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TECHNICAL SPECIFICATION
(132kV CONTROL & RELAY PANELS)

TABLE OF CONTENTS

		Page
1.0	**Arrangement Facilities**	**4**
1.1	Control And Relay Panels - General Construction	4
1.2	Control Panels	5
1.3	Relay Panels	5
2.0	**Control And Selector Switches**	**5**
2.1	Control Switches	5
2.2	Selector Switches	5
2.3	Control of Circuit Devices	6
3.0	**Instruments**	**7**
4.0	**Energy Meters (for other than tariff metering)**	**7**
5.0	**Indications And Alarm Schemes**	**7**
6.0	**Indicating Lamps**	**9**
7.0	**Synchronising Apparatus**	**9**
8.0	**Relays, Fuses, Links and Ancillary Apparatus**	**10**
8.1	Relays - General requirements	10
8.2	Fuses / Links & MCBs'	13
9.0	**Earthing Arrangements**	**13**
10.0	**Cable Terminations**	**14**
11.0	**Protection relays & Protection Schemes**	**14**
12.0	**132 KV Busbar Protection**	**15**
13.0	**Circuit Breaker Fail Protection**	**18**
14.0	**Over current and Earth Fault Inverse Time Relays**	**18**
15.0	**Bus Coupler Protection**	**19**

16.0	**132 kV OHL Feeder Protection**	**19**
16.1	Main 1 Protection	20
16.2	Main 2 Protection	21
16.3	132 KV OHL Feeder	23
16.4	Auto-reclosing equipment for 132 KV Transmission Line	23
17.0	**Power Transformer Protection**	**24**
17.1	Differential Protection	25
17.2	Transformer Restricted Earth Fault & Standby Earth Fault Protection	25
17.3	Over fluxing protection	26
17.4	Protection for Tertiary Windings	26
17.5	Buchholz Protection (Aux. relay)	26
17.6	Oil and Winding Temperature Protection (Aux. relay)	26
17.7	Pressure Relief Device Protection (Aux. relay)	26
17.8	Backup Over current and Earth Fault Protection	26
18.0	**132 kV Cable Feeder Protection**	**27**
18.1	Main Protection	27
18.2	132kV Cable Feeder Backup Protection	27
19.0	**Trip Relays**	**27**
20.0	**Supervision Relays, Test Blocks:**	**28**
20.1	Trip Circuit and Protection Supply Supervision	28
20.2	D.C. Supply Supervision	29
20.3	Voltage Transformer Supervision Relays	29
20.4	Relay Test Blocks:	29
21.0	**Fault Recorder Equipment**	**30**
22.0	**Routine Tests**	**31**
23.0	**Relay Settings Calculation:**	**32**
24.0	**CT/VT Calculations:**	**32**
25.0	**As Built Drawings/Co-ordinated Schemes:**	**32**
26.0	**Standards**	**32**

1.0 ARRANGEMENT FACILITIES

1.1 Control And Relay Panels - General Construction

Remote Control equipment and relay equipment for 132KV circuits shall be mounted in separate panels.

Panels provided as extensions or for installation 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 of the Authority.

Control and relay panels shall be of the cubicle type, and shall be constructed of sheet steel not less than 2.5 mm thickness. 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.

Panels shall be drip-proof, and vermin proof, with the minimum IP52 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. The panel shall have plinth of 75 mm. at least.

Rear double door of control 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 preferred to all control and relay panels.

A lamp shall be fitted inside each cubicle and an utility socket in selected Panels 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 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 clause 1.2 and clause 1.3 of this specification 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.

The panels shall have external paint colour of RAL 7032. Internal shall be painted with semi gloss white colour. The minimum thickness of paint shall not be less than 60 microns and an average of 90 microns to be proved during factory inspection of panels.

1.2 Control Panels

One remote control panel shall accommodate apparatus associated with one circuit only. The control panels shall incorporate all necessary control and indication facilities for the operation of plant from the substation control room.

1.3 Relay Panels

Separate panels shall be provided for the protection relays associated with 132kV circuits. Relay equipments shall be mounted on a rack-type arrangement. Each panel shall be provided with a front perspex (glass) 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.

2.0 CONTROL AND SELECTOR SWITCHES

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

Labels shall clearly indicate all positions and function of each switch.

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.

All control switches shall have additional labelling giving the reference identification of the primary device, its Scada number as per SLD (e.g. Q0, E3010 etc.).

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 Local Control Panels the control switches for all devices and the lockable local/remote selector switch shall be mounted behind the lockable glass panelled front door.

Lockable control switches with spade type handles shall be provided for the maintenance earth and busbar earth switches and circuit earth switches.

Control switches with pistol grip type handles for circuit breakers and spade type handles for both busbar selector isolators, circuit isolators shall be provided. These switches shall not be lockable.

All control switches shall be effective only when local mode is selected.

A semaphore indicator is required for each device as part of the mimic diagram. Each semaphore is to be labelled with the device identification reference.

(b) On the Remote Control 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 for 132 kV control panels are required for the circuit breakers, busbar selector 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. The key shall be unique key and removable in supervisory position only. Master key shall also be provided.

(c) 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.

d) On the remote control panels one remote/supervisory control selector switch shall be fitted per circuit.

e) Lockable manual/off/check synchronising selector switch shall be provided for all 132kV circuits. The key shall be removable in 'off' position and interchangeable type shall be provided.

3.0 INSTRUMENTS

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

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

Interposing current transformers shall be used in all instances where the instruments or transducers are not designed to carry full fault current or wherever protection and instruments are connected to the same core of CTs or wherever ammeter with selector switches are employed.

All voltage circuits to instruments shall be protected by an MCB in each unearthed phase of the circuit 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.

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.

4.0 ENERGY METERS (FOR OTHER THAN TARIFF METERING)

Energy meters shall be precision grade flush mounting, switchboard pattern in accordance with IEC Recommendation 60521. The meter shall be draw-out and back connected and have a register of the cyclometer drum type.

5.0 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 shall 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 subjct to approval of FEWA. However, 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 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. The switch shall be labelled as attended/unattended.

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

6.0 INDICATING LAMPS

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

Indicating lamps and lamp holders shall be arranged so that replacement of lamps and the cleaning of glasses and reflectors employed can be readily effected from the front of panel, without the use of special tool. A selector switch shall be provided on the bus-section 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 (black colour) 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

7.0 SYNCHRONISING APPARATUS

The synchronising facilities are required on all 132 kV circuits.

The scheme shall mainly comprise of key operated Synchronise/Off/Bypass 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 draw out 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 synchronise/off/bypass 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 synchronise/off/bypass 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 scheme (synchronising check or dead line / bus check) shall prevent simultaneous energization of second check relay. Once energised, the check relay shall remain operated, until automatically reset after preselected 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 energization 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 affected until preset time is lapsed after the energization 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 contractor 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.

8.0 RELAYS, FUSES, LINKS AND ANCILLARY APPARATUS

8.1 Relays - General requirements

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

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

Static relays will only be considered where a particular type/field proven numerical relay is not available. In case of solid state and microprocessor based relays, steps shall be taken to protect the relay circuitry from externally impressed transient voltages which could reach the circuitry via connections to instrument transformers or to the section dc systems. Static and microprocessor based relays shall comply with the Impulse withstand and high frequency disturbance tests specified in Appendix E of IEC publication 60255-4 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 testing of protective relays, meters and associated circuits. This requirement is additional to any permanently connected injection test scheme or locally mounted CT/VT test links.

If any form of modern modular numerical 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.

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.

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

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 well 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 DC system except through contacts which are normally open and shall wherever possible be continuously connected to the negative pole of the DC system, 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 in accordance with this specification, the supplier shall supply the CT and VT with the necessary increased capacity at no extra cost. All necessary design calculations for CT /VT shall be submitted within two (2) months of Contract award.

The contractor/relay manufacturer shall provide all necessary literature, methods of checking etc. if required for design of CTs/VTs and checking the calculated relay setting of the supplied protection relays.

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

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

The contractor 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.

Test blocks with sufficient number of contacts shall be employed for each relay scheme. Test plugs shall also be supplied at least two numbers for each type. Test blocks shall have sufficient contacts for connecting CT circuits, VT circuits, DC supply, trip circuit, etc. The type of test block to be applied for the protection scheme shall be subject to FEWA approval during detail design stage and shall be supplied within the quoted price.

8.2 Fuses / Links & MCBs'

Isolating links, MCBs' etc. 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 60947-2 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 purpose.

The contractor shall ensure satisfactory time and current grading with other MCBs' or fuses. 20% spare MCBs'/fuses of each type / rating shall be provided to the client.

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.

9.0 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 via copper earthing connection of size not less than 185 mm^2. The common earthing of earth bus inside panels will be at two locations to earth grid. 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 tertiary 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.

10.0 CABLE TERMINATIONS

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

All cables shall enter vertically from below and at their point of entry to the equipment they shall be sealed by fitted boards. These shall be of an approved, non-flammable, insulating, 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.

11.0 PROTECTION RELAYS & PROTECTION SCHEMES

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

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

(i) Environmental withstand

- Temperature

IEC 60068-2-1	Transit and storage Operating	-25°C to +70°C +5°C to +70°C

- Humidity

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

- Enclosure Protection

IEC 600529	IP50 (Dust Protected)

- Vibration

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

(ii) Voltage withstand

- Insulation voltage/impedance

  IEC 60255-5

- High Voltage Impulse

  IEC 60255-5
  IEC 61000-4-5, class 4

- High Frequency Disturbance

  IEC 60255-6 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.

12.0 132 KV BUSBAR PROTECTION

Bus-bar protection shall be of high speed circulating current type. It shall be of high impedance type bus-bar protection scheme.

The schemes shall confirm that following requirements are met -

(1) The busbar protection shall be such that there will be no operational restrictions as to the operation of the primary system including conditions of on-load transfer of circuits.

(2) The bus-bar protection shall be capable of detecting three phases, phase to phase and phase to earth faults under all system plant conditions.

(3) The protection operation shall give clear indication of the phase involved in the fault.

(4) 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.

(5) Automatic and continuous supervision of current transformer circuit 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 with time delays 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.

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 designed as discriminating system and the

other check system. Each system shall be capable of detecting all types of faults under all system conditions.

(b) Busbar protection scheme shall be such that coincident operation of both check and discriminating system shall initiate tripping of the appropriate bus-zone.

(c) When a bus-bar fault occurs, all circuit breaker connected to the faulty section shall be tripped, bus coupler circuit-breaker shall trip for a fault on either bus and intertrip to opposite breakers.

(d) Operation of the bus-bar protection shall send intertrip to remote end breakers as well as other circuit breakers of power transformers.

(e) Tripping relays with hand reset facility shall be provided in the busbar protection panels. The number of trip 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 the Authority.

(f) The tripping relays shall exclusively be for the bus-bar protection scheme. However with the agreement of the Authority, the bus-bar protection tripping circuits may also be used for back tripping from the circuit-breaker failure protection. The circuit breaker fail protection can also be an integral part of the busbar protection scheme.

(g) It is preferable to have built-in Auto-Test facility, which enables complete testing of all vital function of the busbar scheme, at a preselected time.

(h) Blind zones if any shall be completely protected by the Bus bar protection scheme.

(i) The unearthed side of the CT circuits shall pass through two-position bolted type test link before being connected to a 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 Klippon terminals can be utilized for this purpose.

(j) 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.

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

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

(m) 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, 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.

(n) Means shall be provided to permit tripping and intertripping of individual circuit breakers from test operations of the busbar protection, without tripping all circuit-breakers connected to the protected bar.

(o) Check system shall not be routed through auxiliary switches. Discriminating system C.T. secondaries shall however be routed through two parallel - connected, silver-plated early make late break type auxiliary switches of the associated busbar isolators.

(p) No more than one circuit breaker shall operate should any one relay be inadvertently operated, anyone wire open-circuited or any pair of wires short-circuited.

(q) The protection trip command for each feeder shall be given directly to both trip coils of the circuit-breaker and tripping function of the busbar protection shall block the closing-circuits of all concerned circuit-breakers.

(r) Current-transformers secondary bus wiring shall be suitably dimensioned but not less than 2.5 mm sq. to reduce the CT burdens to minimum.

(s) The contractor shall submit the calculated performance data for the busbar protection scheme confirming the following:

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

(ii) The fault setting for any type of fault shall be between 10% to 30% of the minimum fault current available.

(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 X, low reactance type in accordance with BS 3938 or class TPS as per IEC 60044-6 or class PX as per IEC 60044-1.

t) The discriminating system and check system shall be segregated in different panels.

u) The trip relay shall be high speed, high burden hand reset type with sufficient number of NO and NC contacts to trip, block and indication. The flag indication shall be built in the trip relay itself.

Separate relays for trip, lockout, flag indication etc. are not acceptable.

One single trip relay with sufficient contacts shall be used for each circuits whereas bus coupler/bus section shall have two trip relays for tripping both zones. Metrosils, stabilising resisters, shunt resistors etc. shall be provided.

The busbar protection trip relays type, make, etc. are subject to the approval of FEWA during engineering stage and shall be supplied within the quoted price of panels.

13.0 CIRCUIT BREAKER FAIL PROTECTION

Breaker failure protection shall be fitted to all 132kV circuit breakers.

The breaker failure protection on circuit breakers shall be initiated by all the other protection devices, which normally initiate tripping of that breaker. In the event of the circuit breaker failing to open within a pre-selected time, the breaker failure protection shall initiate retrip and then load tripping of all adjacent circuit breakers. It shall also incorporate provision for initiating direct intertripping of any remote infeeds, via teleprotection channels, and the lower voltage circuit breaker on transformer circuits.

The position of each circuit breaker shall be monitored by a single set of current relays per phase fed from the back-up protection current transformers. The relays shall have an operating time of approximately ten (10) msec., and a consistent reset time of less than fifteen (15) msec. The relays shall be more sensitive than the most sensitive circuit protection, for both phase and earth faults. The relays shall be capable of remaining in the operated position continuously and of carrying twice the circuit rated current continuously.

The operating time of the breaker failure protection shall be selected by means of timers with ranges of 50 to 500 msec. There shall be two timers per circuit breaker. The timer can be an integral part of the breaker-fail protection relay. Back tripping shall be initiated by simultaneous operation of the current check relay and the breaker failure timer. The trip output shall be capable of being isolated by means of an isolating link. With the approval of the Authority, the busbar protection tripping circuits may be used for circuit breaker back tripping. Provision shall also be provided for maintenance testing/CB fail protection primary injection testing of one bay without tripping the connected circuit breakers of other bays.

14.0 OVER CURRENT AND EARTH FAULT INVERSE TIME 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 shall 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 not more than

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 at 25 percent intervals and the time setting adjustment shall be 0 to 3 seconds at ten times the setting current. Other characteristic shall also be selectable. 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 preferred.

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 contractor 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.

For all OHL/cable feeders, combined directional over current and earth fault relay (4 pole) shall be supplied. The residual voltage for directional earth fault protection shall be internally derived from star connected VTs secondary.

15.0 BUS COUPLER PROTECTION

The 132KV Bus-coupler shall be provided with 3 pole IDMT, numeral over current and 1-pole IDMT, numerical earth fault relay as per clause 14.

16.0 132 KV OHL FEEDER PROTECTION

(a) General

Two main, completely independent, instantaneously operating protection devices are required for fast clearance of line faults to maintain system stability.

The two protection systems shall be of different working principles.

16.1 Main 1 Protection

The main 1 protection shall comprise of current comparison type numerical differential relay with built in distance protection for OHL (or OHL + cable) feeders, and shall be suitable for use with dedicated optical fiber communication links or multiplexed systems.

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

- The relay shall have phase-segregated design, operating time of the range of one cycle.
- Relay shall have high sensitivity to in zone faults and shall be very stable against heavy through fault currents.
- Shall remain unaffected by line charging currents.
- Adjustable sensitivity for over current and earth faults.
- Shall have intertrip/permissive-intertrip facilities.
- Power-on diagnostic and continuous monitoring of important parts of the scheme including the communication link. Selectable operation mode on loss of communication.
- The relay shall have event and fault recording facility.
- Suitable for weak/non-infeed terminal.
- Stable in case one end measured (input) current is absent.
- CT Ratio Correction:
- The relay shall have charging current compensation.
- Automatic transmission delay compensation
- Thermal overload protection
- Zero sequence current differential protection for high resistance earth fault
- Distance to fault measurement, faulty phase indication, etc.
- Configurable binary inputs and outputs
- Two serial parts for local PC and a remote PC.
- Metering and recording functions.
- Inbuilt guard feature.
- Inbuilt CT supervision function
- Shall be suitable for in zone shunt reactor.

16.2 Main 2 Protection

Main 2 protection shall be provided by a numerical distance relay scheme operating in the under-reaching or “Blocking” mode with zone acceleration for use with protection signalling equipment.

It shall have the following main features:

At least three independent zones. The characteristics (MHO or quadrilateral) shall be independently selectable at site.

Completely non-switched type with separate measuring elements for 3 zones for all phase to phase and phase to ground faults

Directional characteristic of zones 1, 2 and 3 measuring elements for earth faults shall be quadrilateral and load compensated to minimise overreach for resistive faults

Characteristic for phase to phase faults may be mho or quadrilateral or any other suitable profile

Capable of operation for close-up three phase faults and with switch-on-to-fault facility

Maximum tripping time of 40 ms up to trip signal to the breaker for all practical source-to-line impedance ratios. Contour curves giving the reach and time operating performance for all types of faults at different Zs/Z1 ratios shall be submitted with the proposal

Three pole tripping and shall have additional contacts for signalling, alarms, fault locators etc.

Adjustable characteristic angle.

Variable residual compensation for all zones.

Time settings for zone 2 & 3 shall be upto at least 1.0s and 3.0s respectively in suitable steps.

Power swing detection for selective blocking.

Supervision for all type of V.T. voltage failures.

Unaffected by heavy load transfer, line charging currents, disturbed primary line currents and voltages, external switchings and sudden power reversal.

Distance protection shall be suitable for various scheme selections like PUR, POR, blocking.

Self diagnostic and on-line test features echo and weak infeed features

Serial interfaces for on-line and off-line transmission of relay operation data, line load data, fault recording, remote setting and remote test initiation.

Storage for on fault information for at least the latest three system faults, giving on demand relay operations, operating times, line load data, etc.

Connection facility to a remote PC with printer/plotter for further data exploitation with the required software for this purpose

Common portable PC (80486 processor) with adequate software for use with distance relays

Protection shall be supplemented with a sensitive directional earth fault scheme with following features. :

i) shall operate on zero-sequence current and voltage with voltage or current polarizing for zero sequence direction measurement.

ii) shall be suitable for operation in permissive overreach or blocking modes.

iii) shall ensure stability of healthy circuits in presence of mutual coupling effects from parallel lines.

iv) shall have comprehensive self monitoring features.

v) shall pose low burden to CTs'/VTs'.

Apart from above features, the relay shall have the following facilities also -

(i) A dedicated, numerical based, state-of-the-art distance-to-fault locator is required on each line. It shall have high accuracy of 1% (with printout facility for pre-fault and fault measured values for current and voltage signals.

The equipment should have consistency of performance during fault measurement in respect of:

- line loading
- fault resistance
- mutual coupling
- shunt capacitance
- earth resistivity
- non-homogeneous line
- series line unbalance
- line parameter setting errors
- signal errors from current and voltage transformers

(ii) Auto recloser unit with check-sync. facility can be an integral part of the distance relay. However, if provided separately the same shall be suitable to use with the two main protection schemes. Main features of Auto reclose scheme are described in clause 16.4

16.3 132 KV OHL Feeder

Backup Protection

Four pole, numerical, directional over current and directional earth-fault directional relay shall be provided. These shall be of multicharacteristic type. Directional over current relays shall have a relay characteristic angle of 30^{o} current leading polarising voltage. Directional earth fault elements shall employ residual voltage for polarising (internally derived inside relay) and the relay characteristic angle shall be 60^{o} current lagging polarising voltage. Thermal overload feature is to be included.

Backup protection relay shall be as per clause 14.0

16.4 Auto-reclosing equipment for 132 KV Transmission Line

Auto reclosing units can be an integral feature of distance protection relays, to avoid complexity in the scheme and shall be suitable for tapped lines.

The auto reclosing unit shall also be equipped with a complete check, Synchronising function, built in the distance protection relay.

The auto reclosing scheme shall be of delayed auto-reclosing type and shall have following main features:

(1) Three phase auto-reclosing

(2) Single shot reclosing but multishots selectable.

(3) Wide range of dead time, close pulse time and reclaim time to suit delayed auto reclosing unit/distance

(4) shall function with external unit/main protection schemes also

(5) Shall be able to reclose in all the following conditions –

- Live line/dead bus
- Dead line/live bus and live line/ live bus through its' check synchronising facility.

(6) Monitor circuit-breaker status and block auto-reclose cycle if line breaker is not healthy.

(7) Shall have facility to block and lockout auto-reclose feature from protection or synchro check relay.

(8) The auto-reclose unit shall lockout following should happen :

(i) Lockout signal received from protection relay.

(ii) Protection operates during reclaim time following the final permitted reclose attempt.

(iii) The circuit breaker has not closed when the pre-set close-pulse time has elapsed.

(iv) During three-phase reclose cycle, when the selected pre-closing voltage check conditions do not appear before the end of dead time.

The autoreclosing scheme IN/OUT provision shall also be provided with local indication in out 'selection'.

Local indications for "CB failed to close" and "successful auto recloseure" shall also be provided.

Lockable selector switch shall be provided to select the auto-reclosing when detecting single phase fault (L-G) or single phase and multiphase fault, to the discretion of FEWA.

17.0 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.
- over flux 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.

17.1 Differential Protection

132/11kV transformer differential protections shall comprise of a numerical, 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 choosen to achieve exact overall balance with the transformer at mid-point of the taping range.

However, relays with inbuilt interposing CTs are preferred.

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 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.

17.2 Transformer Restricted Earth Fault & Standby Earth Fault Protection

Transformer HV restricted earth fault protection using high impedance relays shall be provided on all 132kV 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 132kV faults shall be between 10% and 60% of the rated current of the protected winding.

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. 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 numerical type. 132kV side REF & SBEF protection relays shall be installed in 132kV relay panels.

17.3 Over fluxing protection

An over fluxing protection relay shall be provided. It shall have two adjustable definite time delayed operating stages with suitable volts/frequency settings, high reset ratio and hand reset indicator. The relay shall be installed in 132kV relay panels.

17.4 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. This relay shall be located in 132kV relay panel.

17.5 Buchholz Protection (Aux. relay)

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

17.6 Oil and Winding Temperature Protection (Aux. relay)

Necessary auxiliary flag relays with sufficient contacts for trip/alarm initiation and flag indication shall be provided in the protection panel.

17.7 Pressure Relief Device Protection (Aux. relay)

Necessary flag indication, tripping relays and alarm relays associated with this protection shall be supplied and connected in the protection panel.

17.8 Backup Over current and Earth Fault Protection

132KV Back Up Protection

132kV transformer back up over current protection shall comprise a 4 pole, numerical over current and earth fault relay complying with the requirements of clause 14.

High set over current elements shall also be provided for instantaneous over current protection of the transformer main 132kV connections and these shall be of the low transient overreach type and high drop-off/pick-up ratio. The relay shall have an adjustable current setting with an infinity setting.

132kV transformer back up earth fault protection shall comprise a single pole inverse time relay connected to a current transformer on the 132kV neutral.

Thermal overload protection shall also be included.

18.0 132 KV CABLE FEEDER PROTECTION

18.1 Main Protection

Main 1 and Main 2 Protections for 132 kV cable feeders shall be of A.C. longitudinal differential (pilot wire) type unit schemes or fibre optic current differential protection as per the schedule of requirement. The two schemes shall be from different manufacturers and shall subject to Authority approval. These protections shall be so connected to their respective CTs', that best resultant sensitivities for both earth and phase faults can be achieved. The two protections shall operate for in-zone faults but shall remain stable for through faults equal to the maximum short circuit capacities of the associated switchgear.

Protection equipment for use with pilot cables shall employ, preferably, not more than two cores of a pilot cable. Provision shall be made to continuously monitor the integrity of the pilot wires and provide an alarm should the pilots become open or short-circuited. Preference will be shown for monitoring schemes, which also detect crossed pilots. Pilot protection relays shall incorporate three-pole over current and one-pole earth fault check relays to prevent the pilot wire protection tripping the circuit breaker if local end fault current is absent. Introduction of check feature shall not increase the overall operating time of the scheme. To enable the current check feature to be taken in or out of service, a front of panel mounted IN/OUT switch shall be provided. The switch shall be lockable in both IN and OUT positions with the key withdrawable in both positions. Provision shall be made so that the CT input may be shorted to provided fault current driven intertripping if required.

Protection IN/OUT switches shall be provided to enable the isolation of all tripping, fault recorders, alarms, etc for operational or testing purposes. The switch shall be lockable with the key removable in the IN position. A lamp on the relay panel shall indicate if the protection is out of service and this indication shall be repeated into the Remote/Supervisory system. Suitable pilot isolation transformers with 15 KV insulation level shall be fixed in separate Panels with all safety measures and the same to be located in control room/switchgear room.

In case optical fibre cable is used, the above protection scheme shall be as detailed in Clause 16.1 and suitable for cable feeder, the two protections shall also be from two different manufacturers.

18.2 132kV Cable Feeder Backup Protection

Back-up protection shall comprise of 3-pole numerical IDMT directional over current relay and one single-pole numerical IDMT directional earth fault relay as per clause 14.0. Directional over current relays shall have a relay characteristic angle of 30^{o} current leading polarising voltage. Direction earth fault relays shall employ residual voltage for polarising and the relay characteristic angle shall be 60^{o} current lagging polarising voltage. Thermal overload protection feature shall be included.

19.0 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 Main 1 & Main 2 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 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 over current related protection such as circuit over current and transformer winding and oil temperature protection. TR3 shall be electrically resettable from the remote control panel and from the System Control Centre (SCC). OHL feeder protection trip relays TR1 & TR2 shall also be electrical resettable, as these feeders are being provided with auto re-closing facilities.

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

Following shall be the main features of tripping relays:

All tripping relays shall be of the heavy duty type suitable for mounting in 19'' rack and shall have operating coils which are rated sufficiently to operate in conjunction with series flag relays.

All tripping relays shall be high speed high burden type.

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.

All tripping relays shall have inbuilt cut-off contacts. For electrical reset trip relays cut-off contacts are required in both operate and reset coils.

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 provided for operation, from remote and supervisory controls for all electrical reset trip relays.

High speed tripping relays shall prevent closing of the associated circuit breakers until reset. All tripping relays shall have inbuilt hand resettable flag indication.

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.

20.0 SUPERVISION RELAYS, TEST BLOCKS:

20.1 Trip Circuit and Protection Supply Supervision

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

20.2 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.

Trip supply 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. All DC supply supervision relays shall have inbuilt self-reset reverse flag.

20.3 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.

20.4 Relay Test Blocks:

Test blocks shall isolate completely the protection relay from measuring transformers, tripping circuits and other external circuits so that no other device will be affected.

When test plug is inserted into test block, the proper sequence for testing is prepared (i.e. blocking of tripping circuits, blocking of initiating circuit of other device, short circuiting CTs, opening of voltage circuit, making relay terminal available for secondary injection etc.).

The current transformer secondary winding shall not be open circuited when the test plug is removed. Test blocks shall be flush mounting (in 19'' rack) rear connections, switchboard type with removable covers. Test blocks shall be provided with suitable identification labels and readily visible labels. For each type of test blocks atleast two sets of test plugs, test leads, shorting conductor etc. shall be supplied for each substation within the quoted price.

21.0 FAULT RECORDER EQUIPMENT

The fault recorder equipment shall be complete in all respect with data acquisition, storage, local printout and remote transmission of data facilities.

The construction of fault recorder panel shall be similar to that of relay panels and all requirements specified for relay panels are applicable.

Each fault recorder shall have 16 analogue channels to record graphically the voltages and currents for feeders and 32 digital channels for recording trip relays operated and C.B. status of each 132 kV circuit.

All feeders shall be connected to fault recorders. The No. of fault recorders shall be based on the number of feeders including spare circuits as per SLDs.

The following facilities shall be provided :

(i) Oscillograph channels to record 3 voltages and 4 currents per circuit. Frequency measurement is also required.

(ii) Marker channels shall be provided to record chronologically relay and C.B. operation.

(iii) Alarm contacts to indicate “Fault recorder operated” and “Fault recorder paper low” in the control room and “Fault recorder faulty” in the system control centre.

(iv) Memory for recording currents & Voltages at least 5 cycles prior to the occurrence of fault.

(v) The recording period shall be sufficient to cover complete auto-reclose cycle.

(vi) A device, which records and prints the date, the sub-station name, feeder name and precise time of occurrence of fault.

(vii) A push-button for initiating recording of currents & voltages.

(viii) All unused channels shall be fully equipped so that the same can be used when required.

The fault recorder shall have at the minimum, the following features :

- Modern and fully electronic modular design
- Have low power consumption and powered from station battery
- Data acquisition unit shall have sensor triggering i.e. rate of change of voltage/ current triggering, even triggering i.e. change of state of contacts on protection relays and external triggering i.e. initiation received from other recorder at the substation.
- Power failure shall not affect the stored data.

- Have an accurate crystal controlled clock with external synchronisation facility.
- Local master stations to be supplied. (Local storage unit).
- Triggering initiation by individual analogy channel shall be adjustable by the setting of under/over limit and rate of change starters.
- Have a standard interface connected to a high quality laser printer.
- IN/OUT switching facility for all digital channels (separately for each channel) with an “OUT” indicating lamp on the panel front, to inhibit triggering during maintenance.
- Distance to fault locator measurement.
- Software for fault recorder shall be supplied.

Contractor shall include consumable such as printer paper & ribbon cartridges & special fuses if any to last for one year.

Special tools such as card extenders, gain-adjustment tool and any other item, which could be used during commissioning & maintenance, shall be the part of scope of work.

The fault recorder panel shall be complete with wiring, links, test-blocks, shorting/ isolating links, terminal blocks, illumination equipment, permanent labels, earthing bars, padlocks and keys, heater, humidistat, heater on/off switch, ‘heater on’ indication etc.

Fault recorder shall have time synchronisation facility from GPS receiver. GPS receiver antenna, connection, etc. shall be supplied. One GPS receiver shall be used for all fault recorders within each substation.

22.0 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 60255 (BS. 5992 and 142), supplemented by additional tests as is considered necessary by the Authority. Routine tests reports shall be submitted for each relay and piece of equipment. The reports shall record all measurements taken during the tests.

2) The Authority reserves the right to attend 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.

3) All relay panels, BZP, control panels, fault recorder panel, pilot isolation transformer cubicle etc. shall be offered for witness inspection by FEWA at manufacturers works with all components installed. The Authority reserves the rights to insist for prototype inspection of panels to verify the method of wiring, access to mounted components etc. before the wiring of complete sets of panels.

23.0 RELAY SETTINGS CALCULATION:

All relay setting calculation shall be submitted to FEWA approval before commencing protection testing. The relay manufacturer shall prepare the relay setting calculations for all main protections before commencing site testing. Setting calculation of all protection relays other than main protection may be carried out by the contractor/suitable design consultant. Approved software may be used for protection grading (OC & EF) with suitable calculation, grading chart etc shall be submitted. All fault current required for this calculation shall be calculated by the contractor. This shall include the remote end relays affected by the interconnection of new substations to existing substations.

The relay manufacturer shall also provide all literature, methods and guidance for setting of supplied protection relays. Any items (relays, resistors, metrosils etc.) which are not in line with the relay setting calculation shall be replaced as per FEWA's schedule without any cost and time implication to the Authority.

24.0 CT/VT CALCULATIONS:

The relay manufacturer shall prepare CT/VT calculations and is subjected to the approval of Authority during detailed engineering stage.

25.0 AS BUILT DRAWINGS/CO-ORDINATED SCHEMES:

The GIS and LCC schematic diagram shall be properly co-ordinated and interfaced with relay panels, control panels, busbar protection, MV side of IBTs etc. The contractor shall submit co-ordinated control and protection schematic diagram including the interface terminal numbers, drawing number, sheet reference etc. of GIS, LCC and busbar protection schemes etc. Such schematic diagrams shall be submitted for each bay separately.

The co-ordinated schematic diagram of each bay shall contain all relevant schemes (switchgear and LCC, control panel, relay panel etc.) bunched together in a single folder with proper references. All schematic diagrams shall also include the terminals arrangement with clearly marked ferrule No., internal side, field cable side etc.

The manufacturer/contractor shall submit 6 sets of re-writable CD's of the final as built drawings, after erection, testing & commissioning of panels at substations.

The "as manufactured drawings" shall be submitted for each panel separately as hard copy also. The co-ordinated schematic diagrams indicating the reference drawing No., sheet No., terminal No., etc. of LCC scheme, control and protection scheme, Buszone scheme, fault recorder scheme, etc. shall also be submitted before FAT.

26.0 STANDARDS

IEC 60255	Electrical Protection Relays
BS 142	Electrical Protection Relays
IEC 60044-1	Current Transformers
IEC 60044-2	Voltage Transformers
IEC 60529	Degree of Protection