least one month before each inspection.

The following routine tests shall be conducted. In addition, any other tests referred by the standard but not listed below shall also be applicable.

33.2 (a) Metal enclosed switchgear

The switchgear components under the contract shall be fully assembled including busduct at the manufacturer works and subjected to routine tests in accordance with IEC 62271, IEC 60694 and IEC 62271-100.

33.2 (b) Circuit Breaker

Routine tests shall be in accordance with IEC 62271-100 and IEC 60694. Resistance and current of all closing coils and trip coils shall be measured at nominal rated voltage and the values shall be recorded in the routine test reports.

For SF6 Gas circuit breakers the gas pressure, gas supply conditions, test connections and the measuring shall be recorded in the routine test reports.

Circuit breakers shall be tested complete with any housing of which they form an integral part.

33.2 (c) Disconnectors and Earth Switches

Routine tests to IEC 62271-102 and IEC 60265.

33.2 (d) Current Transformers

Routine Tests to all current transformers shall be done as per relevant IEC and BS standards. In addition the following tests are mandatory.

- Measurement of Secondary winding resistance at all taps.
- Measurement of magnetizing current characteristics of all CTs up to rated secondary current and up to 1.1Vk for Class PX CTs.
- Determination of Turns ratio Error for Class PX CTs
- Verification of knee-point voltage for Class PX CTs

During Factory acceptance tests, magnetization characteristics and secondary winding measurements for all ratios of all class-PX CTs shall be taken. Number of test points will be decided by FEWA engineer. For other class of CTs FEWA engineer shall decide the number but minimum 10% will be inspected.

33.2 (e) Voltage Transformers

Routine Tests applicable to Voltage Transformers as per specified standards.

33.2 (f) Insulators

Routine tests to –

- IEC 60233 (BS 4963) for hollow porcelains
- IEC 60137 for bushings

- IEC 60168 and 60273 for high voltage post insulators
- IEC 60383 and 60305 for cap and pin string insulators.

The performance of the components of the switchgear shall be substantiated by test data relevant to the particular designs offered.

Evidence of type tests shall be submitted with the Tender.

33.2 (g) Protection Relay and Controls

33.2 (h) Bay Control and protection Unit (BCPU)

One number of each type of BCPU and protection relays shall be subject to factory routine tests at manufacturer works in presence of FEWA. The complete characteristics, functions, operation of BCPU, relays are to be satisfactorily demonstrated and tested at factory. Also complete routine test reports of all BCPU's/ relays and all other calibrated protective devices shall be available at factory during witness test by FEWA for verification.

34.0 RATINGS

Switchgear and substation equipment shall be suitable for continuous operation on a 3-phase 50 Hz system of 11kV nominal voltage as per "Design Criteria" and under the climatic conditions specified. The 11kV system is earthed through Neutral Resistor 1000A, 10 sec. rated.

a) Circuit Breaker

Reference Standard IEC 62271-100

Unless otherwise approved by FEWA, Offered circuit breakers shall have the following rating:-

Electrical endurance class	E2
Mechanical endurance class	M2
Restrike performance class	C2
Nominal Voltage	11 kV
Highest Voltage for equipment	12 kV
Frequency	50 Hz
Power frequency withstand voltage	28 kV at 50HZ/(1.min)
Lightning impulse withstand voltage	75 kV at 1.2/50 μ secs.
Short-circuit breaking current at 11 kV	31.5 kA
Short-circuit making current at 11 kV	80 kA
Duration of short circuit	3 s
Nominal current, incomer (Site rating at 50°C)	2000 A
Nominal current, Bus section	

(Site rating at 50°C)	2000/2500 A
Nominal current, feeders (Site rating at 50°C)	630 A
Operating sequence	O-0.3S-CO-3 min-CO
Supply voltage	
Closing coil	110 V d.c.
Tripping coil	110 V d.c.

b) Earthing switches

Reference standard	IEC 62271-102, 60265 & 61129
Nominal Voltage	11 kV
Highest Voltage for equipment	12 kV
Frequency	50 Hz
Power frequency withstand voltage at 50HZ/(1 min).	28 kV
Lightning impulse withstand voltage at 1.2/50 μ secs	75 kV
Short-time withstand current	31.5 kA
Peak withstand current	80 kA
Rated making current	80kA
Duration of short circuit	3 s
Supply voltage	
Closing device	110 V d.c.
Opening device	110 V d.c.

c) Current Transformer CT

Reference standard	IEC 60044-1
Nominal Voltage	11 kV
Highest Voltage for equipment	12 kV
Frequency	50 Hz
Power frequency withstand voltage at 50HZ/(1.min).	28 kV
Lightning impulse withstand voltage at 1.2/50 μ secs.	75 kV
Short-time withstand current	31.5 kA
Peak withstand current	80 kA

Duration of short circuit	3 s
Primary current	*As per single line diagram.
Secondary current	1 A
Output	** VA
Accuracy class	*As per single line diagram.
d) Voltage transformer	
Reference standard	IEC 60044-2
Nominal Voltage	11 kV
Highest Voltage for equipment	12 kV
Frequency	50 Hz
Power frequency withstand voltage at 50HZ/(1 min).	28 kV
Lightning impulse withstand voltage at 1.2/50 μ secs.	75 kV
Accuracy Class	As per SLD
Over voltage factor	120% continuous/190 % for 8 Hrs.
Voltage ratio	$\frac{11}{\sqrt{3}} / \frac{0.11kV}{\sqrt{3}}$ (for line VTs)
	$\frac{11}{\sqrt{3}} / \frac{0.11}{\sqrt{3}} / \frac{0.11kV}{\sqrt{3}}$ (for bus VTs)
Output	**

* Primary current rating and accuracy class as given in the single line diagram.

** Based on the approved CT/VT calculations.

e) Busbars, Bus ducts etc.

Voltage	12 kV
Frequency	50 Hz
Power frequency withstand voltage at 50HZ/min	28 kV
Lightning impulse withstand voltage at 1.2/50 μ secs	75 kV
Rated current (Site rating at 50 ⁰ C)	2000/2500 A
Rated short time current (3 Sec.)	31.5 kA

35.0 APPLICABLE STANDARDS

Except where modified by this specification, the switchgear/accessories shall be designed, manufactured and tested in accordance with following latest IEC Standards and other publications quoted in these Standard :-

The standards used shall be those last published prior to the date of opening of tenders.

LIST OF STANDARDS

IEC 62271-100	High voltage alternating current circuit breakers.
IEC 62271-102	AC disconnectors and earthing switches.
IEC 60694	Common clauses for high voltage switchgear and control gear standards
IEC 60298	AC metal-enclosed switchgear & control gear for rated voltages above 1 kV and up to and including 72.5kV.
IEC 61128	Alternating current disconnectors bus-transfer current switching by disconnectors.
IEC 60376	Specification and acceptance of new sulphur hexafluoride.
IEC 61129	Alternating current earthing switches - Induced current switching.
IEC 60265	High voltage switches.
IEC 60137	Bushings for alternating voltages above 1000V.
IEC 60273	Characteristics of Indoor and outdoor post Insulators for systems with nominal voltages greater than 1000V.
IEC 60815	Guide for the selection of insulators in respect of polluted conditions.
IEC 60233	Tests for hollow insulators for use in electrical equipment.
IEC 60099-4	Metal - Oxide surge arresters without gaps for a.c. systems.
IEC 6099-5	Surge Arresters: Selection and application recommendation.

IEC 60044-1	Instrument transformers, Part-1 : Current Transformers.
IEC 60044-2	Instrument Transformers, Part-2: Voltage Transformers.
IEC 60044-6	Instrument Transformers, Part-6: Current Transformers.
IEC 60186	Voltage transformers.
IEC 60282	High Voltage fuses.
IEC 60269	Low Voltage fuses.
IEC 60270	Partial discharge Measurements.
IEC 61233	High Voltage Alternating current circuit Breakers – Inductive load Switching.
IEC 60059	IEC Standard Current Rating.
IEC 61633	High Voltage Alternating Current Circuit Breakers-Guide for short Circuit and Switching Test - Procedure for Metal Enclosed and Dead tank Circuit Breakers.
IEC 61634	High Voltage Switchgear and Control gear use and handling of SF6 in High voltage Switchgear and Control gear.
IEC 62215	Guide for Asymmetrical Short Circuit Breaking Test Duty T100 a.
IEC 60529	Degree of protection of enclosures.

36.0 NAME PLATE / RATING PLATE

All devices including CB, DS, ES, CT, VT, busbars etc. shall be supplied with proper name plate and rating plate. All information as per the latest edition of relevant IEC standards as applicable shall be included. Any additional information as per FEWA specific requirement shall also be included. All nameplate drawings shall be submitted to FEWA approval.

37.0 DRAWINGS/DOCUMENTS

In addition to the requirement of drawings/documents etc specified in general and special conditions of contracts, the contractor shall submit the following drawings/documents after contract award for FEWA approval for each substation. However tenderer to note that these are the minimum requirement only and any additional drawings/documents found necessary during engineering stage or site installation stage shall be submitted by the contractor without any contractual implication to FEWA.

- a) Single line diagrams indicating the rating table, CT/VT characteristics etc in not less than A2/A1 size format. CT/VT sizing calculations with complete supporting documents.
- b) Catalogues of all components in switchgear, CB etc and LV compartment including cables plugs/termination, CTs, VTs, relays, meters etc arranged section wise as technical submittal.
- c) General arrangement drawings showing sections of typical bays, floor opening drawing, foundation drawing with tolerances etc.

- d) Interlocking logic diagrams.
- e) Schematic diagrams including LV compartment layout, terminal diagrams, interface details etc.
- f) An interfacing drawing with terminal details for interfacing with 33 kV side of DT incomers, LV switchgear for auxiliary transformers, NER/NES, SCADA system etc.
- g) Wiring diagrams for the complete switchgear.
- h) Installation manual for switchgear, CTs, VTs, cable termination etc.
- i) Operation and maintenance manual.
- j) Factory test procedure for switchgear, CTs, VTs, LV compartments, relays, instruments, meters etc.
- k) Site test procedure for switchgear, CTs, VTs, LV compartment relays, instruments, meters etc.
- l) Factory test reports all components and switchgear.
- m) complete set of as manufactured drawings neatly bound in box files (6 sets) hard copies and also as rewritable soft copy in CDs (6 sets of CDs)
- n) Any other drawings/documents found necessary during engineering stage or site installation stage for proper coordination.
- o) After the “RED” marked up drawings are accepted by FEWA. The “As built” drawing (hard copies – 6 sets) and 6 sets of CD’s shall be submitted to FEWA after commissioning of the switchgear.

SECTION B
11KV CONTROL AND PROTECTION

C O N T E N T

- 1.0 General
- 2.0 Arrangement of Facilities
- 3.0 Control & selector switches
 - 3.1 Control switches
 - 3.2 Selector switches
- 3.3 Control of circuit devices
- 4.0 Instruments
- 5.0 Indicating Lamps
- 6.0 Relays, Fuses, Links and Ancillary Apparatus
 - 6.1 Relays - General requirements
 - 6.2 Fuses & Links
- 7.0 Earthing Arrangements
- 8.0 Cable Terminations
- 9.0 Protection relays & Protection Schemes
- 10.0 Bay control and protection unit (BCPU)
- 11.0 Over current and Earth Fault Relays
- 12.0 Transformer Restricted Earth Fault & Standby Earth Fault Protection
- 13.0 Flag Relays
- 14.0 Load shedding / Frequency Relays

- 15.0 Trip Relays
- 16.0 Supervision Relays
 - 16.1 Trip Circuit and Protection Supply Supervision
 - 16.2 D.C. Supply Supervision
 - 16.3 Voltage Transformer Supervision Relays
- 17.0 Routine Tests
- 18.0 Standards
- 19.0 CT/VT & Relay Setting Calculations
- 20.0 Drawings/Documents

1.0 GENERAL

This section shall be read in conjunction with technical specification – 11kV switchgear, schedule of requirements and all the components/equipments described here are to be mounted on 11kV switchgear LV compartment.

The 11kV switchgear shall have following two levels of control.

- a) Local Control: - The switchgear will be controlled from the respective LV compartment.
- b) SCADA Control: - The switchgear will be controlled from the system control centre (SCADA), U.A.Q.

2.0 Arrangement of Facilities

The 11kV Relay protection equipment shall be mounted on the switchgear LV compartment. The bay control and protection units (BCPU's) shall also be located on the LV compartment.

The Controls, analogue measurements, status, alarms, indications etc from protection relays/BCPU shall be interfaced with SCADA by means of hard wired logics.

In addition to the above, all numerical relays and BCPU's shall be compatible with Mod bus/IEC/Profi bus protocol etc for integrating with SCADA at a later date. However the communication protocol will be finalised during engineering stage. Necessary converters, if required, shall be provided by the manufacturer within the quoted price of the switchgear. Interpanel wiring to form a dual redundant communication bus by using fibre optic/communication cables shall also be carried out in the 11kV switchgear by the manufacturer for integrating with SCADA. The BCPU's shall also give a DC output for analogue measurements such as Current, Voltage, MW and MVAR etc. for interfacing with the SCADA system. Necessary wiring up to the terminal blocks shall be carried out in the 11kV switchgear by the switchgear manufacturer.

3.0 Control and Selector Switches

All switches shall be located at a convenient operating height and so constructed, mounted and wired to facilitate the maintenance of contacts without the need to disconnect wiring. Switches shall have locks incorporated in the design. Control switches must be lockable in the inactive or neutral position and selector switches in all positions. Labels shall clearly indicate all positions and function of each switch.

3.1 Control Switches

Control switches shall be of either the handle type and shall be arranged to operate clockwise when closing the circuit devices and anticlockwise when opening.

Handle type switches shall be so designed that when released by the operator the handle and mechanism shall return automatically to the centred neutral position and interrupt the supply of current to the operating mechanism of the circuit device.

All control switches shall have additional labelling giving the reference identification of the primary device.

3.2 Selector Switches

Selector switches shall have spade type handles.

Where key operated switches are specified these shall be operated by inserting and turning the key to the required position. The key shall be removable in the 'off' position only.

3.3 Control of Circuit Devices

- (a) On the LV compartment all control switches shall form part of the mimic diagram on the front sheet. The mimic diagram shall be labelled with each primary device identification reference and SCADA requirements.

A lockable Local/SCADA mode selector switch shall be mounted on the front panel for each circuit. The control switches shall be effective only in the selected position.

- (b) The circuits breakers controls is to be made effective from SCADA only when the mode selector switch on the LV compartment is in the 'SCADA' position.

4.0 Instruments

All instruments shall be of the flush mounting type and shall be fitted with non-reflecting glass.

All instruments and apparatus shall be capable of carrying their full load currents without undue heating. They shall not be damaged by the passage of fault currents within the rating of the associated switchgear through the primaries of their corresponding instrument transformers. All instruments and apparatus shall be back connected and the cases thereof shall be earthed. Means shall be provided for zero adjustment of instruments without dismantling.

Saturable interposing current transformers shall be used in all instances where the instruments or transducers are not designed to carry full fault current.

All voltage circuits to instruments shall be protected by an MCB in each phase placed as close as practicable to the instrument transformer terminals, or, where instruments are direct-connected, as close as practicable to the main connection. All power factor indicators shall have the star point of their current coils brought out to a separate terminal, which shall be connected to the star point of the instrument current transformer secondary windings.

All indicating instrument scales shall be clearly divided and indelibly marked and the pointers shall be of clean outline. The marking on the dials shall be restricted to the scale marking. Instrument transformer ratios, maker's name and accuracy grades shall not appear on the dials. Busbar voltmeters shall be calibrated while hot.

Instrument scales shall be submitted for approval. All instruments mounted on the same panel shall be of similar style and appearance. Instruments shall have 240 degree circular scales.

5.0 Indicating Lamps

All indicating lamps and lamp holder assemblies shall be suitable for continuous operation at the maximum Site ambient temperature. The lamps shall be overrated to prevent frequent failure at the operating voltage. Indicating lamps shall be of Neon type.

Indicating lamps and lamp holders shall be arranged so that replacement of lamps and the cleaning of glasses and reflectors employed can be readily effected from the front of panel, without the use of special tool. A selector switch shall be provided on the bus-section LV compartment so that all indicating lamps can be switched-off, if so desired, at unmanned substations.

To reduce heating and fouling of the panels, lamps, which are continuously illuminated shall have the minimum consumption consistent with good visibility of indications in a brightly-lit room.

Wherever a lamp is mounted on a panel a lamp test push button shall be fitted.

Indicating lamps on L.V compartment shall conform to the following standard colour code:-

<u>Colour of Glass</u>	<u>Indication</u>
Red	Device closed
Green	Device open
White	Indications normally alight
Amber	Alarm indication (on which action is necessary)
Blue	Circuit earthed

6.0 Relays, Fuses, Links and Ancillary Apparatus

6.1 Relays - General requirements

Protective relays shall comply generally with the requirements of IEC 60255 or BS 142 or other approved standards and shall be contained in dustproof flush mounted cases with transparent fronts and semi gloss bezels. The minimum mounting height of relays shall be such that it provides easy viewing/resetting of relay flag indications, easy checking and maintenance of relays, but shall not be less than 600 mm from the floor level in any case.

The relays shall be of the withdrawable and modern numerical type with substantial field experience.

Static relays will only be considered where a particular type/field proven numerical relay is not available. In case of solid state and microprocessor based relays, steps shall be taken to protect the relay circuitry from externally impressed transient voltages which could reach the circuitry via connections to instrument transformers or to the section dc systems. Static and microprocessor based relays shall comply with the Impulse withstand and high frequency disturbance tests specified in Appendix E of IEC publication 255-4 or equivalent standard and Type test reports covering these tests for all these relays shall be provided.

Separate test facilities by means of front test sockets shall be provided for each current and voltage transformer secondary circuit so as to give access for safely testing of protective relays, meters and associated circuits on load. This requirement is additional to any permanently connected injection test scheme or locally mounted CT/VT test links.

Each current transformer circuit shall be earthed through a removable link at one point only.

If any form of modern modular electronic relays or systems are provided, for which specialised test blocks or test plugs are available, these should be provided for each complete relay or scheme. If any other specialized test blocks are required to obviate any disturbance to external wiring during testing, monitoring of currents or voltages or to enable secondary injection testing to be carried out, these shall also be provided.

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. Connection lead for connecting PC to relay for testing purpose shall be supplied at least two sets per substation within the quoted price.

Test facilities shall be provided for testing of signalling schemes between substations. These facilities shall include all features necessary to permit testing with feeder in service, with minimum risk of unwanted tripping.

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 auxiliary supply voltage, rated current/voltage, type, make, catalogue No. Sl. No. etc.

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.

Relay equipment incorporating electronic devices shall be arranged to jack-in and have positive means of retaining them correctly in the service position. Equipment incorporating telephone type or other plug in relays should have similar facilities.

Relays which initiate tripping of more than one circuit breaker shall distinctively coloured and provided with a warning label to avoid incorrect tripping during testing.

All relays which are connected to complete either the tripping circuit of circuit breaker or the coil circuit of an auxiliary tripping relay shall be provided with approved operation indicators. Indicators shall also be provided on 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 kind, 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.

All tripping and intertripping relays shall be of high speed and high burden type.

In order to minimise the effects of electrolysis, operation indicator coils and dc relay operating coils shall be so placed in the circuit that they are not connected to the positive pole of the battery except through contacts which are normally open and shall wherever possible be continuously connected to the negative pole of the battery, by use of resistors if necessary.

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 the adequacy of CT and VT rating shall be submitted to the Authority for approval. In the event that the rating of the VT or CT proposed is insufficient to accommodate the connected burden, protection and metering requirement in accordance with this specification, the supplier shall supply the CT and VT with the necessary increased capacity at no extra cost to FEWA. All necessary design calculations for C.T. /V.T. shall be submitted within one (1) month of Contract award.

The supplier/relay manufacturer shall provide all necessary literature, methods for checking CTs & VTs requirements, calculated relay setting of the supplied protection relays.

The supplier/manufacturer of the relaying equipment shall arrange, if required, to carry out site tests required for the determination of correct relay functioning and settings of special protections such as digital feeder differential protection, transformer protection, busbar protection etc. and sufficient advance information shall be given by the Supplier in such cases. The Supplier shall co-ordinate all such site testing and all test equipment required for site testing and commissioning.

The Supplier shall provide only protection relays and equipment, which are supported by guaranteed works' routine test certificates issued by the manufacturers.

The Supplier shall provide electrical protection relay data to include manufacturer, type designation, characteristic details and ranges to be used, on per circuit basis.

The use of permanently energised relays shall be kept to a minimum and where approved these shall be of a type having a low burden, to prevent drain on the battery.

Relays associated with the three phases shall be marked with the appropriate phase identification and the fuses and links shall also be suitably labelled. In addition to the labelling to identify relays on the front of panels, all relays and components shall be identified from the rear of the panels.

6.2 Fuses / Links & MCB's

Isolating links, MCBs' of approved type shall be provided on each panel to facilitate the isolation of all sources of electrical potential to permit testing or other work on the panel without danger to personnel or interference with similar circuits on other panels. Carriers and bases of links shall be of moulded plastic material, coloured white. Fixed portion of the links shall be shrouded.

Trip and intertrip isolating links shall be provided in series with all tripping relay contacts. These links shall be mounted at the front of the relay panels so as to be easily accessible during relay testing.

Links in current transformer circuits shall be of the bolted type having size M6 hexagon nuts. M5 size may be used provided the material used is phosphor bronze or stainless steel.

The miniature circuit breakers shall be used in relay / control / switchgear panels for d.c. supplies, VT secondary supplies and heating / lighting circuits. The MCBs' shall comply with IEC 947-2 or BS-3871 and be fitted with over current releases of both thermal and instantaneous type. Single, double or triple pole MCBs' may be used where appropriate and tripping of one pole shall cause tripping of all associated poles. All MCBs' shall be fixed with auxiliary contacts for alarm/interlocking purpose.

The Supplier shall ensure satisfactory time and current grading with other MCBs' or fuses. 2 spare MCBs'/fuses of each type/rating shall be provided to FEWA without any extra cost.

The use of fuses instead of MCB's, in general will not be preferred and shall be subject to Authority's approval, wherever required to be used.

All fuse/links/MCBs' shall be grouped and spaced according to their function in order to facilitate identification with distinct segregation between Main and backup protection.

Resistance boxes shall be so mounted inside the cubicle that their adjustment screws are on a vertical and accessible face. Resistances shall be provided with stud terminals.

7.0 Earthing Arrangements

Busbar protection panels shall be provided with copper earth bar of a sectional area of not less than 150 mm² run along the bottom of the panels with provisions at each end to be connected to the adjacent panel and can be joint together to form a common bus. Common earthing bus thus formed shall be connected to the station earthing system at two points via copper earthing connection of size not less than 150 mm². Metal cases of instruments and metal bases of relays on the panels shall be connected to the bar by conductors of a sectional area of not less than 2.5 mm².

Current transformer and voltage transformer secondary circuits shall be complete in themselves and shall be earthed at one point only, through links clearly labelled and mounted in an accessible position. Each separate circuit shall be earthed through a separate link, suitably labelled. The links shall be of the bolted type, having M6 nuts and provision for attaching test leads. The material used shall be phosphor bronze or stainless steel.

The earth links for busbar protection current transformers secondary circuits shall be mounted inside the bus bar protection panels. Earth links for all other current transformer secondary circuits shall be mounted at the switchgear LV compartment.

All panel doors shall be earthed through flexible copper braided wires of proper size.

For voltage transformers consisting of single phase units, separate earth links for each secondary winding shall be provided and shall be situated at the voltage transformer. For other voltage transformers the earth links shall be mounted inside the relay panels.

8.0 Cable Terminations

For the reception of external multi-core cables removable gland plates shall be provided.

All cables shall enter vertically from below and at their point of entry to the equipment they shall be sealed by fitted boards. These shall be of an approved, non-flammable, insulating, and vermin proof material. Cable glands and conduits shall project at least 20 mm above the gland plate to prevent any moisture on the plate draining into cable crutches.

9.0 Protection relays & Protection Schemes

Specific requirements of protection schemes/relays are detailed below, but the Supplier shall ensure that the relays for each application have an adequate range of adjustment to allow all likely settings to be made for proper protection co-ordination purposes.

In general all the protective devices will be static and numerical types and comply with the following standard specifications:

(i) Environmental withstand

- Temperature

IEC 60068-2-1	Transit and storage -25°C to +70°C
Operating	-55°C to +70°C

- Humidity

IEC 60068-2-3	56 days (at 93% RH and +40°C)
---------------	-------------------------------

- Enclosure Protection

IEC 60529	IP50 (Dust Protected)
-----------	-----------------------

- Vibration

BS 142 Section 2.2	Category S2, 0.59 between 10 Hz and 300 Hz
--------------------	---

(ii) Voltage withstand

- Insulation

IEC 60255-5

- High Voltage Impulse

IEC 60255-5

- High Frequency Disturbance

IEC 255-6 Class III

- (iii) All numerical relays and devices with communication facilities shall be compatible with the SCADA and communication protocol implemented in the FEWA system.

10.0 Bay Control and Protection Unit (BCPU)

The Bay Control and protection unit being the backbone of protection, operation and control of the 11kV switchgears must provide a high availability and reliability compared to the conventional system.

The Bay control and protection unit shall be of modular construction and shall have provisions for connecting it to SCADA via a local area network (LAN) and shall be based on the microprocessor Technology and real time operating system. The unit shall have minimum of three years service record in Gulf countries.

Bay Control and Protection units shall be provided with time synchronization from GPS receiver; antenna, connecting cables etc. shall be supplied under the scope of this tender.

All input and out put signals terminals for connections to switchgears and other associated equipment are to include isolation/shorting/test socket facilities as appropriate, for testing purpose and auxiliary relays as other devices, where necessary to provide a galvanic isolation of signals. Power supply of the BCPU is to be derived from the substation 110vdc supply. Unless otherwise approved, BCPUs shall have dual power supply being fed from redundant DC power supply coming from the station battery. The power supply shall have test terminals for all the voltages used in the system. Each BCPU is to include the interface for the LAN to connect to the SCADA system.

The BCPU shall individually programmable for integrated functions such as protection, control, interlocking, logic, metering without transducers and status/event/alarm acquisition in addition to executing commands from SCADA.

Fault in a unit has to be indicated by the illumination of red LED on the front edge of the unit.

The BCPUs shall be such a way that the time for fault tracing and replacement of a faulty unit shall be reduced to a minimum.

Maintenance, replacement, modification or extension of any one unit should not force a shutdown of complete system and should not unsettle/disturb previously configured units. BCPUs shall retain the configuration in the event of a power supply failure and should restore without any configuration on re-download requirement

Generally one BCPU shall be provided per bay; all the features in BCPUs of typical bays shall be identical and shall be easily interchangeable.

The BCPU shall perform all bay internal programs, protections, command sequences, collection of signals and information, outputs of commands and signal processing required for the different switchgear units of corresponding bays.

Following tasks shall be performed as minimum:

- Protection
- Measurements.
- Control
- Monitoring.
- Signal acquisition.
- Data processing.
- Data communication to the SCADA system.
- Generation of group signals.
- Self monitoring routines.
- Mimic display
- Local HMI
- Fault and event records

The control and protection units should be placed together with all necessary input/output equipments in LV compartment of 11kV switchgear.

The protection functions and control functions inside each BCPU shall be carried out independently.

The BCPU shall be provided with functions for self supervision and test. Each circuit board shall contain circuits for automatic testing of its own function.

The functions and design of switchgear interlocking system shall be hardware interlocking with parallel copper cabling and shall be extremely reliable and safe.

Check before operate procedure shall be applied for the operation of circuit breakers. Prefect collection and processing of all switchgear positions must be ensured at all time and unclear information, such as intermediate switchgear positions, switchgear fault, faulty data transfer etc., must never allow switching operations. Control, regulation and synchronizing functions shall require prefect collection and processing of all information of substation. The information must be up to date and valid. Maloperation of control and regulation facilities such as on load switching of an isolator, switching on in asynchronous state etc. shall be avoided.

PROTECTION FUNCTIONS.

The BCPU shall have the following protection functions as minimum.

- Three phase over current and earth fault (Definite time and Inverse Time) (50/50N, 51/51N)
- Three phase Directional Current and Directional earth fault protections (Inverse –time)(67/67N)
- Thermal overload protection.

- Under / Over voltage protection (27/59)
- Directional power protection. (32)
- Other protection functions as detailed in schedule of requirements and manufacturer standard shall also be included.

For inverse over current and earth fault protection (including directional) the characteristics shall be selectable (NI, VI, EI etc). Also for directional earth fault protection, polarizing voltage shall derive internally in BCPU as the VTs do not have open delta windings.

MEASUREMENT FUNCTIONS

- Line currents, three phases with maximum demand indication.
- Phase voltages, three phases.
- Frequency.
- From the measured quantities the following shall be derived and displayed.
- Line voltages, three phases.
- Apparent, Active and Reactive power (MW, MVA & MVA)
- Power factor.
- Active and Reactive energy (MW Hr & MVA Hr)

CONTROLS

- 1 CB close / open control.
- 2 Isolator close/open control (if applicable).

For CB close and open controls dedicated push buttons in HMI shall be used.

MONITORING / SUPERVISION.

- Trip circuit supervision in preclose and post close conditions of CB, and continuous monitoring of CB trip circuit.
- Operational measured values V, I, f, etc.
- Monitoring the status of all devices in the switchgear.
- Continuous self supervision with LED indication and a separate watch dog contact to indicate BCPU failure.
- Self monitoring and self diagnostic includes but not limited to the following
- Power supply voltages.
- Operational reliability of modules.
- Common output & execution.
- Binary I/O cards.
- Software sequences.
- Memory on system startup and restart.
- Serial connections.
- Any other hardware and software of BCPU.
- Fault recording function with supervision of trip current and time in all phases, voltages, fault and event records etc.

Each BCPU shall have a human machine interface (HMI) unit through which all the functions can be established.

The HMI shall have large liquid crystal display (LCD) to indicate all the measured values, status indications, protection settings, fault facilities etc.

A mimic diagram (SLD) shall be provided in the BCPU LCD to clearly indicate the status of all the following devices.

- Circuit breaker in test or service position.
- Circuit breaker in closed or open position.
- Line earth switch in close or open position.
- VTs position and CTs.
- Busbar name, identification Nos etc.
- Measured values etc.

A set of user programmable LEDS (minimum 6 nos) shall be provided and programmed and labeled as required by FEWA (eg: various trips, external trips, CB conditions, faults etc as required by FEWA) and the exact requirement of LED's shall be decided during engineering stage.

Minimum 2 Nos. Binary I/O board with 32 inputs and outputs and 1No. analog I/O board with 4 inputs and outputs shall be provided in each feeder and the exact requirement will be finalized during engineering stage. All cost towards providing any additional Binary I/O boards or analog I/O boards required during engineering stage to complete the interfacing/scheme requirements is deemed to be included in the overall quoted price.

Dedicated push buttons shall be provided for the open and close control of circuit breaker.

Additional push buttons shall be provided for the parameterization of protection functions etc.

Configuration/modification of all protection settings, reading measurements, modifications of other settings, enabling/disabling functions etc shall be possible through HMI without using a PC.

Additional two LED indications shall be provided in the front of BCPU to indicate the conditions of BCPU i.e. healthy or fault conditions.

A front port shall be provided for connecting to a local PC.

11.0 Over current and Earth Fault protection in BCPU

The phase over current and earth fault over current protection function shall be integrated in the bay control and protection unit (BCPU). All BCPU's shall be provided with high set instantaneous features in all poles. These protection functions shall be of multi characteristics type.

BCPU should have adjustable settings for both operating current and time, the design of the BCPU being such that the setting adjustments can be carried out on load without taking the BCPU out of service.

Directional over current relays, and directional earth fault relays, where specified, shall have a characteristic angle suitable for the application, which shall be to the approval of the Authority. Directional elements associated with directional earth fault relays shall employ residual voltage for polarising. Bi-directional feature is required. Also it shall be possible to bypass the directionality of all directional protective at site if required by FEWA.

For transformer feeders specified with directional relays on the secondary side, depending on the transformer vector group, the directional relay elements shall be compensated such that the maximum torque occurs when the current lags the system phase to neutral voltage by 45 degrees. Positive operating torque shall be assured for line voltages down to 5 percent rated voltage. The relay elements shall utilize current from one phase and voltages from the other two phases for this purpose.

Each of the IDMT elements shall have separate trip and alarm contacts and separate trip-indicators. The high set elements shall also have separate trip contacts.

12.0 Transformer Restricted Earth Fault & Standby Earth Fault Protection

Transformer LV restricted earth fault protection using high impedance relays shall be provided on all transformers. The protection shall be connected to class PX current transformers on the transformer neutral connections and on to the line current-transformers of similar characteristics. The line current-transformers shall be of different core for differential and restricted earth fault protections.

The scheme shall be designed and applied such that the primary fault setting for 11kV faults shall be between 10% and 25% of the minimum current available for an earth fault at the transformer terminals.

The rated stability limit of the protection shall not be less than the maximum through fault current, which for the purposes of calculation shall be taken as 16 times the rated current of the protected winding of the transformers.

All necessary stabilising/shunt resistors of adequate rating and non-linear over voltage protection resistors shall be included.

Full design calculations for the application of the protection and for associated current transformers shall be submitted, where earth fault protection is employed for the winding of a transformer which is earthed directly or through an earthing device, the Supplier shall submit the magnetising characteristics curve of REF CT's and the output burden requirement for the stand by earth fault CT's to Authority at an early stage of contract so as to coordinate with the power transformer manufacturer. Standby earth fault protection shall be obtained from a second current transformer having a primary current rating of the winding of the power transformer with which the standby earth fault current transformer is associated.

Separate relays shall be provided for SBEF and REF protection.

The CT characteristics for differential protection relays shall be provided by 11kV switchgear manufacturer as required by FEWA/differential relay manufacturer.

13.0 Flag Relays

All necessary flag indication, tripping relays and alarm relays associated with buchholz protection, oil & winding temperature protection and pressure relief protection etc shall be provided, mounted and connected.

14.0 Load – Shedding / Frequency Relay

A single numeric frequency relay shall be provided per 11 kV busbar section for load shedding purposes. The frequency relay shall be installed completely wired and tested with the load shedding equipment.

The frequency relay shall have 4 independent adjustable tripping stages with over-or under-frequency settings between 45 Hz and 55 Hz in steps of 0.01 Hz as well as a rate-of-change (df/dt) and time settings of 0.1 - 99.99 s in steps smaller than or equal to 10 ms.

The relay shall display the actual frequency measured. The accuracy of the frequency measurement elements shall be ± 0.005 Hz at rated frequency.

The relay shall have built-in self-monitoring system and shall be largely insensitive to voltage fluctuation, harmonics and system transients.

The power supply for the relay and the load shedding equipment shall be provided from the station dc supplies.

Under-frequency relays should be provided with a communication port to provide a virtual connection to SCADA. This facility should include parameter download to and retrieval of internal data from the frequency relays.

A five (5) position stay-put switch shall be provided for each outgoing load feeder for facilitating its disconnection under any one of 4 different stage groups of the load shedding scheme. In the 5th position of the switch, the feeder shall be kept out from the trip of the load-shedding scheme under any of the stage groups.

15.0 Trip Relays

Following shall be the main features of a high speed tripping relays:

All tripping relays shall be of the heavy duty type suitable for panel mounting and shall have operating coils which are rated sufficiently to operate in conjunction with series flag relays.

If necessary, normally closed contacts in series with the relay operating coil, shall be delayed for a period which will allow series flag relays to operate satisfactorily. All other tripping contacts should be instantaneous i.e. no intentional time delay.

The operating time shall not exceed 10 milliseconds at rated voltage.

The operating range of the relay shall be from 70% to 120% of rated voltage.

Electrical reset facilities shall be available for operation, from remote and supervisory controls.

High speed tripping relays shall prevent closing of the associated circuit breakers until reset.

Wherever the tripping relay contacts need to break the d.c. current, sufficiently rated magnetic blow out contacts or such approved means shall be used.

16.0 Supervision Relays

16.1 Trip Circuit and Protection Supply Supervision

The trip circuit supervision function shall be part of Bay control and protection unit provided in the switchgear.

Trip circuit supervision relays shall be provided to monitor each of the trip circuits of all 11kV circuit breakers and each relay shall have sufficient contacts for visual/audible alarm and indication purposes.

The trip circuit supervision scheme shall provide continuous supervision of the trip circuits of the circuit breaker in either the open or closed position and independent of local or remote selection at the local operating position.

Relay elements shall be delayed on drop-off to prevent false alarms during faults on dc wiring on adjacent circuits, or due to operation of a trip relay contact.

Series resistances shall be provided in trip supervision circuits to prevent maltripping a circuit breaker if a relay element is short circuited.

Relay alarm elements shall be equipped with hand resetting flag indicators.

16.2 D.C. Supply Supervision

Supervision relays are required for each protection supply, Main protection, Back-up and Trip Relay Reset. Similarly for each trip circuit supply and for each alarm/indications supply.

These supervision relays are to be independent of alarms from the trip circuit supervision scheme so that the operator can clearly differentiate via the available alarms between loss of supply due to a blown fuse / tripped MCB and failure of a trip circuits supervision /faulty supervision wiring.

16.3 Voltage Transformer Supervision Relays

In addition to the V.T. no volt relays, the following V.T. supervision relays shall be provided:

- A V.T. fuse fail detector relay mounted in the LV compartment for alarms and interlocking purposes, to detect failure of all fuses, including, for those schemes with the V.T. secondary yellow phase earthed, the neutral fuse.
- A 3 phase V.T. supply monitoring relay mounted in the LV compartment to detect loss of protection supply for such equipment as directional over current protection. This relay should give an alarm when the circuit breaker is closed and one or more phases of the V.T. output are dead.

17.0 Routine Tests

- 1) All relays, BCPUs and associated equipment shall be routine tested to prove the quality and accuracy. Routine tests shall be in accordance with IEC. 60255 (BS. 5992 and 142), supplemented by additional tests as is considered necessary by the Authority. Routine tests reports shall be submitted for each relay and piece of equipment. The reports shall record all measurements taken during the tests.

- 2) The Authority reserves the right to attend detailed testing and inspection of some type of relays and BCPUs at relay factory. This shall be included in the tender quoted price. However the cost towards airfare, hotel accommodation etc. for attending such inspection by FEWA Engineers shall be borne by the Authority.

18.0 Standards

IEC 60255	Electrical Protection Relays
BS 142	Electrical Protection Relays
IEC 60044-1	Current Transformers
IEC 60044-2	Voltage Transformers
BS 3938	Current Transformers
IEC 6044-6	Current Transformers

19.0 CT/VT & Relay Setting Calculation

The relay manufacturer shall submit all CT & VT calculations along with all supporting documents for FEWA approval at an early stage of contract award.

20.0 Drawings/Documents

In addition to the requirement of drawings/documents specified in general and special conditions of contract (Vol. 1) and general requirement specification the contractor shall submit the following drawings/documents for FEWA approval for each substation separately. However tenderer to note that these are the minimum requirement only and any additional drawings/documents required during engineering stage or site installation stage shall be submitted by the contractor without any contractual implication to FEWA.

- a) Technical submittal for all components including BCPUs, relays, meters, instruments and all internal components.
- b) CT/VT design calculation.
- c) General arrangement of all panels, floor opening, loads etc.
- d) Schematic diagrams (typical for preliminary approval) including panel internal arrangement, terminal diagram, interface details etc.
- e) Co-ordinated schematic diagrams of control and protection indicating interface terminal nos, drawing reference (For each bay separately)
- f) Interface drawing with 33kV side of distribution transformers, auxiliary transformers, NER/NES etc.
- g) Installation manual.
- h) Operation and maintenance manual.

- i) Factory test procedure for all components.
- j) Site test procedure for all components.
- k) Factory tests reports for all relays, meters, instruments, components, panels etc.
- l) Final complete set of as manufactured drawings/documents neatly bound in box files and also as rewritable soft copy in CDs.
- m) Relay BCPUs software CDs for site testing.
- n) Any other drawings/documents required during engineering stage or site installation stage for proper co-ordination.

11KV SWITCH GEAR

CONTENT

- 1.0 11kV Incomer (33/11kV power transformer circuit)
- 2.0 Aux. Transformer feeder
- 3.0 11kV Bus Section, Bus Riser & Bus V.T's.
- 4.0 11kV, 630A Cable feeder with metering
- 5.0 11kV, 630A f OHL feeder with metering
- 6.0 11kV, 630A cable feeder
- 7.0 11kV, 630A OHL feeder
- 8.0 11kV, 1250 A Capacitor feeder
- 8.0 C.T/Relay/BCPU requirements
- 9.0 Coordination requirements
- 10.0 Bay control & protection unit (BCPU)
- 11.0 Small wiring.
- 12.0 Accessories
- 13.0 Miscellaneous items
- 14.0 11kV Switchgear equipment manufacturer
- 15.0 Factory Tests

1. 11KV INCOMER (FROM 33/11KV , 20 /28 MVA TRANSFORMER)

One panel structure and enclosure assembly with supports, Busbar compartments, Circuit breaker compartment, LV compartment, V.T Compartment, Cable termination compartment, earthing, mechanical operating/indicating devices, interlocks, LV compartment with all wiring, MCBs, fuses, links, aux. Relays, supervision relays, heater, humidistat, indication lamps, control and selector switches, local/remote switch, inter locking facilities, VT supervision relays, volt meter with selector switch, terminal blocks, ICTs/IVTs etc. as required for the complete bay and interfacing with SCADA, control and protection and HV side requirement etc.

The panel shall be suitable for connecting to 20/28 MVA Power Transformer in accordance with the drawing and shall comprise and not be limited to the following.

- a) One set of 3 phase, 2000A site rated busbars in a busbar chamber.
- b) One 3 phase 2000A (site rating) circuit breaker on draw out truck complete with auxiliary switches, closing and shunt trip mechanism of the motor wound spring charged type and panel complete with all interlocks, shutters and locking facilities. Circuit breaker chamber should be of SF6 gas insulated/ vacuum type.
- c) One set of current transformers as shown in the single line diagram on each phase, suitable for the following purposes.
 - i) Transformer differential protection - 1800- 1200/1A, CLPX
 - ii) Transformer REF protection - 1800-1200/1A, CLPX
 - iii) BCPU & Instruments - 1800-1200/1A, CL 5P20
 - iv) Metering (SCADA) - 1800-1200/1A, Class 0.2S
- d) One set of three single-phase Voltage transformers with ratio $11\text{kV}/\sqrt{3}$ to $110\text{V}/\sqrt{3}$, withdrawable voltage transformer (star/star) class 0.2, and connected to the cable side of circuit breaker through current limiting type fuses.
- e) Integral control and protection compartment comprising following:
 - Local/Remote selector switch (lockable).
 - CB open/neutral/close control switch (lockable).
 - One voltmeter scaled 0-15kV with seven position selector switch.
 - Emergency Pushbutton (shrouded).
 - Neon lamp indication that the circuit is alive for each phase (R, Y, B) separate lamp shall be provided).
 - Indicating lamp for spring charged, Heater 'ON' etc. with lamp test facility. (Colours are subject to FEWA approval).
 - Bay control and protection unit (BCPU) for the following functions:-
 - 1) Primary current value for all phases with Maximum Thermal demand Indication
 - 2) Primary voltage value for all phase to phase and phase to neutral values.
 - 3) MW and MVAR values.
 - 4) MWhr. and MVARHr. values.
 - 5) Power factor and Frequency values.

- 6) Directional over current and directional earth fault protection with high set feature, IDMT OC & EF with highest feature.
 - 7) Thermal overload protection.
 - 8) Trip circuit supervision.
 - 9) Mimic Diagram
 - 10) Trip current and time measurement
 - 11) Fault records/event records
 - 12) Sufficient nos. of binary I/O's for all status / control / alarms etc.
- One (1) separate Numerical type Instantaneous high impedance REF relay with stabilizing/shunt resistor, metrosils etc.
 - One (1) separate Numerical type single pole standby earth fault relay with two stages. (Characteristics of both stages shall be selectable time delay relays etc.)
 - Auxiliary interposing relays as required for SCADA command receipt and breaker operation and alarms/status etc. transfer to SCADA information.
 - 1 No. Master protection trip relay hand and electrical reset type with flag indication
 - 1 No. Master protection trip relay with hand reset type with flag indication.
 - 2 Nos. Protection supply supervision relays.
 - 2 Nos. BCPUs supply supervision relays.
 - 1 No. Close supply supervision relay.
 - 1 No. Trip supply supervision relay.
 - 1 No. alarm/indication supply supervision relay.
 - 1 No. protection reset push button.
 - Intertrip send/receive relays as required. (2 ITR & 1 ITS).
 - Relay/meter test blocks, sockets/facilities as necessary for the above BCPUs/relay/meters.
 - All other necessary control/selector switches, fuses/MCB's, auxiliary relays, glands, gland plates, interposing transformers, links, terminals, labels, test points, wiring, bus wiring etc. to complete the scheme.
 - Anti condensation heater(s) with MCB protection and humidistat control for the HV cable and LV compartments with heater ON indication.
 - Illumination lamp with door operated limit switch.
 - One external mimic diagram (colour as per relevant voltage clause) with semaphore/LED indicators for CB truck in test/service position, CB open/close, ES open/close, VT truck open/close etc.
- f) Integral manual earthing switch with suitable interlocks to avoid earthing of live circuit. The interlocks shall be fail safe during auxiliary supply failure.
 - g) One complete set of miscellaneous items required for the safe and efficient operation of the switchgear including labels for the panel (circuit) in the front and back, equivalent labels, independently lockable shutters over busbars, cable and voltage transformer spouts (where appropriate), terminal boxes for multicore cables, busbar end covers or links to adjacent switch panel as appropriate etc.
 - h) Cable terminating chambers shall be designed to accommodate three (3) 11kV cables per phase for cable size up to 1C x 630 sq.mm. Cu. XLPE cables.

- i) All SCADA requirements to connect and integrate switchboard with System Control Centre are to be included.

2. AUXILIARY TRANSFORMER FEEDER

One panel structure and enclosure assembly with supports, Busbar compartments, Circuit breaker compartment, LV compartment, V.T Compartment, Cable termination compartment, earthing, mechanical operating/indicating devices, interlocks, LV compartment with all wiring, MCBs, fuses, links, aux. Relays, supervision relays, heater, humidistat, indication lamps, control and selector switches, local/remote switch, inter locking facilities, terminal blocks, ICTs/ IVTs etc. as required for the complete bay and interfacing with SCADA, control and protection and LV side requirement etc.

The panel shall be suitable for feeding the station auxiliary transformer in accordance with drawings and shall comprise, but not be limited to the following.

- a) One set of 3 phase, 2000A site rated busbars in a busbar chamber.
- b) One 3 phase, 630A (site rating) circuit breaker on draw out truck complete with auxiliary switches closing and shunt trip mechanism of the motor wound spring charged type and panel complete with all interlocks, shutters, locking facilities. Circuit breaker chamber should be of SF6 gas insulated/ vacuum type.
- c) One set of 3 phase current transformers as shown in the single line diagrams, on each phase, suitable for the following purposes.
- | | | |
|------|--|---------------------------------------|
| i) | Transformer delta winding REF protection | - 600/1A, CL PX. |
| ii) | BCPU & Instruments | - 600/1A, CL 5P20. |
| iii) | SCADA Measurement | - 600/1, Class 0.2S
(Y phase only) |
- d) Integral control and protection compartment comprising following:
- Local/Remote selector switch (lockable).
 - CB open/neutral/close control switch (lockable).
 - Neon lamp indication that the circuit is alive for each phase (R, Y, B) separate lamp shall be provided).
 - Emergency Pushbutton (shrouded).
 - Indicating lamps for spring charged, Heater 'ON' etc. with lamp test facility. (Colours are subject to FEWA approval).
 - Bay control and protection unit (BCPU) for the following functions:-
- 1) Primary current value for all phases with Maximum Thermal demand indication.
 - 2) Over current and earth fault protection with high set feature.
 - 3) Trip circuit supervision.
 - 4) Mimic Diagram.
 - 5) Trip current and time measurement.
 - 6) Fault records/event records.
 - 7) Sufficient nos. of binary I/O's for all status / control / alarms etc.

- One (1) separate Numerical type Instantaneous high impedance REF relay with stabilizing/shunt resistor, metrosils etc.
 - Auxiliary interposing relays as required for SCADA command receipt and breaker operation and alarms/status etc..to SCADA information.
 - 1 No. Master protection trip relay (hand and electrical reset type with flag indication).
 - 1 No. Protection supply supervision relay.
 - 2 Nos. BCPUs supply supervision relays.
 - 1 No. Close supply supervision relay.
 - 1 No. Trip supply supervision relay.
 - 1 No. alarm/indication supply supervision relay.
 - 1 No. protection reset push button.
 - Intertrip send/receive relays as required.
 - Relay/meter test socket/facilities as necessary for the above relays/ meters.
 - All other necessary control/selector switches, fuses/mcbs, auxiliary relays, glands, gland plates, interposing transformers if required, links, terminals, labels, test point, wiring, bus wiring etc. to complete the scheme.
 - Anti-condensation heaters with MCB protection and humidistat control for the H.V, cable and L.V. compartment with heater 'on' indication.
 - Illumination lamp with door operated limit switch.
 - One external mimic diagram (colour as per relevant voltage clause) with semaphore/LED indicated for CB truck in test/service position, CB open/ close, ES open/close etc.
- f) Cable termination chamber complete with cable box suitable for accommodating 11kV cables for cable size up to 3C x 300 sq.mm.Cu. XLPE cables.
- g) Integral manual earthing switch with suitable interlock to avoid earthing of live circuit. The interlocks shall be fail safe during auxiliary supply failure.
- h) One complete set of miscellaneous items required for the safe and efficient operation of the switchgear including labels for the panel (circuit) in the front and back, equipment labels, independently lockable shutters over busbars, cables and voltage transformer spouts (where appropriate), terminal boxes for multicore cables, busbar end covers or links to adjacent switch panel as appropriate, etc.
- i) All SCADA requirements to connect and integrate switchboard with CCC/RTU to be included.

3. 11KV BUS SECTION BREAKER PANEL, BUS RISER AND BUS V.T.s

One panel structure and enclosure assembly with supports, Busbar compartments, Circuit breaker compartment, LV compartment, V.T Compartment, earthing, mechanical operating/indicating devices, interlocks, LV compartment with all wiring, MCBs, fuses, links, aux. Relays, supervision relays, heater, humidistat, indication lamps, control and selector switches, local/remote switch, inter locking facilities, VT supervision relays, terminal blocks, ICTs/IVTs etc. as required for the complete bay and interfacing with scada, control and protection etc.

The panel shall be equipped as a bus section panel in accordance with drawing and shall comprise but not limited to the following:

- a) One set of 3 phase, 2000A site rated busbars in a busbar chamber.
- b) One 3 phase 2000A (site rating) circuit breaker on draw out truck complete with auxiliary switches, closing and shunt trip mechanism of the meter wound spring charged type and panel complete with all interlocks, shutters and locking facilities. Circuit breaker chamber should be of SF6 gas insulated/ vacuum type.
- c) Sets of 3 phase current transformers on either side of CB as shown in the single line diagram, suitable for the following purposes.
 - i) Over current and Earth fault protection - 2000-1600/1, CL 5P20
 - ii) Instrument - 2000-1600/1, Class 0.5 (all phases)
- d) One (1) set of three single phase voltage transformers for each bus complete with ratio $11\text{kV}/\sqrt{3}$ to $110\text{V}/\sqrt{3}$, withdrawable voltage transformer (star/star) with class 0.2/0.2 and connected to the busbar through current limiting type fuses as shown in the single line diagram. However for Bus-2 (2 bus VTs required, one in each room).
- e) Integral control/protection compartment comprising the following:
 - Local/Remote selector switch (lockable).
 - CB open/neutral/close control switch (lockable).
 - Emergency Pushbutton (shrouded).
 - Five position (stage 1/2/3/4 and OFF) stay-put switch for under frequency load shedding scheme.
 - Four voltmeters (0-15kV) with individual selector switch for each bus voltages (two in bus section -1 for Bus-1 and Bus-2 and two in Bus section-2 for Bus-2 & Bus-3) as applicable.
 - Neon lamp indication that the Bus is alive. (for each bus and each phase).
 - Indicating lamps for Spring charged, Heater 'ON' etc. with lamp test facility. (Colours are subject to FEWA approval).
 - Bay control and protection unit (BCPU) for the following functions:-
 - 1) Primary current value for all phases with Maximum Thermal demand indication.
 - 2) Primary voltage value for all phase/phase and phase/neutral values.
 - 3) MW and MVAR values.
 - 4) Power factor and Frequency values.
 - 5) Directional Over current and Directional earth fault protection with high set feature. (Bi directional).
 - 6) Trip circuit supervision.
 - 7) OC & EF protection with highest features.
 - 8) Mimic Diagram.
 - 9) Trip current and time measurement.
 - 10) Fault records/event records.
 - 11) Sufficient nos. of binary I/O's for all status / control / alarms etc.

- 1 No. Numerical frequency relay per 11kV busbar section (ie. Three (3) relays for one substation).
 - Multi contact relays to reset, trip from single command from scada.
 - Auxiliary/interposing relays as required for scada command receipt and breaker operation and alarm transfer to scada information.
 - 1 No. Master protection trip relay (hand and electrical reset type with flag indication)
 - 1 No. Trip relay reset supervision relay.
 - 2 Nos. BCPU supply supervision relays.
 - 1 No. Close supply supervision relay.
 - 1 No. Trip supply supervision relay.
 - 1 No. alarm/indication supply supervision relay.
 - 1 No. protection reset push button.
 - Relay/meter test blocks sockets/facilities as necessary for the above relays/BCPU/meters.
 - All other necessary fuses/mcbs, auxiliary relay glands, gland plates, interposing transformers if required, links, terminals, labels, test points, wiring, bus wiring etc. to complete the scheme.
 - Anti-condensation heaters with MCB protection and humidistat control for the HV cable and LV compartments with heater 'ON' indication.
 - Illumination lamp with door operated limit switch
- f) Integral manual busbar earth switch for each bus with interlocks with all the breakers in that section, bus voltage etc. The interlocks shall be fail safe during auxiliary supply failure.
- g) One complete set of miscellaneous items required for the safe and efficient operation of the switchgear including labels for the panel (circuit) in the front and back, equipment labels, independently lockable shutters over busbars, cable and voltage transformer spouts (where appropriate), terminal boxes for multicore cables, busbar end cover or links to adjacent switch panel as appropriate etc.
- h) All SCADA requirements to connect and integrate switchboard with CCC/RTU to be included.

4. 11KV CABLE FEEDER WITH METERING

One panel structure and enclosure assembly with supports, Busbar compartments, Circuit breaker compartment, LV compartment, V.T Compartment, Cable termination compartment, earthing, mechanical operating/indicating devices, interlocks, LV compartment with all wiring, MCBs, fuses, links, aux. Relays, supervision relays, heater, humidistat, indication lamps, control and selector switches, local/remote switch, inter locking facilities, VT supervision relays, terminal blocks, ICTs/IVTs etc. as required for the complete bay and interfacing with SCADA, control and protection requirement etc.

The panel shall be suitable for cable feeder in accordance with drawings and shall comprise, but not be limited to the following.

- a) One set of 3 phase, 2000A site rated busbars in a busbar chamber.
- b) One 3 phase, 630A (site rating) circuit breaker on draw out truck complete with auxiliary switches closing and shunt trip mechanism of the motor wound

spring charged type and panel complete with all interlocks, shutters, locking facilities.

- c) One set of 3 phase current transformers as shown in the single line diagrams, on each phase, suitable for the following purposes.
- i) Over current and Earth fault protection & BCPU - 600/1, CL 5P20.
 - ii) Tariff metering (All 3 phases) - 600/1A, CL. 0.2S
 - iii) SCADA Measurement - 600/1, Class 0.2S
(Y phase only)
- d) One set of three single-phase Voltage transformers with ratio 11kV/1.732 to 110V/1.732, withdrawable voltage transformer (star/star) class 0.2, 50VA and connected to the cable side of circuit breaker through current limiting type fuses.
- e) Integral control and protection compartment comprising following:
- Local/Remote selector switch (lockable).
 - CB open/neutral/close control switch (lockable).
 - Emergency Pushbutton (shrouded).
 - Five position (stage 1/2/3/4 and OFF) stay-put switch for under frequency load shedding scheme.
 - Neon lamp indicator that the circuit is live.
 - Indicating lamps for spring charged, Heater 'ON' etc. with lamp test facility. (Colours are subject to FEWA approval).
 - Bay control and protection unit (BCPU) for the following functions:-
 - 1. Primary current value for all phases including MD.
 - 2. Primary voltage value for all phase/phase and phase/neutral values.
 - 3. MW and MVAR values.
 - 5. Power factor and Frequency values.
 - 6. Energy measurement MWhr, MVAR Hr & MVA Hr.
 - 7. Over current and earth fault protection with high set feature.
 - 8. Trip circuit supervision.
 - 9. Mimic Diagram.
 - 10. Trip current and time measurement.
 - 11. Fault records/event records
 - 12. Sufficient nos. of binary I/O's for all status / control / alarms etc.
 - Auxiliary interposing relays as required for scada command receipt and breaker operation and alarms/status etc.to scada information.
 - 1 No. Master protection trip relay (hand and electrical reset type with flag indication)
 - 1 No. self reset trip relay for UF trip
 - 2 Nos. BCPU supply supervision relays.
 - 1 No. Close supply supervision relay.
 - 1 No. Trip supply supervision relay.
 - 1 No. alarm/indication supply supervision relay.
 - 1 No. protection reset push button.
 - Relay/meter test blocks, sockets/facilities as necessary for the above BCPU/relay/meters.

- All other necessary control/selector switches, fuses/ mcbs, auxiliary relays, glands, gland plates, interposing transformers if required, links, terminals, labels, test point, wiring, bus wiring etc. to complete the scheme.
Anti-condensation heaters with MCB protection and humidistat control for the H.V, cable and L.V. compartment with heater 'on' indication.
 - Illumination lamp with door operated limit switch.
- f) Cable termination chamber complete with cable box suitable for accommodating Two (2) nos. 11kV cables of size up to 400 Sq.mm per phase.
 - g) Integral manual earthing switch with suitable interlocks to avoid earthing of live circuit. The interlocks shall be fail safe during auxiliary supply failure.
 - h) One complete set of miscellaneous items required for the safe and efficient operation of the switchgear including labels for the panel (circuit) in the front and back, equipment labels, independently lockable shutters over busbars, cables and voltage transformer spouts (where appropriate), terminal boxes for multicore cables, busbar end covers or links to adjacent switch panel as appropriate, etc.
 - i) All SCADA requirements to connect and integrate switchboard with CCC/RTU to be included.

5. 11KV, 630A OHL FEEDER WITH METERING:

Same as relevant cable feeder with energy meter but with the following additional items

- Core balance CTs with suitable ratio class of accuracy for protection.
- BCPU shall have additional SEF protection function.

6. 11KV, 630A CABLE FEEDER

One panel structure and enclosure assembly with supports, Busbar compartments, Circuit breaker compartment, LV compartment, V.T Compartment, earthing, mechanical operating/indicating devices, interlocks, LV compartment with all wiring, MCBs, fuses, links, aux. Relays, supervision relays, heater, humidistat, indication lamps, control and selector switches, local/remote switch, inter locking facilities, VT supervision relays, terminal blocks, ICTs/ IVTs etc. as required for the complete bay and interfacing with scada, control and protection requirements etc.

The panel shall be suitable for feeding underground cable circuit in accordance with the single line diagram:

- a) One set of 3 phase, 2000A site rated busbars in a busbar chamber.
- b) One 3 phase, 630A (site rating) circuit breaker on draw out truck complete with auxiliary switches, closing and shunt trip mechanism of the motor wound spring charged type and panel complete with all interlocks, shutters and locking facilities. Circuit breaker chamber should be SF6 gas insulated/ vacuum type.
- c) One set of 3 phase current transformers as shown in the single line diagram, on each phase suitable for the following purposes. The Instrument and metering Current transformers shall be of 1 Phase and it shall be mounted on "Yellow" phase.

- i) Over current and Earth fault protection, BCPU - 600/1 CL 5P20
 - ii) Instruments and Metering
(Single phase CT on "Y" phase) - 600/1 CL 0.2S
- d) Integral control and protection compartment comprising following:
- Local/Remote selector switch (lockable).
 - CB open/neutral/close control switch (lockable).
 - Emergency Pushbutton (shrouded).
 - Five position (stage 1/2/3/4 and OFF) stay-put switch for under frequency load shedding scheme.
 - Neon lamp indication that the circuit is alive for each phase (R, Y, B) separate lamp shall be provided).
 - Indicating lamp for spring charged, Heater 'ON' etc. with lamp test facility. (Colours are subject to FEWA approval).
 - Bay control and protection unit (BCPU) for the following functions:-
 - 1) Primary current value for all phases with Maximum Thermal demand indication.
 - 2) Primary voltage value for all phase/phase and phase/neutral values.
 - 3) MW and MVAR values.
 - 4) Power factor and Frequency values.
 - 5) Over current and earth fault protection with high set feature.
 - 6) Trip circuit supervision.
 - 7) Mimic Diagram.
 - 8) Trip current and time measurement.
 - 9) Fault records/event records.
 - 10) Sufficient nos. of binary I/O's for all status / control / alarms etc.
 - Auxiliary interposing relays as required for scada command receipt and breaker operation and alarms/status etc.to scada information.
 - 1 No. Master protection trip relay (hand and electrical reset type with flag indication).
 - 1 No. self reset trip relay for UF trip.
 - 2 Nos. BCPU supply supervision relays.
 - 1 No. Close supply supervision relay.
 - 1 No. Trip supply supervision relay.
 - 1 No. alarm/indication supply supervision relay.
 - 1 No. protection reset push button.
 - Relay/meter test blocks, sockets/facilities as necessary for the above BCPU/relay/meters.
 - All other necessary control/selector switches, fuses/mcbs, auxiliary relays, glands, gland plates, interposing transformers, links, terminals, labels, test points, wiring, bus wiring etc. to complete the scheme.
 - Anti condensation heater(s) with MCB protection and humidistat control for the HV, cable and LV compartments with heater ON indication.
 - Illumination lamp with door operated limit switch.
- f) Integral manual earthing switch with suitable interlocks to avoid earthing of live circuit. The interlocks shall be fail safe during auxiliary supply failure.
- g) Cable termination chamber complete with terminal arrangement suitable for accommodating 2 nos. outgoing 11kV XLPE insulated aluminium/copper conductor cables of size up to 400 Sq.mm

- h) One complete set of miscellaneous items required for the safe and efficient operation of the switchgear including labels for the panel (circuit) in the front and back, equipment labels, independently lockable shutters over busbars, cable and voltage transformer spouts (where appropriate), terminal boxes for multicore cables, busbar end cover or links to adjacent switch panel as appropriate etc.
- i) All SACAD requirements to connect and integrate switchboard with CCC/RTU to be included.

7. 11KV, 630A OHL FEEDER:

Same as relevant cable feeder but with the following additional items.

- Core balance CTs with suitable ratio class of accuracy for protection.
- BCPU shall have additional SEF protection function.

8. 11kV, 1250 A CAPACITOR FEDER

One panel structure and enclosure assembly with supports, Busbar compartments, Circuit breaker compartment, LV compartment, V.T Compartment, Cable termination compartment, earthing, mechanical operating/indicating devices, interlocks, LV compartment with all wiring, MCBs, fuses, links, aux. Relays, supervision relays, heater, humidistat, indication lamps, control and selector switches, local/remote switch, inter locking facilities, VT supervision relays, terminal blocks, ICTs/ IVTs etc. as required for the complete bay and interfacing with scada, control and protection and capacitor bank etc.

The panel shall be suitable for capacitor bank in accordance with drawings and shall comprise, but not be limited to the following.

- a) One set of 3 phase, 2000A site rated busbars in a busbar chamber.
- b) One 3 phase, 1250A (site rating) circuit breaker on draw out truck complete with auxiliary switches closing and shunt trip mechanism of the motor wound spring charged type and panel complete with all interlocks, shutters, locking facilities.
- c) One set of 3 phase current transformers as shown in the single line diagrams, on each phase, suitable for the following purposes.
 - i) BCPU & Instruments - 600/1, CL 5P20.
 - ii) Capacitor protection - 600/1, CL 5P20.
 - iii) Measurement SCADA - 600/1, Class 0.2S (all phases)
- d) One set of three single-phase Voltage transformers with ratio 11kV/1.732 to 110V/1.732, withdrawable voltage transformer (star/star) class 0.2, and connected to the cable side of circuit breaker through current limiting type fuses.

- e) Integral control and protection compartment comprising following:
- Local/Remote selector switch (lockable).
 - CB open/neutral/close control switch (lockable).
 - Emergency Pushbutton (shrouded).
 - Neon lamp indication that the circuit is alive for each phase (R, Y, B) separate lamp shall be provided.
 - Indicating lamps for Spring charged, Heater 'ON' etc. with lamp test facility. (Colours are subject to FEWA approval).
 - One voltmeter 0 - 15kV with seven position selector switch.
 - Bay control and protection unit (BCPU) for the following functions:-
 1. Primary current value for all phases with Maximum Thermal demand indication.
 2. Primary voltage value for all phase/phase and phase/neutral values.
 3. MW and MVAR values.
 4. MWhr. and MVARHr.values.
 5. Power factor and Frequency values.
 6. Over current protection with high set feature.
 7. Earth fault protection with high set feature.
 8. Over voltage protection.
 9. Under voltage protection.
 10. Trip circuit supervision.
 11. Mimic Diagram.
 12. Trip current and time measurement.
 13. Fault records/event records
 14. Sufficient nos. of binary I/O's for all status / control / alarms etc.
 - One (1) separate Numerical type capacitor bank protection relay with harmonic protection, reconnection block, interlocks etc. (SPAJ, 160 C of ABB make or equivalent).
 - One (1) separate Numerical type neutral unbalance protection relay (SPAJ, 160 C of ABB make or equivalent).
 - Auxiliary interposing relays as required for scada command receipt and breaker operation and alarms/status etc.to scada information.
 - 1 No. Master protection trip relay (hand and electrical reset type with flag indication)
 - 1 No. Master protection trip relay with hand reset type with flag indication.

- 2 Nos. Protection supply supervision relays.
 - 2 Nos. BCPU supply supervision relays.
 - 1 No. Close supply supervision relay.
 - 1 No. Trip supply supervision relay.
 - 1 No. alarm/indication supply supervision relay.
 - 1 No. protection reset push button.
 - Relay/meter test blocks, sockets/facilities as necessary for the above BCPU/relay/meters.
 - All other necessary control/selecter switches, fuses/MCB's, auxiliary relays, glands, gland plates, interposing transformers if required, links, terminals, labels, test point, wiring, bus wiring etc. to complete the scheme.
 - Anti-condensation heaters with MCB protection and humidistat control for the H.V, cable and L.V. compartment with heater 'on' indication.
 - Illumination lamp with door operated limit switch.
- f) Cable termination chamber complete with cable box suitable for accommodating Two (2) 11kV cables per phase for cable size up to 1C x 630 sq.mm.Cu. XLPE cables.
- g) Integral manual earthing switch with suitable interlocks to avoid earthing of live circuit. The interlocks shall be fail safe during auxiliary supply failure.
- h) One complete set of miscellaneous items required for the safe and efficient operation of the switchgear including labels for the panel (circuit) in the front and back, equipment labels, independently lockable shutters over busbars, cables and voltage transformer spouts (where appropriate), terminal boxes for multicore cables, busbar end covers or links to adjacent switch panel as appropriate, etc.
- i) All scada requirements to connect and integrate switchboard with CCC/RTU to be included.

9. CT/RELAY/BCPU REQUIREMENTS

The quantities and ratios of CT specified are the minimum requirement only. The actual, CT ratio and all other parameters shall be based on detailed design and FEWA requirement and shall be provided without any cost implication to the Authority.

The indicated BCPU/relay requirements are the minimum requirement only. Any other relays, auxiliary relays, contactors, switches, components etc found required during the detailed design stage shall be provided without any extra cost implication to the authority.

10. COORDINATION REQUIREMENTS

- a) Each of the above equipments shall form one integrated board at site and hence all requirements to achieve their interconnection as one system are to be included.
- b) Co-ordinated drawings and schematic diagrams for above boards shall be submitted for review and approval.
 - a) For detailed SCADA requirements, to be provided in 11kV switchgear, refer relevant section of specification.

11. BAY CONTROL AND PROTECTION UNIT (BCPU)

Bay control and protection (multi-function) and control unit with proved field experience from reputed manufacturer shall be offered and subject to FEWA approval.

The following are to be included within the overall quoted price.

- a) Spare units for each type (minimum one no. each type) shall be provided.
- b) Satisfactory training for FEWA staff at site.
- c) Extended warranty for 2 years shall be provided.

Emergency local electrical control with all interlocks as back-up for any failure of unit or DC supply shall be provided per substation.

Unit shall be suitable to satisfy all scada requirements.

Unit shall be fail safe.

All setting shall be changed from unit – keys on the front without using PC.

Software CD's, special connectors etc with connecting cables shall be supplied within the quoted price.

12. SMALL WIRING

The size of wiring cores shall be selected with due regard to thermal requirements, voltage drop and mechanical strength. Cores shall be multi and terminated with crimped terminations. The minimum size of wiring apparatus shall be not less than 2.5 sq.mm for all circuits and insulation grade not to be less than 600/1000 volts.

Colours

Small wiring colour code shall be as follows:

A.C. circuits	:	Black or phase coloured (R, Y, B, Black)
D.C. circuits	:	Grey
Earth circuits	:	Green-Yellow
Trip circuits	:	Grey
CT circuits & VT circuits	:	Red, Yellow, Blue, Black

Markings

- a) General Circuits
Circuit numbers marked on ferrules read from technical outwards on all wires.
- b) C.Ts & VT circuits
Circuit number marked on ferrules with circuit identification e.g.
- | | |
|-------------------------|-----|
| Over current protection | 'C' |
| Main protection | 'A' |
| Metering | 'D' |
- Same coloured wiring for all phases are not acceptable.
- c) Trip circuits
Circuit numbers marked on white ferrules and addition red ferrule marked 'Trip'.
- d) Kind of Wiring
All wiring shall be neatly run and securely fixed in cleats, bunched in neat forms or run in approved wiring troughs or non-corrodible tubes. The number of wires in any one bunch or tube shall not exceed 20 and the number in a trough shall not exceed the number and size for which it is designed

13.0 Accessories

13.1 Signal Lamps

The following coloured cover to be generally used for various indications.

Circuit breaker on	:	Red
Circuit breaker off	:	Green
Lockout relay operated	:	Amber
Heater supply on	:	White
D.C. supply fail	:	Amber
Earth switch on	:	Red
Earth switch off	:	Green
Main supply fails	:	Amber
Spring charged	:	Blue

13.2 Heaters:

The rating minimum to be	
Circuit breaker space	: 150 watts (Minimum)
Cable box	: 100 watts (Minimum)
Instrument space	: 50 watts

14. MISCELLANEOUS ITEMS

The following items shall be supplied within the overall quoted price of 11kV switchgear for each substation.

- Wheeled ladder with locking facility suitable for working at panel top.
- Wheeled ladder with two steps and locking facility suitable for working at LV compartment.
- Two (2) sets of primary injection test probes suitable for the maximum current rating suitable for all types of panels.

- Four (4) sets of secondary injection test probes.
- One (1) set of complete operational tools with toolbox.
- One (1) set of special tools with toolbox.
- One (1) set of HV test probe/adopter/connecting cables etc.
- If SF6 circuit breakers are supplied, one set (1) of SF6 gas handling plant with necessary adapters for filling/evacuating SF6 gas in the circuit breakers shall be supplied.

15. 11KV SWITCHGEAR EQUIPMENT MANUFACTURER

The tenderer shall quote 11kV switchgear manufactured and tested in Europe, North America and Japan only, the offered switchgear shall have minimum three (3) years experience record in UAE/GCC.

16. FACTORYTESTS

The contractor shall make provision in the offer to bear all costs that are incurred in carrying out the factory acceptance tests/inspection to the satisfaction of FEWA. However, cost towards travel, accommodation etc. of FEWA representative shall not be included in the tendered price.

11kV SWITCHGEAR

S.No.	Description	Unit	Required	Tendered
1.	Common Features			
	Manufacturer			
	Country of origin			
	Type			
	Standards		IEC	
	Operating voltage (U)	kV	11	
	Rated voltage	kV	12	
	Rated short-time withstand current (3s)	kA	31.5	
	Rated peak withstand current	kA	80	
	Material of enclosures		Aluminum alloy/ steel	
	Average thickness	mm		
	Weight per feeder	kg		
	Heaviest part	kg		
	Lightning impulse withstand voltage (peak) (1.2/50 μ sec.)	kV	75	
	Power frequency withstand voltage (1 min)	kV	28	
	External Colour of switchgear		RAL 7032	
	Heat losses per feeder at rated power	kW		
	Design maintenance period	Years		
	First commercial operation of the offered type			
	- in the year of			
	- according to the attached reference list/ sheet		Ref : Number	

DATE : _____

TENDERER'S STAMP & SIGNATURE : _____

S.No.	Description	Unit	Required	Tendered
	Interlocks for safe operation	Yes/No	Yes	
	<u>Busbars/Bus ducts</u>			
	- Common enclosed phases	Yes/No		
	- Material of Busbar		Copper	
	- Busbars Insulated	Yes/No		
	- Shape of Busbar			
	- Cross section area	Sq.mm		
	- Dimension of Busbar			
	a) Rectangular	mm xmm		
	b) Tubular (Inner dia/outer dia)	mm/mm		
	- Insulation material of Insulators and spouts			
	- Rated continuous current at 40° C (IEC rating)			
	- Rated continuous current at 50°C (Site rating)		2000/2500 A	
	Maximum Temperature rise (at hottest point) at rated bus bar current and at ambient of 50 deg. C	°C		
	40 deg. C	°C		
	- Minimum distance between			
	a) Phase busbar and earth	mm		
	b) Busbar phases	mm		

DATE : _____

TENDERER'S STAMP & SIGNATURE : _____

S.No.	Description	Unit	Required	Tendered
2.	CIRCUIT BREAKERS			
	Type			
	Standards		IEC 62271-100	
	Ratings :			
	Rated current of Out going feeders/aux. transformer feeders at 40 ⁰ C	A		
	Rated current of Out going feeders/aux. transformer feeders at 50 ⁰ C	A	630 A	
	Rated current of Incomer at 40 ⁰ C	A		
	Rated current of Incomer at 50 ⁰ C	A	2000/2500A	
	Rated current Bus section/Bus riser at 40 ⁰ C	A		
	Rated current Bus section/Bus riser at 50 ⁰ C	A	2000/2500 A	
	Rated short circuit breaking current			
	- AC component, r.m.s. value	kA		
	- percentage of DC component	%		
	- DC time constant	ms		
	Rated short time withstand current (3s)	kA	31.5	
	Rated short circuit making current	kA	80	
	Rated charging breaking current	A		
	Rated small inductive breaking current A	A		
	Rated out-of-phase breaking current	A		
	Maximum inductive breaking current for switching shunt reactors under site conditions	A		
	No. of series breaks per phase	No.		
	Contact material of Breakers (Kind of alloy)			
	Test reports for the all above values attached	Yes/No	yes	

DATE : _____

TENDERER'S STAMP & SIGNATURE : _____

S.No.	Description	Unit	Required	Tendered
	Weight of complete circuit breaker	Kg.		
	First-pole-to-clear-factor		1.5	
	Rated operating sequence of CB			
	Closing time	ms		
	- tolerances	ms		
	Dead time	ms		
	- tolerances	ms		
	Break time	ms		
	- tolerances	ms		
	Make time	ms		
	- tolerances	ms		
	Arcing time	ms		
	- tolerances	ms		
	Number of possible operations under			
	- rated short circuit breaking current			
	- rated normal current			
	Material of main contacts			
	Arcing quenching medium			
	Auxiliary contacts :			
	- number (NO/NC)	pcs	As per scheme requirements	
	- wiping contacts	pcs		
	- voltage	V DC	110	

DATE : _____

TENDERER'S STAMP & SIGNATURE : _____

S.No.	Description	Unit	Required	Tendered
	<u>APPLICABLE FOR SF6 CIRCUIT BREAKER</u>			
	Rated pressure of SF6 gas	bar		
	Maximum admissible pressure of SF6 gas	bar		
	Minimum admissible pressure of SF6 gas	bar		
	Maximum annual gas loss	%		
	Volume of gas per phase	Litre		
	Total volume of gas	Litre		
	Rated arc quenching pressure of SF6 gas	bar		
	<u>APPLICABLE FOR VACUUM CIRCUIT BREAKER</u>			
	Rated pressure of vacuum chamber	bar		
	Max. allowable pressure of vacuum chamber	bar		
	Operating mechanism:			
	- for closing			
	- for opening			
	<u>Closing coil:</u>			
	- number	pcs	1	
	- Normal voltage	V		
	- Min. Voltage	V		
	- rated power each	W		
	Material of main contacts			
	<u>Trip coil:</u>			
	- numbers	pcs	1	

DATE : _____

TENDERER'S STAMP & SIGNATURE : _____

S.No.	Description	Unit	Required	Tendered
	- Normal voltage	V		
	- Min. Voltage	V		
	- rated power each	W		
	Motor voltage	V DC	110	
	Motor power	W		
	Spring charging time	Sec.		
	Hand operating facility	Yes/No	Yes	
	Satisfactory experience	Years		
3.	EARTHING SWITCH			
	Type			
	Standards		IEC62271-102	
	Earth switch endurance class			
	Ratings			
	Rated short-time withstand current (3 s)	Ka	31.5	
	Rated peak withstand current	Ka	80	
	Rated making current	Ka	80	
	Material and size of earthing contacts			
	Auxiliary contacts :			
	- number (NO/NC)	pcs/pcs	As required	
	- voltage	V DC	110	

DATE : _____

TENDERER'S STAMP & SIGNATURE : _____

S.No.	Description	Unit	Required	Tendered
4,0	<u>CURRENT TRANSFORMERS</u>			
	To be filled-in for each type of C.T. (C.T. data are subject to separate approval)			
	- Manufacturer			
	- Country of Manufacturer			
	- Type			
4.1	<u>INCOMER</u>			
a)	Transformer differential protection			
	- Ratio	A	1600-1200/1	
	- Class		CLPX	
	- Vk : Rated knee point voltage	V		
	- Magnetizing current at Vk/2	Ma		
	- Rct : secondary winding resistance at 75 ⁰ C	ohm		
b)	Transformer REF. Protection			
	- Ratio	A	1600-1200/1	
	- Class		CLPX	
	- Vk : Rated knee point voltage	V		
	- Magnetizing current at Vk/2	Ma		
	- Rct : secondary winding resistance at 75 ⁰ C	ohm		
c)	Bay control & Protection unit			
	- Ratio	A	1600-1200/1	
	- Class		5P20	
	- Burden	VA		
d)	Metering SCADA			
	- Ratio	A	1600-1200/1	
	- Class		0.2S	
	- Burden	VA		

DATE : _____ TENDERER'S STAMP & SIGNATURE : _____

S.No.	Description	Unit	Required	Tendered
4.2	<u>AUXILIARY TRANSFORMER</u>			
a)	Transformer REF. protection			
	- Ratio	A	600/1	
	- Class		CLPX	
	- Vk : Rated knee point voltage	V		
	- Magnetizing current at Vk/2	Ma		
	- Rct : secondary winding resistance at 75° C	ohm		
b)	Bay control & Protection unit			
	- Ratio	A	600/1	
	- Class		5P20	
	- Burden	VA		
c)	SCADA Measurement			
	- Ratio	A	600/1	
	- Class			
	- Burden	VA	0.2S	
4.3	<u>CABLE FEEDER WITH METERING</u>			
a)	Bay control & Protection unit			
	- Ratio	A	600/1	
	- Class		5P20	
	- Burden	VA		
b)	Metering (all three phases)			
	- Ratio	A	600/1	
	- Class		0.2 S	
	- Burden	VA		

DATE : _____

TENDERER'S STAMP & SIGNATURE : _____

S.No.	Description	Unit	Required	Tendered
c)	SCADA Measurement			
	- Ratio	A	600/1	
	- Class		0.2 S	
	- Burden	VA		
4.4	<u>CABLE FEEDER/OHL</u>			
a)	Bay control & Protection unit			
	- Ratio	A	600/1	
	- Class		5P20	
	- Burden	VA		
b)	Metering (only Y phase)			
	- Ratio	A	600/1	
	- Class		0.2 S	
	- Burden	VA		
	OHL SEF Protection			
	- Ratio	A		
	- Class		CLPX	
	- Burden	VA		
4.5	<u>BUS SECTION</u>			
a)	Bay control & Protection unit			
	- Ratio	A	2000-1600/1	
	- Class		5P20	
	- Burden	VA		

DATE : _____ TENDERER'S STAMP & SIGNATURE : _____

S.No.	Description	Unit	Required	Tendered
b)	SCADA Measurement			
	- Ratio	A	2000-1600/1	
	- Class		0.5	
	- Burden	VA		
5.	VOLTAGE TRANSFORMERS			
	To be filled-in for each type of V.T. (V.T. data are subject to separate approval)			
	- Manufacturer			
	- Country of Manufacturer			
	- Type			
	For protection & metering, synch. Purposes			
	Ratio:	VA		
	- Primary	Kv	11/√3	
	- Secondary – 1	V	110/√3	
	- Secondary – 2 (only for bus VT's)	V	110/√3	
	- Class of accuracy		0.2/0.2	
	- Rated output	VA		
	- Rated thermal burden	VA		
	- Rated voltage factor and duration			
6.	<u>LV COMPARTMENT:</u>			
	Manufacturer			
	Country of origin			
	Material		Sheet steel	
	Steel thickness (minimum):			
	- Door	mm	2.5	
	- Side/top/rear panels	mm	2.5	
	Paint colour – External		RAL 7032	
	Paint thickness (average)	Microns	90	
	Paint thickness (minimum)	Microns	80	

DATE : _____

TENDERER'S STAMP & SIGNATURE : _____

S.No.	Description	Unit	Required	Tendered
	Dimensions:			
	- Length	mm		
	- Width	mm		
	- Height	mm		
	- Total net weight	Kg.		
	Degree of protection		IP52	
	Cross section of earth bar	Sq.mm	185 min.	
	Method of mounting control switches & mimic etc.			
	Type of Terminal Blocks:			
	- CT circuits			
	- VT circuits			
	- Other circuits			
	Voltage grade of wires inside panels wiring	KV	0.6/1.0	
	Paint thickness (minimum)	Microns	80	
	Dimensions:			
	- Length	mm		
	- Width	mm		
	- Height	mm		
	- Total net weight	Kg.		
	Cross section of earth bar	Sq.mm	185 min.	
	Method of mounting control switches & mimic etc.			
	Type of Terminal Blocks:			
	- CT circuits			
	- VT circuits			
	- Other circuits			
	Voltage grade of wires inside panels wiring	KV	0.6/1.0	
	Wire cross section:			
	- CT circuits	Sq.mm	4	
	- VT & AC circuits	Sq.mm	2.5	
	- DC circuits	Sq.mm	1.5	

DATE : _____

TENDERER'S STAMP & SIGNATURE : _____

S.No.	Description	Unit	Required	Tendered
	Colour code for wiring	Yes/no	Yes	
	Shrouds for AC wiring	Yes/no	Yes	
	Segregation of wiring of each application	Yes/no	Yes	
	Heater, Humidistat, Heater on/off switch indication	Yes/no	Yes	
	Panel illumination, door switch	Yes/no	Yes	
	Socket outlet	Yes/no	Yes	
7.	<u>PROTECTION AND CONTROL (LV COMPARTMENT):</u>			
	General features:			
	Standards	IEC		
	Rated voltage (DC supply)	V	110	
	Rated current	A	1	
	Rated frequency	Hz	50	
	Insulation tests	As per technical spec.		
	Temperature range (min/max)	°C	0/50	
	Relative humidity	%	100	
	Restricted Earth Fault Protection (ANSI 64 REF):			
	Manufacturer			
	Type		Numerical	
	Country of manufacturer			
	Model designation			
	Satisfactory Service years	Years	> 3	
	Relay catalogue/literature enclosed.	Yes/no	Yes	
	DC Infeed:			
	- DC/DC converter included	Yes/no		
	- Voltage tolerance requested	%	+15,-15	
	Operating time (including trip relay):			
	- less than	ms	30	
	Thermal rating:			

DATE : _____

TENDERER'S STAMP & SIGNATURE : _____

S.No.	Description	Unit	Required	Tendered
	- continuous	x I _n	2	
	- for 1 sec.	x I _n	100	
	Auxiliary elements:			
	- Metrosil included	Yes/no	Yes	
	- series/ shunt resistor included	Yes/no	Yes	
	Harmonics filter	Yes/no	Yes	
	Segregated alarms	Yes/no	Yes	
	Voltage operated relay:	Yes/no		
	- voltage setting range	Yes/no		
	Current operated relay:	Yes/no		
	- Current setting range 5% to 110% of I _N	Yes/no	Yes	
	- in steps of	% x I _N		
	Self-monitoring	Yes/no		
	Type of mounting			
	Case size	U		
	<u>Ground Over current Relay (ANSI 51N)/ Standby Earth Fault Relay:</u>			
	Manufacturer			
	Type		Numerical	
	Country of manufacturer			
	Model designation			
	Satisfactory Service years	Years	> 3	
	Relay catalogue/literature enclosed	Yes/no	Yes	
	DC Infeed:			
	- DC/DC converter included	Yes/no		
	- Voltage tolerance requested	%	+15,-15	

DATE : _____

TENDERER'S STAMP & SIGNATURE : _____

S.No.	Description	Unit	Required	Tendered
	Thermal rating:			
	- continuous		2 x I _N	
	- for 1 s		100 x I _N	
	Characteristics (BS 142):-			
	- IDMT inverse	Yes/no	Yes	
	- very inverse	Yes/no	Yes	
	- extremely inverse	Yes/no	Yes	
	- long time inverse	Yes/no	Yes	
	- definite time	Yes/no	Yes	
	Highset element included	Yes/no	Yes	
	Current setting: earth element:			
	- Earth element : 5% to 80% of I _N	Yes/no	Yes	
	In steps of	% x I _N		
	Operating time:			
	- Continuously variable	Yes/no		
	- alternatively variable with steps smaller than 10 ms			
	Contact data:			
	- Quantity	pcs		
	- Trip	pcs		
	- Signal	pcs		

DATE : _____

TENDERER'S STAMP & SIGNATURE : _____

S.No.	Description	Unit	Required	Tendered
	Event recording/measuring values	Yes/no		
	Fault recording	Yes/no		
	Self-monitoring	Yes/no	Yes	
	Communication with DCS	Yes/no	Yes	
	Protocol			
	Type of mounting			
	Case size	U		
	Under Frequency Relay			
	Manufacturer			
	Type		Numerical	
	Country of manufacturer			
	Model designation			
	Satisfactory Service years	Years	> 3	
	Catalogue/literature enclosed	Yes/no	Yes	
	DC Infeed:			
	- DC/DC converter included	Yes/no		
	Over – or - Under frequency settings	Hz	45 to 55 In steps of 0.01 Hz	
	Independent adjustable tripping stages	Nos.	4	
	Rate – of – change (df/dt) and adjustable time settings	Yes/no	Yes	
	Adjustable time settings	Sec.	0.1 – 99.99	
	Built in self monitoring system	Yes/no	Yes	

DATE : _____

TENDERER'S STAMP & SIGNATURE : _____

S.No.	Description	Unit	Required	Tendered
	Bay Control and Protection Unit (BCPU):			
	Manufacturer			
	Type			
	Country of manufacturer			
	Model designation			
	Satisfactory Service years	Years	> 3	
	Catalogue/literature enclosed	Yes/no	Yes	
	V.T secondary voltage Input	V	110V AC	
	C.T secondary Input	A	1	
	Rated Frequency	Hz	50	
	Rated Auxiliary voltage	V	125V DC	
	Tolerance		+15%, -15%	
	Rated Burden	VA		
	All control/protection/ monitoring/ measurement /alarms/status/ indications etc. and other features are complying with specification requirements	Yes/no	Yes	
	No. of Binary I/O boards	As per scheme reqmts.	Yes	
	No. of Analog I/O boards	As per scheme reqmts.	Yes	
	No. of Power output relays	As per scheme reqmts.	Yes	
	Communication protocol	Suitable for interfacing with SCADA	Yes	

DATE : _____

TENDERER'S STAMP & SIGNATURE : _____

S.No.	Description	Unit	Required	Tendered
	Built-in event and fault recorder:			
	- Time resolution	ms	Yes	
	- Max nos. of events	Nos.		
	- Fault recording	Yes/no	Yes	
	Self-monitoring	Yes/no	Yes	
	Type of mounting			
	Case size	U		
10.	Tripping Relays:			
	Manufacturer			
	Type & model			
	Country of manufacturer			
	Satisfactorily Service years	Years	> 3	
	Catalogue/literature enclosed	Yes/no	Yes	
	Operating time at Nominal voltage	ms	<10	
	Operating time at Minimum voltage	ms	<10	
	Contacts rating:			
	- Make and carry for 3 seconds	W (DC)	7500	
	- Make and carry continuously	W (DC)	1250	
	- Break	W (DC)	1250	
	High burden type	Yes/no	Yes	
	In-built cut off contacts	Yes/no	Yes	

DATE : _____

TENDERER'S STAMP & SIGNATURE : _____

S.No.	Description	Unit	Required	Tendered
	In-built hand resettable flag	Yes/no	Yes	
	Minimum operating voltage	V DC		
	Operating current	mA		
11.	DC Supply Supervision Relays:			
	Manufacturer			
	Type			
	Country of manufacturer			
	Satisfactorily Service years	Years	> 3	
	Catalogue/literature enclosed			
	Operating time	ms		
	No. of contacts available			
	Contacts rating:			
	- Make and carry for 3 seconds	W (DC)		
	- Make and carry continuously	W (DC)		
	- Break	W (DC)		
	Inbuilt self reset reverse flag	Yes/no	Yes	
	Relay self reset type	Yes/no	Yes	
12.	Relay Test Blocks:			
	Manufacturer			
	Type			
	Country of manufacturer			
	Satisfactorily Service years	Years	> 3	
	Catalogue/literature enclosed	Yes/no	Yes	

DATE : _____

TENDERER'S STAMP & SIGNATURE : _____

S.No.	Description	Unit	Required	Tendered
14.	INDICATING INSTRUMENTS			
1.	Manufacturer/Country of Origin			
2.	Type			
3.	CT ratio/PT ratio scale ranges			
4.	Accuracy class			
5.	Dimension			
6.	Type of mounting			
7.	Applicable standard			
8.	VA Burden:			
9.	Voltmeter	VA		
10.	Catalogue/literature enclosed	Yes/No	Yes	
11.	Number of years in satisfactory service	Years	> 3 Years	

DATE : _____

TENDERER'S STAMP & SIGNATURE : _____