United Arab Emirates دولة الإمارات العربية المتحدة
الهيئة الاتحادية للكهرباء والماء
Federal Electricity & Water Authority

FEWA-PL-SS-E-0063 REV.0

TECHNICAL SPECIFICATION
33kV CONTROL & RELAY PANELS

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1. ARRANGEMENT FACILITIES

1.1. Control And Relay Cubicles - General Construction

Remote Control equipment and relay equipment for 33KV circuits shall be mounted combined in one panel per circuit.

Panels provided as extensions or for erection in the same room as existing panels, shall be of similar design and appearance, to those existing. The characteristics and appearance of all such equipment/panels shall be to the approval the Authority.

Combined control and relay panels shall be of the cubicle type, and shall be constructed of sheet steel not less than 2.5 mm thick. Panels shall be reinforced where necessary to prevent distortion or the mal-operation of relays or other apparatus by impact, having regard to the number and size of cut- outs and the size of the panel.

Tenderer shall describe briefly the metal treatment and panel painting both inside and outside.

Cubicles shall be drip-proof, and vermin proof, with the minimum IP51 protection degree. Equipment shall be arranged to give reasonable access to all components mounted on the panel front and inside. To assist in achieving this, cubicle width shall not be less than 600 mm. The depth shall not exceed 600mm. The width between apparatus mounted on the cubicle side shall not be less than that which will permit full and easy access to all terminals and to apparatus mounted on the panels.

Rear double door and front relay door of control/relay panels and rear double and front doors of relay panels shall be hinged to lie back flat to avoid restricting access. Doors shall be secured by locking integral handles and locking provision shall be made. Each cubicle door shall be closed by a handle that operates on 3-point closing device. Rear double doors are referred to all control and relay panels and combined control/relay panels.

A lamp shall be fitted inside each cubicle and an utility socket in selected cubicles and so arranged that all wiring is illuminated as evenly as possible without dazzle. The lamps shall be controlled from a door switch. The sockets shall be fused.

Circuit labels shall be provided both in English and Arabic on the front and back of the panels and on the outside of cubicle doors. The labels shall be of engraved type, and subject to the Authority’s approval.

The panel arrangement shall combine the design solutions described in 1.2, 1.3 and 1.4 and shall be subject to the Authority’s approval.

Principal apparatus shall be flush mounted on the front of the cubicle, unless specified otherwise.

Measures are to be provided for dissipation of internal heat.

1.2. Control Cubicles

One remote control cubicle shall accommodate apparatus associated with one circuit only. For voltage level of 33KV, the protection equipment shall also be mounted in the respective

control panels. The control panels shall incorporate all necessary control and indication facilities for the operation of plant from the substation control room.

1.3. Relay Cubicles

Separate cubicles shall be provided for the protection relays associated with 132kV circuits. Equipment may be mounted on either a removable panel or a rack-type arrangement. Each cubicle shall be provided with a front door. The door shall consist of a full length and width translucent window contained in a steel frame. The door shall be closed by a handle that operates on a 3-point closing device and locking provision shall be made.

1.4. Combined Control/Relay Panels

Combined control/relay panel cubicles shall be provided for 33kV equipment. One panel shall accommodate the equipment for not more than one circuit. The main relays shall be covered with front glazed doors. All relays shall be mounted in 19'' rack within the perspex glass door in bottom half of combined control/relay panel. However control equipments shall be mounted in the front panel without doors. Rear side shall have double doors. Other requirements as per clause 1.1 also applicable.

2. 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.

2.1. Control Switches

Control switches shall be of either the handle type or, where specified, discrepancy type and shall be arranged to operate clockwise when closing the circuit devices and anticlockwise when opening. Discrepancy type switches shall be arranged so that two discrete movements are required to effect operation, i.e. from either the dressed to open or dressed to close position the switch must be pushed to permit rotation to the operate positions.

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. Discrepancy switches when released from the operate position shall return automatically to the associated dressed position.

When locked it shall not be possible to move discrepancy switches to the operate positions, however, they shall be free to move to either of the dressed positions.

Discrepancy switches shall not be lit when dressed to the same position as the primary device but shall show a flashing light when switch and device are in disagreement.

A lamp test facility shall be provided in association with any discrepancy switch.

Pistol grip type handles shall be used for circuit breaker control switches and not for any other switch.

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

2.2. 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. All key switches for a particular voltage level at a substation shall have a common lock change number such that with one key available only one switch can be in an operated position at any one time.

2.3. Control of Circuit Devices

(a) On the Remote Control Panels and combined control/relay panels all discrepancy switches and semaphore indicators 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.

Semaphore indicators are required for the maintenance earth and busbar earth switches.

Discrepancy control switches without locking facility for 33kV are required for the circuit breakers, busbar isolators and circuit isolators.

A lockable remote/supervisory selector switch shall be mounted on the front panel for each circuit. The control switches shall be effective only when the control mode selector switches on both the local control cubicle and the remote control panel are in the 'remote' position.

(b) Supervisory control of circuits breakers, busbar selector isolators, and circuit isolators is to be effective only when the mode selector switch on the local control cubicle is in the 'remote' position and the mode selector on the remote control panel is in the 'supervisory' position.

(c) On the remote control panels and combined control/relay panels one remote/ supervisory control selector switch shall be fitted per circuit.

3. 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.

4. ENERGY METERS (OTHER THAN TARIFF METERING)

Energy meters shall be precision grade flush mounting, switchboard pattern in accordance with IEC Recommendation 521. The meter shall be draw-out and back connected and have a register of the cyclometer drum type numerical meters suitable for measuring MWHr & MVAr in both directions shall be supplied. Software for energy meter shall be supplied one per substation. Energy meters shall have programmable CT/VT inputs. Also pulse output shall be provided for scada indications.

5. INDICATIONS AND ALARM SCHEMES

Semaphore indicators shall be of the magnetic type, which shall operate reliably at voltages from 120% to 80% of normal. They shal1 be arranged to assume a mid position upon failure of supply so that an erroneous indication is at no time created. All protection equipment supplies shall be fully supervised and failure conditions alarmed.

All discrepancy lamps shall be arranged to light and give an audible alarm when the position of isolating device is at variance with that of indicator and shall be arranged to extinguish when the indicator is set to correct position.

Annunciators shall be grouped on a per circuit basis with station alarms on a common panel.

Annunciations, which are initiated from signals of short duration (fleeting alarms) shall be retained by the equipment through the audible, flashing and steady state sequence. Operation of the reset button shall clear the annunciation but this button shall not be effective until after the alarm has been accepted. Where a fleeting alarm is re-initiated after acceptance but before reset, the annunciator shall return to the first state of audible alarm and flashing facia.

Annunciators, which are initiated from signals of a long duration (persistent alarms) shall not reset until the initiating device returns to the normal non-alarm state.

Annunciator circuits shall be readily adaptable for use with either fleeting or persistent alarm initiation signals. Spare ways shall be fully equipped, half of which should be ready to accept fleeting alarms.

The test button on each circuit equipment shall operate a full functional test sequence on the associated annunciators including the spare ways.

The facia legends shall comprise black letters on a white background, which should not be of the 'secret' type. The duration of the lamp flash shall be such that the legend can be easily read with not more than 3 flashes per second.

The design of the facia shall be such that a coloured screen or bulb cap can be added at a later date.

All lamps shall be accessible from the front.

The audible alarm shall be of a distinctly different tone for each primary voltage level.

The alarm annunciator equipment shall be equipped with initiation repeat contacts. Where supervisory alarm initiation contacts are not provided directly on a particular device these repeat contacts may be used, subject to approval of FEWA. However, the Scada alarms as per Scada circuit data sheet shall be initiated directly from the source wherever specified. The repeat contacts must mimic exactly the operation of the contact on the initiating device so that both remote and SCADA alarm systems operate independently.

Where stabilising power packs are used these shall be on per circuit group basis and the output monitored. Failure shall be alarmed on a per circuit basis using an alternative ac source. A contact shall also be available and wired out to give a SCADA repeat alarms failure per circuit.

An acknowledge button shall also be mounted on the common panel which will silence the audible alarm initiated by any annunciator on that suite of panels. The annunciator shall however remain in the flashing mode until individually accepted and reset.

As the substations are normally operated from the SCADA centre both the audible alarm and all facias, other than supply failure, shall accept automatically after a time delay. The timer shall be adjustable over wide limits and shall be fitted with an override control switch mounted on the front of the common panel.

Alarm scheme shall also include provisions to avoid unnecessary alarms being sent to control panel and to SCADA during momentary voltage dip conditions.

6. 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 lampholders 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 control relay panel 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 lamp glasses on control and relay panels shall conform to the following standard colour code:

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

7. SYNCHRONISING APPARATUS

The synchronising facilities are required on selected 33kV circuits as per schedule of requirement, drawings etc. (IBT incomer, HVDT, bus section and outgoing feeders).

The scheme shall mainly comprise of key operated Manual/Off/Check synchronising selector switch, check synchronising relays, dead line/dead bus check relays, auxiliary relays/timers etc. Also included are incoming and running supply voltmeters, frequency indicators and synchronscope with ON/OFF switch on a centrally mounted drawout type hinged synchronising panel on common panel subject to the approval of Authority. It shall be possible to synchronize through scada also.

The check synchronising relays shall check phase, slip frequency and magnitude of voltage difference at synchronising and inhibit closure outside the acceptable limits. A dead bus/line check facility shall prevent closure of breaker unless at least one side of the breaker is dead.

Either the check synchronising relay or dead line/dead bus check relays shall energise upon selecting Manual/Off/check selector switch to ‘check’ in remote control panel or by a specific ‘Sync. select’ command from SCADA if in supervisory mode. The ‘Sync select’ command from SCADA shall cause synchronising selection arrangements to be made independent of Manual/off/check selector switch in control panel. The command duration shall be 0.5 sec. Interlocks shall be provided to inhibit selection of more than one circuit at a time to check sync. circuit while operating in Remote or in supervisory mode.

Energization of one check relay (synchronising check or dead line / bus check) shall prevent simultaneous energisation of second check relay. Once energised, the check relay shall remain operated, until automatically reset after pre-selected time or until closure of circuit breaker or until a reset/de-select command is received from SCADA or from sync. selector switch in remote control panel.

An indication that the appropriate check relay is energised shall be given to the SCADA system and shall also be displayed on the remote control panel.

After energisation of selected check relay and upon closure of check relay contacts, a signal shall be sent to SCADA system to indicate that conditions to permit closing have been established. These indications shall be referred to as ‘Sync. Available’ or Dead Line / Dead Bus Available’ as appropriate. Closing signal then be given and it shall be wired through check relays contacts to ensure that closure, takes place only under correct conditions. Means shall be included to prevent circuit breaker closing if check-synchronising relay contacts are closed prior to application of voltages to the relay.

Means shall also be provided at remote control panel to automatically override check synchronising relay when switching dead equipment or circuits. A time delay shall be incorporated in this feature so that override is not effected until preset time is lapsed after the

energisation of synchronising relay. The Supplier shall include the approved methods for ensuring that the live primary circuit is not erroneously be indicated as a dead circuit due to incorrect selection, fuse failure, broken wire, VT protection operated, failure of selection relay or failure to racking-in the VT or VT disconnector is opened and the likes.

Check sync. override shall not however, be made automatic in supervisory mode. A specific supervisory command shall be provided for override closing.

The Supplier shall incorporate following requirements :

- Interlocks shall inhibit selection of more than one feeder at a time to the check sync. circuits, while operating in Remote or in supervisory.
- There shall be two sets of check synchronising and deadline/bus relays one each for remote and supervisory mode, placed in common panel.
- Auto recloser synchronising scheme shall be independent of above described scheme.

8. RELAYS, FUSES, LINKS AND ANCILLARY APPARATUS

8.1. Relays - General requirements

Protective relays shall comply generally with the requirements of IEC 255 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 electronic 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 atleast two sets per substation within the quoted price.

Test facilities shall be provided for testing of signalling schemes between sub-stations. 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, distance relaying 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.

8.2. Fuses / Links & MCBs'

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 MCBs', 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 1 and Main 2 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.

9. EARTHING ARRANGEMENTS

All control and relay panels shall be provided with copper earth bar of a sectional area of not less than 150 mm^2 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 mm^2. Metal cases of instruments and metal bases of relays on the panels shall be connected to this bar by conductors of a sectional area of not less than 2.5 mm^2.

Current transformer and voltage transformer secondary circuits shall be complete in themselves and shall be earthed at one point only, through links situated 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 earth links for protective and instrument current transformer secondary circuits shall be mounted inside the relay panels. Earth links for metering current transformer secondary circuits shall be mounted at the switchgear.

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.

10. 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, 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.

11. 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 68-2-1	Transit and storage	-25°C to +70°C
	Operating	-55°C to +70°C

- Humidity

IEC 68-2-3 56 days(at 93% RH and +40°C)

- Enclosure Protection
  IEC 529 — IP50 (Dust Protected)
- Vibration
  BS 142 Section 2.2 — Category S2,0.59 between 10 Hz and 300 Hz

(ii) Voltage withstand

- Insulation

  IEC 255-5

- High Voltage Impulse

  IEC 255-5

- 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.

12. 33 KV BUSBAR PROTECTION

Busbar protection of the unbiased high impedance circulating current type shall be capable of detecting three phase, phase to phase and phase to earth faults, under all system plant conditions. Low impedance design is subject to FEWA approval.

The operating time of the measuring relays shall not exceed 25 ms at five times the relay current setting.

The rated stability limit of each fault detecting system for phase faults shall not be less than the rated breaking capacity of the associated switchgear. The sensitivity shall not exceed thirty per cent of the minimum fault level for all types of faults.

Automatic and continuous supervision of current transformer circuits shall be provided to give an alarm when the out-of-balance current reaches an undesirable value. Operation of current transformer supervision equipment should take the defective protection zone out of service by short-circuiting the current transformer bus wiring. Current transformer shorting relays shall be hand reset latching devices with contacts capable of carrying for three seconds a secondary current equivalent to the maximum fault current and a voltage capability across open contacts of 3 kV peak.

The busbar protection shall have the following features incorporated in the scheme :

(a) Two independent systems shall be provided for each busbar fed from separate current transformer, one designated as discriminating system, and other check system. The discriminating system shall comprise a separate differential scheme for each section of busbar. The check system shall comprise a differential scheme covering each section of all busbar sections. Each system shall be capable of detecting all types of faults under all system conditions.

(b) Check and discriminating zones shall each comprise high impedance circulating current relays connected across busbar protection current transformer bus wiring. Coincident operation of discriminating and check relays shall be arranged to initiate tripping of the appropriate busbar zone.

(c) A hand reset busbar protection trip relay shall be associated with each circuit breaker. The trip relays shall normally be used exclusively for the busbar protection. The no. of relays and contact arrangements etc. for the respective zones of protection shall be sufficient to meet the protection scheme requirements and to the approval of Authority.

(d) In the case of transformer circuits, operation of the busbar protection shall trip the HV and LV circuit breakers.

(e) Bus section C.B. will trip for a fault on either side of bus.

(f) The protection operation shall give clear indication of the faulty phase.

(g) Any blind zone arising due to physical arrangement of protection Cts' in bus-section breaker shall be fully protected by the Busbar protection scheme.

(h) The unearthed side of the CT circuits shall pass through two-position bolted type test link before being connected to common bus-wires or to any other apparatus. In one position the link shall short-circuit the transformers as well as disconnect the unearthed side of the residual circuit from the rest of the equipment and in the other position the link shall give normal connection. It shall be possible to change the test link from one position to the other on load without open circuiting the current transformers. Suitable terminals can be utilized for this purpose.

(i) The trip circuits in the busbar protection cubicle shall be fully insulated or shrouded on the positive side of the protection IN/OUT switch contacts and on the trip coil and intertrip relay coil sides of the fuses or links.

(j) Full provision for testing each part of the equipment shall be made so that it is not necessary to disconnect wires from terminals.

(k) Current transformer rings shall be formed at the busbar protection relay panels and not at the switchgear cubicles.

(l) Means shall be provided at the front of the busbar protection panel for interrupting the trip and intertrip functions of the busbar protection while leaving the operation and indication of the equipment otherwise unimpaired. These means shall comprise insulated links, distinctively labelled, and connected in the trip and intertrip circuit connections, on the side of the busbar trip relay contacts far from the bus bar protection IN/OUT switch contacts. These lockable two-way multi-contact switches of approved type, shall be mounted on the front of the busbar protection panels for each zone of the busbar protection including the check zone. These switches shall include contacts for alarm and indication functions. The contacts of this switch shall be connected on the live (positive) side of each of the busbar trip relay contacts.

The contract shall include for all necessary current transformers, relay panels, marshalling boxes, isolating and shorting links, etc. All busbar protection tripping outputs shall have isolating links. A lockable busbar protection IN/OUT switch is to be provided.

Current transformer secondary bus wiring shall be suitably dimensioned but not less than 2.5 mm^2 to reduce current transformer burdens to a minimum.

Suitable over voltage limiting devices shall be provided as necessary.

The calculated performance data for instantaneous high impedance differential busbar protection systems has to be submitted to the Authority confirming the following :

(i) The rated stability limit shall be no less than the three phase symmetrical breaking capacity of the associated switchgear i.e. 40kA.

(ii) The fault setting for any type of fault shall be between 10% to 30% of the minimum fault current available (i.e. 1000A – Minimum fault current shall be considered for design).
(iii) Current transformer knee point voltages shall not be less than twice the relay circuit setting voltage. The relay setting voltage and the associated calculations shall be to the approval of the Authority.
(iv) The maximum peak voltage across current transformer secondary wiring shall not exceed 3 kV under maximum internal fault conditions.
(v) Associated current transformers shall be Class PX, low reactance type as per IEC 60044-1.

13. OVER CURRENT AND EARTH FAULT RELAYS

The phase over current and earth fault over current relays shall be of modern numerical type, with proven field experience. Considering inter changeability of relays, all relays shall also be provided with high set instantaneous features in all poles. These relays shall be of multi characteristics type.

Relays should have adjustable settings for both operating current and time, the design of the relay being such that the setting adjustments can be carried out on load without taking the relay out of service. For the relays offered, time multiplier settings in steps of at least 0.025 are required, allowing settings of, say, 0.125, 0.15, 0.175, etc. The range of current settings for phase faults shall cover the range 25 - 400 percent of rated current with tappings not exceeding 25 percent intervals and the time setting adjustment shall be 0 to 3 seconds at ten times the setting current. Inverse time earth fault relays, where specified, should also comply with the foregoing, but shall have a range of settings from 10% to 80% with tappings at 5% intervals.

The relays shall be thermally rated such that the operating time of the relay at the highest practical current levels on any combination of current and time multiplier settings shall not exceed the thermal withstand time of the relay.

Directional elements associated with directional over current relays, and directional earth fault relays, where specified, shall have a relay 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.

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.

The Supplier may provide the specified elements in one casing however, in relays where directional features also are combined with IDMT units, a facility of bypassing the same shall be provided.

14. FIBRE OPTIC CURRENT DIFFERENTIAL PROTECTION RELAY

The protection shall comprise of current comparison type numerical differential relay for cable feeders, and shall be suitable for use with dedicated optical fibre communication links and multiplexed systems.

For 33kV cable feeders the relay shall be suitable for direct communication using fibre optic cable without multiplexers to a distance of at least 20 KM.

The relay shall have a feature of monitoring the communication link and block the relay (selectable) in case loss of communication channel.

Some main features which this relay shall have, are stated as below :

a) The relay shall have phase-segregated design, operating time of the range of one cycle and suitable for direct communication using fibre optic cable without multiplexers to a distance of at least 20 KM.
b) Relay shall have high sensitivity to in zone faults and shall be very stable against heavy through fault currents.
c) Shall remain unaffected by line charging and cable charging currents.
d) Adjustable sensitivity for over current and earth faults.
e) Shall have intertrip/permissive-intertrip facilities.
f) Power-on diagnostic and continuous monitoring of important parts of the scheme including the communication link. Selectable operation mode on loss of communication.
g) The relay shall have event and fault recording facility.
h) Suitable for weak/non-infeed terminal.
i) Stable in case one end measured (input) current is absent.
j) Shall have in-built CT supervision, guard feature etc.

15. POWER TRANSFORMER PROTECTION

Power transformers shall be protected by the usually applied gas and oil surge and pressure detectors, oil and winding temperature monitoring devices, including the monitoring and protection of the tap changer and/or the cable connection chambers. Fire protection shall also be included.

The following electrical protection relays shall be provided, but shall not be limited to:

- differential protection
- restricted earth fault (REF) protection
- back-up over current and earth fault protection and thermal overload protection.
- standby earth fault protection.

The protection cubicle(s) shall incorporate all the protection functions for each power transformer. For this purpose, the cubicle shall be provided with all auxiliary relays for alarming and trip and it shall receive from the transformer local control kiosk/ marshalling box, the corresponding cabling and wiring with an adequate number of terminals. All alarms and tripping orders shall be suitably indicated at the front of the power transformer protection cubicle(s).

Tripping interface shall be provided such that any protection relays tripping on the higher voltage side shall trip the lower voltage side circuit breaker and vice versa for transformer

faults. Back-up protection for other than transformer faults (external faults), installed at the low voltage side of the transformer shall only trip the low voltage side circuit breaker and keep the transformer energised from the primary network side.

The protection relays for the power transformers shall be mounted on a panel associated with the winding to which the relevant CT is connected. For overall protection the relays shall be situated on the panel associated with the highest voltage winding.

15.1. Differential Protection

Transformer differential protections shall comprise of a numeric, high speed, three phase biased differential relay (single unit) or three independent single phase relays with magnetising inrush restraint and over - excitation (over-fluxing) restraint features and high set feature.

The relays shall have a load current bias adequate to overcome the effects of full range of tap changing of the protected transformer. Interposing transformers as necessary shall be of multiratio type and the setting ratio shall be chosen to achieve exact overall balance with the transformer at mid-point of the taping range. The relay shall have inbuilt thermal overload function as a standard protection function.

Second harmonic bias (or other approved means) shall be included to overcome the unstabilizing effects of magnetising in rush current. Delayed operation is not an approved means.

The minimum operating setting shall not be more than 20% of the rated current of the transformer and the overall scheme including main current-transformers, interposing current-transformers and the relay shall be designed to ensure stability on any tap position under maximum through fault conditions with maximum d.c. offset in the fault current.

It shall be easy to measure the on load differential current, fault currents etc. without disturbing the wiring.

The protection performance requirement and setting calculations shall follow in general, the relevant ESI standard and subject to the approval of Authority.

15.2. Transformer Restricted Earth Fault & Standby Earth Fault Protection

Transformer HV and LV restricted earth fault protection using high impedance relays shall be provided on all 132/33 kV transformers. The protection shall be connected to class X current transformers on the transformer neutral connections and on to the line current-transformers of similar characteristics. The line current-transformers may be common to both differential and restricted earth fault protections.

The scheme shall be designed and applied such that the primary fault setting for 132 kV faults shall be between 10% and 60% of the rated current of the protected winding, and for 33 kV 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 the Supplier shall provide and fix current transformers in the neutral earthing connection of the winding of the power transformer. One such current transformer in the neutral connection shall be used for the balanced earth fault protection and, 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.

The standby earth fault relay shall be of the inductive pattern so designed that it will operate in 10 secs.

15.3. Protection for Tertiary Windings

The tertiary windings shall be provided with a separate restricted earth fault relay. The relay shall be a instantaneous over current type for rapid clearance of tertiary faults.

Current ranges 10% to 80% in step of 10%.

Operating time shall be less than 30 ms at three times of the setting current.

15.4. Buchholz Protection

All necessary flag indication, tripping relays and alarm relays associated with this protection shall be provided, mounted and connected.

Buchholz Surge Protection shall be provided separately for OLTC tank/compartment with associated flag relays for trip/alarm purposes.

15.5. Oil and Winding Temperature Protection

Transformers will be provided with oil and winding temperature protection. These will be of the two-stage type with adjustable settings giving remote alarm and trip facilities. Necessary auxiliary relays with sufficient contacts for trip/alarm initiation and flag indication shall be provided in the protection panel.

15.6. Pressure Relief Device Protection

Transformers will be provided with pressure relief device in order to isolate the transformer in case of excessive internal pressure build up. All necessary flag indication, tripping relays and alarm relays associated with this protection shall be supplied and connected in the protection panel.

15.7. 33 kV side Over current, earth fault, thermal overload protection

132/33kV Transformer LV Back-up protection shall comprise of 3-pole numerical IDMT, directional over current relay and a single-pole numerical, directional earth fault relay with protection settings range and characteristics as detailed in clause 13. Thermal overload protection shall also be included.

15.8. Transformer LV star winding (and neutral earthing resistor) protection

Protection of LV Star windings and thermal protection of neutral earthing resistors for 132/33kV transformers and 33/11 kV transformers shall comprise of a two stage, numerical standby earth fault relay. This relay shall be connected to a separate CT, connected in neutral path of the transformer winding to earth/resistor.

The first stage shall comprise a long time inverse time delayed earth fault relay having an operating characteristic to BS 142 of the form t-120/I-1,

where t = relay operating time with time multiplier set to 1.0.

I = relay current expressed as multiplier of the current setting.

The first stage shall have current settings, which allow a setting of down to 10% and time multiplier settings of 0-1.0 in steps of 0.025.

Stage I shall be arranged to trip the LV bus-section circuit breaker .

Stage II shall comprise a time delay relay having settings, which cover the range of 0.1-3 seconds in steps of 0.1 sec.

Stage II shall be arranged to trip the transformer HV and LV circuit breakers.

16. 33/11KV TRANSFORMER PROTECTION

33/11kV transformer shall be provided with following protections.

(i) Overall transformer differential protection as described in clause 15.1 with magnetizing restraint and over excitation (over-fluxing) restraint features and thermal overload protection.

(ii) 33kV side 4-pole, numeric, multi characteristics, over current and earth fault relay with high set instantaneous feature.

(iii) 11kV star winding shall be protected by REF protection and the LV neutral earthing resistor shall be protected by a two stage standby earth fault relay fed from a neutral CT.

(iv) 11kV side shall also be provided with three pole over-current and one-pole earth fault relay.

(v) 11 kV side protection intertrips.

(vi) Transformer protection like Buchholz, OTI/WTI, pressure relief trips, buchholz alarms, OTI/WTI alarms, oil-level low alarms etc. as required.

17. 33/0.415 KV AUXILIARY TRANSFORMER

33/0.4 kV Auxiliary transformer shall be provided with following protections.

33 kV side shall comprise of :

(i) 4-pole static, multicharacteristics, over current and earth fault relay with high-set instantaneous elements. The relay protection settings range and characteristics shall be as per above clause.

(ii) One single pole, high impedance, instantaneous, restricted earth fault protection relay for delta winding with correctly sized stabilizing resistors.

(iii) 415V side protection shall be as detailed in LVAC single line diagram and as per schedule of requirement.

18. 33 KV BUS-SECTION PROTECTION

33 kV Bus-section protection shall comprise of 3-pole, numeric, bi-directional over current relay and single-pole numerical, bidirectional, earth fault relay with protection-setting range and characteristics as detailed in above clause 13.0. Bi-directional feature is required.

19. 33 KV CABLE CIRCUIT PROTECTION

33 kV Cable feeder protection shall comprise of a pilot wire/fibre optic type, current differential protection as the main protection and 3-pole, numeric directional over current and single-pole, numeric, directional earth fault relay as the back-up protection with thermal overload protection feature.

The pilot wire/fibre optic protection shall have all the features as detailed in above clause and directional over current and earth fault relays shall be as per above clause.

20. 33KV OHL FEEDER PROTECTION

33kV OHL Feeder shall have three- zone distance protection scheme as Main protection and directional O/C and E/F relays as described in clause 13.0 as back-up protection. Definite time delayed sensitive E/F protection shall also be provided as described in clause 20.2. The distance relay shall be suitable for use in effectively or non-effectively earthed systems as required.

20.1. Distance Protection

The relay shall operate for all types of phase and earth faults. Separate phase and earth fault distance measuring elements but with zone switching arrangement shall be provided. Compensation features shall be provided to permit the earth fault setting and the phase fault settings to be made in terms of feeder positive sequence impedance.

Tenderers shall demonstrate by calculation and diagram that the relay can protect the shortest line and can provide adequate fault resistance coverage.

Zones 1 and 2 shall operate only for faults in the protected direction. Under no circumstances shall the relay operate for reverse faults even when the voltage supplied to the relay falls to zero on all three phases. Details of methods used for polarising relays to deal with faults close to the relaying point shall be provided. The relay characteristics shall ensure adequate fault resistance cover under system conditions mentioned in section B, vol.2. Zone 3 may be non-directional and may be capable of being independently offset in both directions.

Starting shall be by impedance measurement. Over current starting shall not be accepted. The starting relays shall not operate during maximum power transfer. During single phase to earth faults conceding with maximum power transfer, only the starting relay associated with the faulted phase shall operate. The starting relays can be employed as Zone-3.

The reach of each measuring zone and starting relay shall be individually adjustable by means of an approved method and auto recluse feature shall be included.

The characteristic angle shall be adjustable between approximately 50 and 80 degrees.

Zone 2 and Zone 3 shall have a time delay setting range of at least 0.2 to 1.0 second and 0.2 to 3.0 seconds respectively.

The sensitivity of the protection shall be adequate for definite operation under system conditions state in section B of Vol.2 and shall not exceed 20% of the rated current.

The operating time of each zone shall be substantially independent of fault current magnitude. The operating times are provided showing the effect of line and source impedance, fault position and operating current.

Under no circumstances shall the distance protection operate because of normal system switching including de-energisation of the line.

A feature shall be incorporated to ensure instantaneous tripping in the event that the circuit breaker is closed on to a fault on a previously de-energised line.

A monitoring system shall be provided to supervise the voltage transformer supply to each distance relay. In the event of loss of one or more phase, the monitoring system shall inhibit relay operation and initiate a time-delayed alarm.

The distance relays shall incorporate indicators to show the zone in which the relay tripped and the phase or phases faulted. Indication must not be lost in event of a supply failure.

The protection shall be suitable for 3 pole tripping and shall have additional contacts for initiating auto-re-closing, signalling, alarms, fault locators... etc.

The distance relay shall include the following minimum features, and it shall be possible to select at site any mode of operation.

a) Overlapping mode or Basic mode (without communication channel).
b) Permissive under reach or over-reach transfer trip (with communication).
c) Zone acceleration mode, where applicable (with communication channel).

Associated current transformer shall be class X to BS-3938 with a suitable over current factor or as recommended by the distance relay manufacture the design calculations for current transformers for use with the distance shall be submitted to the Authority for approval.

20.2. Sensitive Earth Fault

Numerical sensitive earth fault relay shall have adjustable current setting down to 0.5% of CT rated current and adjustable time delay setting for grading with other protections. Relay shall be of high reset/operate value and harmonic rejection feature.

21. 33 KV CAPACITOR FEEDER PROTECTION

A three-pole, Static, IDMT Over current relay with high-set elements and one single pole, static, IDMT earth fault relay. The relay protection-settings range and characteristics shall be as detailed in clause 12. Since system harmonics increase capacitors current, the relays will respond more correctly if it does not have inbuilt tuning for harmonic rejection. The same shall be considered while selecting over current & earth fault protection relays for capacitors.

A neutral out-of balance current relay shall be provided. This relay will be fed from a current-transformer in the common neutral of double star connected capacitor banks. The relay shall have adjustable current settings with an in-built bias circuit fed from an external voltage-transformer to compensate for healthy state spill current in the neutral. Auxiliary time delay elements shall also be provided for alarm and trip.

A static definite time-delay two stage over-voltage relay shall be provided. The relay shall have wide range of voltage-settings with step size of not more than 2.5V (secondary volts) and time setting range of 0.1-9.9 sec. with step size of not more than 0.1 seconds. First stage shall send alarm to control room and second stage shall trip the breaker.

The relay shall have following general features :

a) Drop-off / pick-up ratio close to unity
b) Low ac burden
c) Non-volatile trip indication

One definite time delay under voltage relay shall be provided, which shall have wide voltage range and time settings of 0.1-9.9 sec with step size of not more than 0.1 sec.

One harmonic current sensing type relay with built-in time delay element to delay the trip shall be provided. Both harmonic current level and delay settings shall be site programmable.

22. TRIP RELAYS

Trip relays shall be provided as follows :

Trip relays 1 and 2 (TR1 and TR2) shall be operated by a circuit fault condition such as for pilot protection, intertrip from remote line end, transformer standby and restricted earth fault protection, transformer differential protection and transformer Buchholz protection. TR1 and TR2 shall be hand reset resettable from the relay panel only. On feeder circuits operation of TR1 and TR2 shall initiate a direct intertrip to the remote line end.

Trip relay 3 (TR3) shall be operated by all over current related protection such as circuit over current and transformer winding and oil temperature protection and also OHL feeder protection as these feeders are being provided with auto re-closing facilities. TR3 shall be electrically resetable from the remote control panel and from the System Control Centre (SCC).

Trip relay 4 (TR4) shall be operated by the busbar protection only and shall be hand reset resetable from the relay panel only. It will be mounted on the busbar protection panel.

Trip relay 5 (TR5) shall be operated by under frequency relays to trip the feeders (33 kV/11kV). These are self-reset type and flag is hand resetable.

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.

23. SUPERVISION RELAYS

23.1. Trip Circuit and Protection Supply Supervision

Trip circuit supervision relays shall be provided to monitor each of the trip circuits of all 11 kV, 33 kV and 132 kV 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.

23.2. D.C. Supply Supervision

Supervision relays are required for each protection supply, e.g. Main 1, Main 2, Back-up and Trip Relay Reset. Similarly for each trip circuit supply, e.g. Trip Circuit 1 and Circuit 2 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 relay coil/faulty supervision wiring.

23.3. 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 local control cabinet 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 relay panel 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.

24. ROUTINE TESTS

1) All relays and associated equipment shall be routine tested to prove the quality and accuracy. Routine tests shall be in accordance with IEC. 255 (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 technical presentation and detailed testing and inspection of some type of relays 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.

25. STANDARDS

IEC 255	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

26. MANUFACTURER FOR CONTROL/RELAY PANELS

26.1 Control/Relay panel shall be manufactured by quality manufacturers in Europe, North America and Japan only.

26.2 For Control/Relay Panels local manufacturers who have supplied similar panels to power authorities in UAE, duly fabricated and assembled by them, having collaborations with reputed protection relay manufacturers from countries as per 26.1 clause above shall also be considered, however subject to FEWA's separate approval only.

26.3 All protection relays shall be from one reputed manufacturer only. Mixing of different manufacturer relays in the same panel is generally not acceptable.

27. CT/VT & RELAY SETTING CALCULATION

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

Also relay setting calculations for all main protection relays including busbar protection, transformer differential protection, REF protection, fibre optic current differential protection, pilotwire protection, distance protection, etc shall be carried out by the relay manufacturer and to be submitted for FEWA approval. All required parameters for setting including the maximum, minimum fault current etc shall be calculated by the contractor. If the calculations are carried out by separate contractor other than the relay manufacturer evidence shall be submitted for these calculations reviewed/verified by the relay manufacturer and their recommendations shall also be included.

28. DRAWINGS/DOCUMENTS

In addition to the requirement of drawings/documents specified in general and special conditions of contract (Vol. 1) and general requirement specification Vol II, Sec. 1, etc 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 in control/relay panels including relays, meters, instruments and all internal components.

b) CT/VT 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, sheet reference etc of GIS scheme alongwith GIS schemes. (for each bay separately)

f) Interface drawing with 132kV side of IBT, 11kV side of distribution 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) Relay setting calculations.

m) Final complete set of as manufactured drawings/documents neatly bound in box files and also as re-writeable soft copy in CDs.

n) Relay software CDs for site testing.

o) Any other drawings/documents required during engineering stage or site installation stage for proper co-ordination.