

**FEWA-PL-SS-E-0062 REV.0**

**TECHNICAL SPECIFICATION**

**33kV INDOOR GAS INSULATED SWITCHGEAR**

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## **33KV GAS INSULATED SWITCHGEAR**

### **1. GENERAL REQUIREMENTS**

The switchgear shall be single busbar, SF6 gas insulated, single or three phase encapsulated 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 supply Contractor shall state the test facilities provided and indicate any attachments or special equipment provided for this purpose.

Circuit breakers, disconnectors, VTs, CTs, cable termination chambers, and any other chambers and components must be capable of withstanding a gas overpressure of 130% of normal operating pressure continuously.

All grounding system, special tools and tackles, O & M manuals etc required for erection, operation, testing and maintenance of GIS shall be supplied within the quoted price. The requirements of embedded plates and channels for the GIS foundations and maintaining floor tolerances shall be provided by GIS supplier in advance as per requirement of FEWA. However, the embedded plates and channels will be supplied by the Civil Contractor. Anchoring bolts for fixing GIS shall be supplied by the GIS supplier.

### **2. CURRENT RATING**

Every current-carrying part of the switchgear including current transformers, disconnecting switches, 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 Standards. Any derating to meet Site ambient conditions shall be taken into account and declared in the Schedules.

Every part of the switchgear shall also withstand, without mechanical or thermal damage the instantaneous peak currents and rated short-time currents 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.

### **3. 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 including Distribution transformer circuits, Aux. Transformer circuits, Capacitor banks etc. shall be suitable for connecting 2 Nos. 33kV single core 500 sq.mm, Cu. XLPE cable per phase with plug-in terminations. However one cable shall be connected at present and the other cable termination shall be provided with H.V. dummy plugs within the quoted price. The incomer feeder shall be suitable for connecting 4 Nos. 33kV single core 500 sq.mm Cu. XLPE cable per phase with plug-in type cable termination. The plug-in termination suitable for the above cables, sockets, as well as dummy plugs as required shall be included in the scope of supply. However dummy plugs shall be supplied for all termination facilities for spare circuits.

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 10 kV A.C. for one minute and 10 kV D.C. for one minute.

### **4. GAS COMPARTMENTS**

The switchgear units shall be divided into several gas-filled compartments, sealed from each other by gas- tight partitions so that any leakage may be quickly localised.

Proposals for the partitioning of gas zones shall be clearly indicated on the drawings submitted with the tender.

The equipment and connections within each compartment shall be so arranged as to allow ready removal and replacement of any section with minimum isolation and disturbance of adjacent pressurised sections.

This feature should also permit the erection and testing of extension units alongside equipment already in service with the minimum of outage time being required for final connections.

The busbars of each bay shall have separate gas compartment such that any gas leakage will be localised to one bay only. Also during extension degassing of complete busbars shall not be required.

Suitable arrangements shall be provided for the thermal expansion and contraction of the busbars and busbar chambers without detriment to the current carrying capacity or gas volume.

Special attention shall be paid to the sealing of housing joints so that leakage of SF6 gas is kept to an absolute minimum.

Devices shall be provided for each gas compartment to allow for pressure relief to the switchgear room. All relief devices shall be located such that operation of the devices shall not endanger personnel working on the equipment or in the vicinity of the equipment. Where necessary the devices shall be fitted with cowls to deflect any gases or fragmented parts away from locations where personnel may be expected to be present.

Each separate compartment or gas zone must be provided with its own device for monitoring continuously the gas density. These devices shall be arranged to give individual compartment indication in the local control units and initiation of remote alarms. Means shall also be provided to facilitate the checking of moisture content and gas purity. All gas density monitors shall be temperature compensated type with sufficient No. of alarm and lockout contacts for local, remote and Scada indications.

## **5. 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 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, restriking 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 OHL shall be suitable for auto reclose duty. All circuit breakers shall be suitable for switching 20 MVAR shunt reactor and also 20 MVAR capacitor banks. Evidence shall be submitted for circuit breaker switching duty for reactive compensation system. Any over voltage protection device included for such duty shall be clearly stated in the tender offer.

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

If the bidder does not have circuit breakers of class M2 in the production range, alternately class M1 may also be offered.

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.

### **5.1. 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.

## **5.2. 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.

## **6. CIRCUIT-BREAKER OPERATING MECHANISM**

The circuit-breaker operating mechanism shall be power operated. Operation will normally be from a remote or supervisory 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 resetable 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 and solenoid operated valves, 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, there shall be sufficient energy to trip, close and then trip the circuit breaker.
- (c) Mechanical indication shall be provided to indicate the state of the spring. This indication shall be clearly visible from the front of the breaker. In addition, suitable contacts shall be provided which may be used for remote indication.
- (d) Motor charged mechanisms shall be provided with means for charging the springs by hand, and also a shrouded push- button for mechanical tripping initiation.

- (e) 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.
- (f) 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.

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 / SCADA 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 a circuit-breaker is in the open or closed, 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. Where earthing through the circuit breaker is adopted the method of earth position selection shall be arranged to disconnect the trip supply in the earth position.

## **7. DISCONNECTING DEVICES AND REMOTE OPERATION**

All circuit-breakers shall be connected to their associated busbars through disconnectors of an approved design which shall be arranged for operation whilst the busbars or feeder circuits are live. The disconnecting devices shall be suitable for remote operation and status indication shall also be provided. Disconnectors shall comply with IEC 62271-102 standard. The motor operating mechanism shall be employed for disconnectors. Also emergency hand operation facility shall be provided.

## **8. 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 disconnectors and earth switches together with selector switches to prevent local, remote/supervisory 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 and supervisory control, alarms, indications, protection and local ring main supplies.

The LV compartment shall have sufficient space to accommodate all components, 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 field wiring.

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, disconnectors, earth switches etc. shall be lockable, spring return to neutral position type ie, 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 whereas other DC wiring shall be 1.5 sq.mm grey colour wires. Also the specification for electrical small wiring and terminations enclosed in Vol. II, Sec. 3.5 are applicable for all wiring in GIS, LV compartment etc.

Colour of mimic shall be green (RAL 6024)

## **9. DISCONNECTING AND EARTHING SWITCHES**

Disconnectors and 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.

Disconnecting and earthing switches shall be arranged to permit safe maintenance of any section of the equipment when the remainder is live. Disconnecting switches shall be arranged for operation while the equipment is live, but will not be required to break current other than the charging currents of busbars and connections.

Switch mechanisms shall be so designed that the disconnector cannot be opened by forces due to currents passing through it and shall be self-locking in both the "open" and "closed" positions. The mechanism shall open and close all three phases simultaneously. Busbar disconnectors shall have the capability of loop current breaking during on load bus transfer. Local mechanical position indicators shall be provided on all switches and shall be visible from the front side of the panel.

For safe isolation and earthing of the busbars and feeders, high speed fault-making spring driven disconnector/earth switches shall be provided. The contacts shall have the same fault making capability as that of the circuit breaker.

As an alternative to the fault making earthing switches, circuit breakers may be used for the earthing, of the outgoing feeders and busbars. In such case adequate interlocking facilities

shall be provided, subject to approval of FEWA. The earth switches and disconnectors shall employ motor operation mechanism. In addition, emergency hand operation shall be provided.

## **10. INTERLOCKING**

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

- (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 which could lead to a hazardous situation to plant, equipment and personnel.
- (c) To prevent earthing of live circuit.

The interlocking scheme shall be electrical for all operational interlocks and preferably of the mechanical/key 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.

## **11. AUXILIARY SWITCHES AND CONTACTORS**

Auxiliary switches shall be provided on all circuit breakers disconnectors and earthing switches for local, remote & 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 panel 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.

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 latching relays (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 latching relay contacts, this shall be monitored and alarmed locally and for remote indication.

All repeat relays are subject to approval of FEWA.

## **12. CURRENT TRANSFORMERS**

Current transformers shall be of the toroidal core type and 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.

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 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 continuous maximum rating of at least 1.2 times the rated current.

The characteristics and capacities of current transformers used for protective gear circuits, shall be calculated by the manufacturer who shall prove by calculation the suitability of the CT's provided in conjunction with the relay 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 panels and instrumentation. All different CT ratios terminals shall be wired upto terminal block 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.

Where current transformers have to be supplied for mounting in apparatus provided under other contracts, the Contractor supplying the current transformers shall be responsible for making all necessary arrangements to ensure compatibility with the other Contractors, through the Authority.

### **13. VOLTAGE TRANSFORMERS**

Voltage transformers shall be of electromagnetic type.

They shall be a part at the panel assembly. They 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 separate earth links for each secondary shall be provided and each neutral lead shall be connected together at a single earth point in the local control cubicle. Earthing of the VT HV winding shall be through a link separate from the LV winding.

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

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 30 seconds.

It shall not be possible for the voltage transformer secondary circuits to be connected in parallel, except through interposing voltage transformers associated with synchronisation scheme to prevent any possibility back energisation through synchronising circuits.

Busbar VTs shall be connected by using motor operated isolator/3 position switches. Line VTs shall have disconnecting facilities preferred.

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.

#### **14. SF6 IMMERSSED INSULATION**

Busbars and items of switchgear shall be supported in the enclosures by insulators of materials compatible with SF6 gas and the products of gas decomposition.

Gas barrier insulators shall comply with the specified conditions for sealing of enclosures. FEWA shall be advised of design pressures used and may require test evidence to substantiate performance under extremes of differential pressure and temperature.

The insulators shall be free at all times of partial discharges at all voltage levels within the working range and shall be tested for voids and partial discharges during manufacture.

#### **15. GAS LOSSES**

The Manufacturer should be prepared to guarantee the equipment for a gas loss of not more than 1.0% per annum in any single gas compartment. In case of extensive and repeated gas leakage at any time during the warranty period, the Authority will have the right to request the contractor to replace the part of the assembly, which caused the leakage. All costs associated with such works shall be borne by the contractor.

#### **16. 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 Contractor.

Earthing conductor cross section shall be in accordance with the overall substation system calculation. However, for 33kV GIS minimum 300 mm<sup>2</sup> cross section copper bar shall be employed for earthing. The earthing shall be at not less than two points.

#### **17. LOCKING DEVICES**

Locking devices shall be provided for securing each control switch in the "neutral" position, each control selector switch in all positions and for securing each disconnecter and earthing switch operating handle in either the "open" or "closed" position.

#### **18. ANTI-CONDENSATION HEATERS/LIGHTS**

Anti-condensation heaters of an approved type shall be provided inside each control cubicle. They shall be shrouded and located so as not to cause injury to personnel or damage to equipment. The heaters shall have humidistat 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.

#### **19. GAS HANDLING EQUIPMENT**

A mobile Gas handling unit with SF6 gas shall be provided for each new substation to permit emergency topping up of gas in the switchgear in the event of leakage.

The unit shall be capable of evacuating air from the switchgear compartments and replenishing them with gas.

All necessary pipe work, flexible hoses, couplings, valves, pressure and vacuum gauges shall be included to enable interconnection between the switchgear compartments and gas handling unit.

An approved portable SF6 gas leakage detector shall also be provided for each new substation.

## **20. INSTALLATION**

The installation/commissioning of the GIS is to be supervised by original manufacturer. Providing the manufacturers specialist for the above shall be supply contractors responsibility and in accordance with general requirement specification (Volume II Section 1), scope of supply and price schedule.

## **21. TESTS**

### **21.1. 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.

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

**21.2. (a) Complete Bay**

IEC 62271-200

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
- 6.103 Pressure withstand tests for gas filled compartments
- 6.104 Tests on non-metallic partitions & shutters
- 6.106 Internal arcing tests

**(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-earthfault 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

Additionally, the circuit breaker shall comply with IEC 61233 in regard of inductive load switching.

**(c) Disconnecter & Earth Switch**

IEC 62271-102

- 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 protection
- 6.8 Tightness test
- 6.9 Electromagnetic compatibility (EMC) tests
- 6.101 Tests to prove the short-circuit making performance of earthing switches
- 6.102 Operating and mechanical endurance tests
- 6.105 Test to verify functioning of position indication

**(d) Current Transformers IEC 60044-1, 60044-6**

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

**(e) Voltage Transformers IEC 60186 & 60044-2**

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

**Routine Tests**

**(a) Complete Bay**

IEC 62271-200

Clause

- 7.1 Dielectric tests on the main circuit
- 7.2 Tests on auxiliary and control circuits
- 7.3 Measurement of the resistance of the main circuit
- 7.4 Tightness tests
- 7.5 Design and visual checks
- 7.101 Partial discharge measurement
- 7.102 Mechanical operation tests
- 7.103 Pressure tests of gas filled compartment
- 7.104 Tests of auxiliary electrical, pneumatic and hydraulic devices

Additional Tests

- Verification of the correct wiring
- Measurement of gas condition after filling (gas purity/moisture content, gas leakage/dew point etc.)
- Scheme checks including interlocks, alarms etc.

**(b) Circuit Breaker**

IEC 62271-100

**Clause**

- 7.1 Dielectric tests on the main circuit
- 7.2 Dielectric withstand tests on control and auxiliary circuits
- 7.3 Measurement of the resistance of the main circuit.
- 7.4 Tightness Test
- 7.5 Design and visual checks.
- 7.6 Mechanical operating tests (including resistance and current measurement of Closing and trip coils and checking anti-pumping function, timing etc).

**(c) Disconnectors & Earth Switch**

IEC 62771-102

**Clause**

- 7.1 Power-frequency voltage withstand dry tests on the main circuit
- 7.2 Voltage withstand tests on control and auxiliary circuits
- 7.3 Measurement of the resistance of the main circuit
- 7.5 Design and visual checks
- 7.5.1 Mechanical operation tests

**(d) CTs**

Routine Tests to all current transformers shall be done as per specified standards. In addition the following Tests are mandatory.

- Measurement of Secondary winding resistance
- Measurement of magnetizing current characteristics of all CTs
- Determination of Turns ratio Error for Class PX CTs
- Verification of knee-point voltage for Class PX CTs

**(e) Voltage and Current Transformers IEC 60044-2 & 60044-1**

Routine Tests applicable to Voltage Transformers as per specified standards.

Acceptance tests during inspection by FEWA's engineer in the works of manufacturer shall comprise all the routine tests specified for the items. Reading for magnetic characteristics for all ratios of all class CTs shall be taken. Number of test points will be decided by FEWA engineer. All class-PX CTs shall be tested for inspection. For other class of CTs & VTs FEWA engineer shall decide the number but minimum 10% will be inspected.

**(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.

## 22. RATINGS

Switchgear and substation equipment shall be suitable for continuous operation on a 3-phase 50 Hz system of 33kV nominal voltage as per "Design Criteria" and under the climatic conditions specified. The 33kV system is earthed through Neutral Resistor 1500A, 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
Voltage	36 kV
Normal current, Bus section (at 40 deg.C IEC rating)	2500 A
Normal current IBT incomer (at 40 <sup>0</sup> C IEC rating)	2500 A
Normal current, feeders (at 40 <sup>0</sup> C IEC rating)	1250 A
Frequency	50 Hz
Lighting impulse withstand voltage	170 kV
Power frequency withstand voltage	70 kV
Short-circuit making current at 36 kV	100 kA
Short-circuit breaking current at 36 kV	40 kA
First-pole-to-clear factor	1.5
Operating sequence	O-0.3S-CO-3 min-CO
Duration of short circuit	3 s
Out-of-phase breaking current (factor 2.5)	10 kA
Line charging breaking current	10 A
Cable charging breaking current	50 A
Single capacitor bank breaking current	400 A
Back to back capacitor back breaking	
Current	400 A
Shunt Reactor Switching duty	20 MV Ar

Supply voltage :	
Closing device	110 V d.c.
Opening device	110 V d.c.

b) **Disconnectors**

Reference standard	IEC 62271-102,61128
Voltage	36 kV
Lightning impulse withstand voltage	
phase to earth and between poles	170 kV
across isolating distance	195 kV
Power frequency withstand voltage	
phase to earth and between poles	70 kV
across isolating distance	80 kV
Frequency	50 Hz
Normal current, Bus section and Bus riser (at 40 <sup>0</sup> C IEC rating)	2500 A
Normal current IBT incomer (at 40 <sup>0</sup> C IEC rating)	2500 A
Normal current, feeders (at 40 <sup>0</sup> C IEC rating)	1250 A
Short-time withstand current	40 kA
Peak withstand current	100 kA
Duration of short circuit	3 s
Supply voltage	
Closing device	110 V d.c.
Opening device	110 V d.c.
Mechanical endurance	M0/M1

c) **Earthing switches**

Reference standard	IEC 62271-102 & 61129
Voltage	36 kV
Lightning impulse withstand voltage	170 kV
Power frequency withstand voltage	70 kV
Frequency	50 Hz
Short-time withstand current	40 kA
Peak withstand current	100 kA
Duration of short circuit	3 s

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Supply voltage	
Closing device	110 V d.c.
Opening device	110 V d.c.
<b>d) Fast acting earth switch</b>	
Reference standard	IEC 62271-102 & 61129
Voltage	36 kV
Lightning impulse withstand voltage	170 kV
Power frequency withstand voltage	70 kV
Frequency	50 Hz
Short-time withstand current	40 kA
Short-circuit making current at 36kV	100 kA
Duration of short circuit	3 s
Supply voltage	
Closing device	110 V d.c.
Opening device	110 V d.c.
Electrical endurance	E 2
<b>e) Current Transformer CT</b>	
Reference standard	IEC 60044-1 IEC 60044-6
Voltage	36 kV
Frequency	50 Hz
Lightning impulse withstand voltage	170 kV
Power frequency withstand voltage	70 kV
Primary current	As per single line diagram
Secondary current	1 A
Output	** VA
Short-time withstand current	40 kA
Peak withstand current	100 kA
Duration of short circuit	3 s
Accuracy class	As per single lien diagram
<b>f) Voltage transformer</b>	
Reference standard	IEC 60186 & 60044-2
Voltage	36 kV
Frequency	50 Hz

Lightning impulse withstand voltage	170 kV
Power frequency withstand voltage	70 kV
Accuracy Class	cl.0.5/3 P
Over voltage factor	120% continuous/190 % for 30 s
Voltage ratio	$\sqrt{3} \sqrt{3}$ <u>330.11kV</u>
Output	**

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

\*\* Based on the approved CT/VT calculations.

### g) Busbars

Voltage	36 kV
Frequency	50 Hz
Rated current (at 40 <sup>0</sup> C IEC rating)	2500 A
Lighting impulse withstand voltage	170 kV
Power frequency withstand voltage	70 kV
Rated short time current ( 3 Sec.)	40 kA

## 23. 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:

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 62271-200	AC metal-enclosed switchgear & control gear for rated voltages Above 1 kV and up to and including 52 kV.
IEC 60376	Specification and acceptance of new sulphur hexafluoride.
IEC 61128	Alternating current disconnectos bus-transfer current switching by disconnectors
IEC 61129	Alternating current earthing switches - Induced current switching
IEC 60265	High voltage switches.
IEC 60137	Bushings for alternating voltages above 1000V.
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 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.
BS 3938	Current Transformers
IEC 61259	Requirements for switching of bus charging current by G1S disconnectors.

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 T10
IEC 60529	Degree of protection of enclosures

#### **24. 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 and BS 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.

#### **25. DRAWINGS/DOCUMENTS**

In addition to the requirement of drawings/documents etc specified in general and special conditions of contracts, Vol. I, General requirement specification Vol. II Sec. 1 etc. 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.
- b) GA, layout and foundation drawing indicating the method of fixing, floor opening, static and dynamic loads, clearances, embedded plates/channels, tolerances on floor level etc.
- c) Gas section diagrams/gas compartment scheme indicating all gas monitors, rated alarm/lockout pressure, location of gas barriers etc in not less than A2/A1 size format.
- d) Catalogues of all components in GIS and LV compartment including cables plugs/termination, CTs, VTs, gas filling plant etc arranged section wise as technical submittal.
- e) Proposed interlocking logic.
- f) Schematic diagrams (typical for preliminary approval) including LV compartment layout, terminal diagrams, interface details etc.
- g) Coordinated schematic diagrams of GIS indicating the interface terminal nos, drawing reference, sheet reference etc of control & protection scheme alongwith control and protection scheme. (For each bay separately)

- h) An interfacing drawing with terminal details for interfacing with 132kV side of IBT incomers, 11kV switchgear for distribution transformers, NER/NES etc.
- i) Installation manual for GIS, CTs, VTs, cable termination etc.
- j) Operation and maintenance manual.
- k) Factory test procedure for GIS, CTs, VTs, LV compartments etc.
- l) Site test procedure for GIS, CTs, VTs, LV compartment etc.
- m) Factory test reports all components and GIS.
- n) Final complete set of as manufactured drawings neatly bound in box files and also as re-writeable soft copy in CDs.
- o) Any other drawings/documents found necessary during engineering stage or site installation stage for proper coordination.