CHAPTER 14: TECHNICAL SPECIFICATION OF CONTROL AND RELAY PANEL

TECHNICAL SPECIFICATIONS FOR CONTROL & RELAY PANELS:

This Section is intended to cover the design, manufacture, assembly, testing at manufacturer's works and erection, testing & commissioning of Indoor Relay and Control Panels.

The Control and Relay Panels required are for control and protection of the Power Transformers and Feeders according to requirements. The supply shall include all accessories, special tools, supporting steels, spare parts, drawings, relevant software, instruction manuals etc. The panels shall be supplied complete with all accessories as specified and completely assembled and all internal wiring completed.

The sub-stations shall have automation as per IEC 61850 protocol in Bay & Station level. The bidder has to supply the C&R panels to match the requirement of Sub-station Automation System (SAS) as specified in the subsequent chapter, from the same manufacturer.

The manufacturer/supplier of Control and Relay Panels shall necessarily be an OEM (Original Equipment Manufacturer) of Numerical Protective Relays, Bay Control Units and Sub Station Automation System (SAS), having registered servicing unit in India.

Design and fabrication of Control & Protection Panels for mounting the relay and relay assemblies along with all necessary accessories like switches, indicating lamps etc. and wiring up of the same to provide self contained and ready to use protection as per this specification.

Complete testing at manufacturer's works of the relays and protection schemes including SAS after mounting and fully wiring up in the Control & Protection Panels.

STANDARDS:

All equipment and all component parts supplied under this specification shall conform in all respects to the latest issue of relevant IEC and Indian Standard Specifications except where specified otherwise in this specification. Equipment meeting any other authoritative standards which ensure an equal or better quality may also be acceptable.

SERVICE CONDITIONS:

The plant and materials supplied shall be suitable for operation under the following climatic and other conditions as mentioned in chapter 2 of this Bid document:

TYPE TEST REPORTS.

Equipment, which have never been tested for critical performance, shall not be accepted. In such cases, a promise or agreement by a bidder to have the equipment tested after award of a contract is not acceptable.

All Bids must be accompanied by the full Type Test Certificates of equipment offered. Such type test certificates shall be acceptable only if:

Tests are conducted in KEMA/NABL accredited laboratory, for GOOSE messaging etc as per relevant IEC 61850 Standards.

Inter-operability Tests are conducted in manufacturer's own laboratory. In this case (i) the laboratory must have ISO 9000 (or its equivalent) series certification; and (ii) tests have been witnessed by technically qualified representatives of earlier Indian clients of Central/State Transmission Utilities.

iii) The Validity of the Type Test Reports of CRP, Relays, BCUs and Energy Meters shall be as per CEA's "Guidelines for the Validity Period of Type Tests Conducted on Major Electrical Equipment in Power Transmission System", File No CEA-PS-14-80/1/2019-PSETD Division-Part (2).

TYPE OF PANEL

All simplex panels shall be swing type with front glass door with locking arrangement. The Minimum number of Panels shall be as per Table 1 below:

Table -1

	400kV	220kV	132kV	33kV
Feeder Panel	4 Nos if SWLR	2 Nos	2 Nos	1 No
Bus Coupler/Tie Breaker/Sectionalizer Panel	2 No	1 No	1 No	1 No
Reactor Panel	2 No			
Bus Bar Protection panel	4 Nos	2 Nos		

	400kV	220kV	132kV	33kV
Transformer Panel	400/220/33kV AT	220/132kV AT	132/33kV PT	
	3Nos (Minimum)	2Nos (Minimum)	2 Nos (Minimum)	

Swing type Simplex Control and Relay Panels shall consist of vertical swing front panels with equipment mounted thereon and having front glass door. As there will be no rear door, manufacturer shall have to keep suitable swing angle, for maintenance & testing of equipment, circuitry inspection etc. Panel front shall have lockable glass door.

These panels shall be of the Simplex type with the following approximate dimensions:

i. Height: 2250mm + 15mm anti-vibration pad + 50 mm (base)

ii. Depth: 800mm to 1000 mm

iii. Width: 800 mm to 1000 mm

iv. Operating Height: 1800 mm

14.5.4 For 33kV feeder, panel shall be of simplex type and it should accommodate one 33kV feeder in

a single cubicle and one BCU will control single 33kV feeder.

CONSTRUCTIONAL FEATURES:

The panels shall be completely metal enclosed to ensure a dust, moisture and vermin proof atmosphere. The enclosure shall provide a degree of protection not less than IP 54 in accordance with IS-2147/IEC-60529.

Panels shall be rigid free standing and floor mounting type and comprise of structural frames enclosed completely with specially selected texture finished, cold rolled sheet steel of thickness not less than 3.15 mm for weight bearing members of the panels such as base frame, front sheet and door frames and not less than 2.0 mm for sides, door top and bottom portions. There shall be sufficient reinforcement to provide level surfaces, resistance to vibration and rigidity during transportation and installation.

All joints shall be made flush and all edges shall be bent at right angles and rounded. All structural members shall be bolted or welded together. Necessary arrangement shall be provided for bolting together the adjacent panels as well as for fastening them to the floor. The opening required for mounting the equipment shall be punched or cut and filed smooth.

All doors, removable covers and panels shall be sealed all around with synthetic rubber gaskets Neoprene/EPDM generally conforming to provision of IS 11149. However, XLPE gaskets can also be used for fixing protective toughened glass doors. Ventilating louvers, if provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh.

Panels shall have additional rolled channel plinth at the bottom with smooth bearing surface. The panels shall be fixed on the embedded foundation channels with intervening layers of anti-vibration strips made of shock absorbing materials which shall be supplied by the contractor.

MOUNTING OF EQUIPMENTS:

All equipment on and in the panels shall be mounted and completely wired to the terminal blocks ready for external connection. All equipment on the front panels shall be mounted flush. Terminal markings shall be clearly visible.

Bay level intelligent electronic devices (IED) BPU for protection and control (BCU) and the Managed Ethernet Switch shall be housed in the C&R panels installed in the local control room.

INTERNAL WIRING:

Panels shall be supplied completely with interconnecting wiring provided between all electrical devices mounted and wired in the panels and between the devices and terminal blocks for the devices to be connected to equipment outside the panels. When panels are located adjacent to each other all inter panel wiring and connections between the panels shall be furnished and wiring shall be carried out internally. These adjacent inter panel wiring shall be clearly indicated in the drawing furnished by the supplier.

Bay level intelligent electronic devices (IED) for protection, control (BCU) and the Managed Ethernet Switch shall be housed in the C&R panels installed in the local control room.

All Circuits except instrument transformers and incoming AC/DC Supply circuits: 1.5 sq. mm. per lead.

Instrument transformers circuit: 2.5 sq. mm. per lead.

Auxiliary bus wiring for AC and DC supplies, voltage transformer circuits, annunciation circuits and other common services shall be provided near the top of the panel running throughout the entire length of the panels.

Wire terminals shall be made with solder less clamping type of tinned copper lugs, which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond

with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wires and shall not fall off when the wire is disconnected from blocks.

Interconnections to adjacent panels shall be brought out to a separate set of terminals blocks located near the slots or holes meant for taking the interconnecting wires. Arrangement shall permit easy interconnection to adjacent panels at site and wires for this purpose shall be provided by the supplier looped and bunched properly inside the panel.

A laminated copy of total schematics is to be fixed on the inside of door.

TERMINAL BLOCKS:

All internal wiring to be connected to the external equipment shall terminate on terminal blocks, preferably vertically mounted on the side of each panel. Terminal blocks shall be of 1100 volts grade and have 10 amps continuous rating, moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Terminal block designs include a white fibre-marking strip with clear plastic/silicon chip on terminal covers. Marking on the terminal strips shall correspond to block and terminal number on the wiring diagram.

Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. Current transformer secondary leads shall also be provided with short-circuiting and earthing facilities.

At least 20% spare terminals shall be provided on each panel and these terminals shall be uniformly distributed on all terminal blocks.

There shall be a minimum clearance of 250 mm between first row of terminal blocks and associated cable gland plates. Also, the clearance between two rows of terminal blocks shall be a minimum of 150 mm. A steel strip shall be connected between adjacent terminal block rows at 450-mm intervals for support of incoming cables.

PAINTING:

All Sheet steelwork shall be phosphated in accordance with IS 6005.

Oil grease, dirt and warp shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of 2 (two) coats of ready mixed, stoving type zinc chromate primer. The first coat may be ‘flash dried’ while the second shall be stoved.

After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after completion of tests. Exterior Paint shall be texture finishing with RAL 7032 paint shade.

Each coat of primer and finishing paint shall be of a slightly different shade to enable inspection of the painting.

The inside of the panels shall be glossy white.

A small quantity of finishing shall be supplied minor touching up required at site after installation.

NAME PLATES AND MARKINGS:

All equipment mounted on front and rear side as well as equipment mounted inside the panel shall be provided with individual nameplates with equipment designation engraved. Also, on the top of each panel on front as well as rear side large and bold name plates shall be provided for circuit /feeder designation.

All front mounted equipment shall be also provided at the rear with individual name plates engraved with Tag numbers corresponding to the one shown in the panel internal wiring to facilitate easy tracing of the wiring. The nameplates shall be mounted directly by the side of the respective equipment and shall not be hidden by the equipment wiring.

Nameplates shall be made of non-rusting metal or 3 ply lamicord. Nameplates shall be black with white engraved lettering.

14.12 MISCELLANEOUS ACCESSORIES:

A 240 Volts, single-phase plug points shall be provided in the interior of each cubicle with ON-OFF switch for connection of headlamp.

Each panel shall be provided with a LED lighting fixtures for the interior illumination of the panel complete with all fittings, i.e. lamp, switch (controlled by panel door)

Each control panel shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of D.C. and A.C. supplies of various control, AC & DC supervision, signalling, lighting and space heater circuits. MCBs of requisite capacity with fail indicators shall be used, HRC fuse is not acceptable. The main input A.C. and D.C. circuits will be protected with miniature circuit breakers.

Pistol Grip Trip Switch shall be provided.

14.13 EARTHING:

All panels shall be equipped with an earth bus securely fixed along with inside base of the panels. The materials and the sizes of the bus bar shall be at least 25X6 mm copper. When several panels are mounted joining each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply. Provisions shall be made for extending the earth bus bar to future adjoining panels on either side.

All metallic cases of equipment shall be connected to the earth bus by independent copper wires of size not less than 2.5 sq. mm. Earthing wire shall be connected on terminals with suitable clamp connectors and soldering shall not be permitted.

PT and CT secondary neutrals or common lead shall be earthed at one place only at the terminal blocks, where they enter the panels.

14.14 RECORDING METERS (ABT TRIVECTOR METERS):

General

All meters shall be housed in dust proof, moisture resistant, black finished cases and shall be suitable for tropical use. They shall be accurately adjusted and calibrated at works and shall have means of calibration, check and adjustment at site.

All these instruments and meters shall be flush mounted type and back connected, suitable for front panel mounting.

The ABT meters shall be SAMAST compatible as per specification given in subsequent chapter.

The meters should be compatible to IEC62052-11 and IEC62053-22, IEC62053-24, IS14697, IS15959.

The manufacturer shall provide Performance Certificate from CTU/STU of successful operation of minimum 3 years as on BID Opening.

RELAYS:

General

All relays shall conform to the requirements of IS 3231/ IEC 60255/ IEC 61000 or other relevant standards. The relay firmware/software shall be of the latest version.

All protective relays shall be numerical type and communication protocol shall be IEC 61850. Further, test levels of EMI as indicated IEC 61850 shall be applicable to these relays.

Two sets of relevant software (latest version) for relay configuration & setting, maintenance etc to be supplied to each station. The numeric relay and software shall be upgradable.

The protective relays shall be suitable for efficient and reliable operation of the protection scheme described in the specification. Necessary auxiliary relays and timers required for interlocking schemes for multiplying of contacts suiting contact duties of protective relays and monitoring of control supplies and circuits etc. also required for the complete protection schemes described in the specification shall be provided. All protective relays shall be provided with at least two pairs of potential free isolated output contacts. Auxiliary relays and timers shall have pairs of contacts as required to complete the scheme contacts shall be silver faced with spring action. Relay case shall have adequate number of terminals for making potential free external connections to the relay’s coils and contacts, including spare contacts.

Relays shall be suitable for flush or semi-flush mounting with connectors from rear.

All draw out cases or plug in type modular cases will have proper testing facilities. The testing facilities provided on the relays shall be specifically stated in the bid. All protective relays shall be with proper online testing facilities without isolation from TB where inputs viz CT/ PT and DC are wired. All main relays shall be provided with test plug to test the relay online & required test handle may be invariably indicated. Necessary test plug shall be in the supplier's scope of supply and shall be supplied loose. Unless otherwise specified all auxiliary relays and timers shall be supplied either in non-draw out cases or plug in type modular cases.

All A.C. relays shall be suitable for operation at 50 Hz. A.C. Voltage operated relays shall be suitable for 110 volts VT secondary and current operated relays for 1Amp. CT secondary. DC auxiliary relays and timers shall be designed for 110 volts/ 220 volts DC and shall operate satisfactorily between 70% and 110% of rated voltage. Voltage operated relays shall have adequate thermal capacity for continuous operation.

All Protective relays, auxiliary relays and timers except the lockout relays and interlocking relays shall be provided with self-reset type contacts. All protective relays, trip relays and timers shall be provided with externally/ electrically reset positive action operation indicators provided with proper inscription. All protective relays which do not have built-in hand reset operation indicators shall have additional auxiliary relays with operating indicators for this purpose. Similar separate operating indicators (auxiliary relays) shall also be provided in the trip circuits of protections located outside the board such as Buchholz relays, temperature protection etc.

No control relays that shall trip the circuit breaker when the relays are de-energized shall be employed in the circuits.

All relays shall withstand a test voltage of 2.5 kV, 50 Hz rms. voltage for one second. In case of static relays, the Clause 14.28.1.l shall be applicable.

Auxiliary seal-in unit provided in the protective relays shall preferably be of shunt reinforcement type. If series relays are used the following shall be strictly ensured:

(i) The operating time of the series seal-in unit shall be sufficiently shorter than that of the trip coil relay in series with which it operates to ensure definite operation of the flag indicator of the relay.

(ii) Seal - in unit shall obtain adequate current for operation when one or more relays operate simultaneously.

(iii) Impedance of the seal-in unit shall be small enough to permit satisfactory operation of the trip coil on trip relays when D.C. supply is minimum.

(iv) Trip-circuit seal-in is required for all trip outputs, irrespective of the magnitude of the interrupted current. The trip-circuit seal-in logic shall not only seal-in the trip output(s),but also the relevant initiation signals to other scheme functions, (e.g. initiate signals to the circuit-breaker failure function, reclosing function etc.), and the alarm output signals.

(v)Two methods of seal-in are required, one based on the measurement of AC current, catering for those circumstances for which the interrupted current is above a set threshold, and one based on a fixed time duration, catering for those circumstances for which the interrupted current is small (below the set threshold).

(vi)For the current seal-in method, the seal-in shall be maintained until the circuit-breaker opens, at which time the seal-in shall reset and the seal in method shall not now revert to the fixed time duration method. For this seal-in method, the seal-in shall be maintained for the set time duration. For the line protection schemes, this time duration shall be independently settable for single- and three-pole tripping.

(vii)Seal-in by way of current or by way of the fixed duration timer shall occur irrespective of whether the trip command originates from within the main protection device itself (from any of the internal protection functions), or from an external device with its trip output routed through the main protection device for tripping. Trip-circuit seal-in shall not take place under sub-harmonic conditions (e.g. reactor ring down).

Whenever solid state auxiliary relays are used the following requirements shall be met with:

The printed circuit cards shall be of fibre glass type and the contact shall be gold plated. All connectors with the connector pegs shall be through wire wrapping. All solder Joints on the printed circuit boards shall be encapsulated or covered with varnish.

The components shall be loaded by less than half of their rated values. The resistor shall be of carbon composition or metal oxide type and the capacitors shall be plastic film or tantalum type. Stringent measures including shielding of long internal wiring should be taken to make relays immune to voltage spikes. Relays must withstand 5kW, 1x150 microsecond, O.5 Joule source energy impulse test or 1.5 MHz damp oscillations with initial value of 2.5 kV decaying to half the initial value in 6 microseconds with internal source impedance of 150 ohms.

The supplier shall ensure that the terminals of the contacts of the relays are readily brought out for connectors as required in the final approved scheme.

DC /DC converter shall be provided in the solid state protective relays wherever necessary in order to provide a stable auxiliary supply for relay operation. Provision of DC cell in the protective relays as relievable stand-by power supplies will however not be acceptable.

Provision shall be made for easy isolation of trip circuits of each relay for the purpose of testing and maintenance.

All Spare pair of contacts of all IEDs and Alarm Relays shall be wired to Terminal Blocks exclusively for Employer’s use.

All relays and their drawings shall have phase indications as R-Red, Y-Yellow, B-Blue.

The bidder shall include in his bid a list of installations where the relays quoted have been in satisfactory operation.

General Specification of Numerical Relays

Numerical Relays shall be provided for the following applications:

Distance Protection (Main I & Main II) of different make and model for 400KV and 220 kV lines.

Distance protection for 132 kV lines.

Back up directional over current and earth fault relays for 132 kV Lines.

Back up non directional over current (3 O/C) and earth fault relays for 33kV lines

Bus Bar Protection.

Integrated Numerical Transformer Differential Protection as Main –I & Main-II of different make and model with non-directional overcurrent and earth fault function with high set units for power and autotransformers/ reactors.

Reactor Protection.

Line Differential Protection

(viii) 3 winding transformer protection relay for Main-1 & Main-2 shall be provided for all the transformers under the scope of this bid

All Numerical Relays should have following minimum features.

i) Relays shall be communicable on IEC61850 protocol without any protocol converter. Certificate from KEMA confirming interoperability, Goose messaging & publishing as per IEC61850 standard shall be submitted along with the tender. The relay shall have suitable communication facility for future connectivity to SCADA.

ii) Relays shall have one no. front RJ45 or USB port (for RS 232 port Converter to USB shall be supplied for each substation along with spare) for Local Relay Parameterization and Two nos. rear FO port for connectivity to SAS over IEC61850 protocol.

The relay shall have self-communication port monitoring feature and failure shall generate alarm.

The relay shall have sufficient battery back up to keep the internal clock running for at least 2 years in absence of auxiliary supply. The capacitor discharging power is not sufficient and won't be accepted. Proper battery back must be provided.

Should have minimum 12 configurable LEDs for 132kV and above voltage class.

vi) Should have minimum 24 Binary Inputs and 32 Binary Outputs. Moreover, the relays shall have minimum 30% BI & BO as spare after fulfilment of scheme requirement.

All BI/BOs shall be site configurable

Shall have front minimum 3 lines LCD display with Alpha numeric keypad.

Numerical relays are to be provided with built in Event / Disturbance / Fault Recorder features.

The bidder shall bring out in the bid that the Numerical relays providing different protection features / application in a single unit if any one of the application/ features goes out of service the other feature/application (s) will remain un-effected.

The relays shall be site configurable (Including logic development)

Configured features & set values shall be in non-volatile memory

Must have real time clock for time stamping of events/ disturbances with time synchronization inputs (GPRS etc.). Time synchronisation through SNTP compatible.

The major component cards shall be hot swappable and front or rear loading.

The relays should have self-diagnostic features identifying area of fault or failure of a particular component or card.

Shall have in built Circuit Breaker Failure protection based on undercurrent detection and/or circuit breaker auxiliary contact status. Provision shall be given to initiate the breaker fail logic using a digital input from external protection devices.

Relay shall have inbuilt PRP ports.

Relays shall have redundant communication channels for Protection Communication.

Hardware based measurement shall not be acceptable.

The relay should have high immunity to electrical and electromagnetic interference.

The same relay shall be provided with both 1A CT inputs and shall be site selectable.

It shall be possible to energise the relay from either AC or DC auxiliary supply. Auxiliary dc supply shall be suitable for both 110 and 220 Volt and shall be site selectable.

Be capable of performing basic instrumentation functions and displaying various instantaneous parameters like Voltage, current, active power, reactive power, phase sequence etc. in primary values. Additionally, all sequence current and voltage values shall be displayed on-line. Also the direction of power flow shall be displayed.

Extensive disturbance recording facility shall be available for at least up to 10 seconds to capture maximum possible information. Necessary software shall be provided for retrieving and analysing the records.

Facility for developing customised logic schemes inside the relay based on Boolean logic gates and timers should be available. Facility for renaming the menu texts as required by operating staff at site should be provided.

Must have additional feature of local breaker back up protection

i) The relay shall have built in Circuit Breaker Supervision Functions.

ii) The relay shall be able to detect any discrepancy found between NO & NC contacts of breaker.

iii) The relay shall monitor number of breaker trip operations.

iv) The relay shall also monitor the breaker operating time.

The relays shall have the following tools for fault diagnostics:

Fault record (shall be function of IED): – The relay shall have the facility to store fault records with information on cause of trip, date, time, trip values of electrical parameters.

Event record (shall be function of IED): – The relay shall have the facility to store time stamped event records with 1ms resolution.

Disturbance records (shall be function of IED): – The relay shall have capacity to store disturbance records of at least 10 sec. duration and sampling rate per cycle shall be more than 15.

It shall be possible to preserve stored information in the event of an auxiliary supply failure with the help of a battery backup.

The relay settings shall be provided with password protection.

It shall be possible to change the relay setting from the front panel using the key pads/ Work station of SAS and Laptop.

The relay shall have comprehensive self-diagnostic feature. This feature shall continuously monitor the healthiness of all the hardware and software elements of the relay. Any failure detected shall be annunciated through an output watchdog contact. The fault diagnosis information shall be displayed on the LCD. These records shall also be retrieved from local as well as remote terminal through the communication port.

The Numerical Relays shall be provided with 2 sets of common support software (latest version) compatible with latest version of Windows OS which will allow easy settings of relays in addition to uploading of event, fault, disturbance records, and measurements to Station HMI/ DR Work Station. The relay settings shall also be changed from local or remote using the same software.

In case of line protection and transformer/reactor protection, the features like fault recorder, disturbance recorder and event logging function as available (including if available as optional feature) in these relays shall be supplied and activated at no extra cost to the owner.

The manufacturer shall have to provide up-graded support software if any within 10 years span.

Transmission Line Protection :

Line Differential Protection Relay (If Applicable)

Main I and Main II Line Differential Protection shall be of different make and model.

The relay shall have all the features as per Distance protection relay over and above following features

1. It shall be working on phase segregated Current Differential protection principle.

2. It shall have multiple slope characteristic (preferably) to have stability against CT saturation and heavy through faults as well as sensitivity for internal faults.

3. It shall measure Differential as well as restrain current continuously and shall display the same as measurement.

5. It shall communicate to remote end through IEEE C37.94 format.

6. It shall have redundant communication channels for protection communication.

7. It shall communicate analogue as well as digital signals to remote end.

8. It shall have various communication options for remote communication i.e. mono-mode / multi-mode for direct communication / communication through multiplexer.

9. It shall have Line charging current compensation feature for better sensitivity.

10. Distance protection function can be utilized as independent or as back up of Differential protection in case of failure of remote communication. . It shall have a full scheme distance protection scheme to provide independent protection in parallel with the differential scheme in case of a communication channel failure for the differential scheme. The distance protection then provide protection for the entire line including the remote end back up capability either in case of a communications failure or via use of an independent communication channel to provide a fully redundant scheme of protection (that is a second main protection scheme). Eight channels for intertrip and other binary signals are available in the communication between the IEDs. The auto-reclose for single-, two- and/or three phase reclosing includes priority circuits for multi-breaker arrangements. It co-operates with the synchronism check.

11. It shall communicate time coordinated current signals for remote communication to execute Line differential protection algorithm accurately. Time synchronization through GPS shall also be possible.

12. It shall monitor individual communication links continuously and switchover to standby link after preset time in case of failure of one link.

13. It shall supervise individual telegrams.

14. It shall detect reflected telegrams.

15. It shall detect change in communication It shall measure delay time for remote end along with dynamic compensation of the same in differential protection algorithm.

17. It shall also supervise maximum permissible delay time.

18. It shall generate alarm for heavily disturbed communication link. Technical Parameters

A. Line Differential Protection setting:

1. Minimum operating current - 20 to 200% of In

2. Slope (Single/dual) - 10 to 100%

3. End section (Single/dual) - 20 to1000% of In

4. Highset operating current - 100 to 5000% of In

5. 2 nd Harmonic blocking - 5 to100 %

6. Typical operating time - 25 ms

7. Operating time for high set - 15 to 20 ms

8. Charging current comp. – Selectable

B. Remote communication:

9. Analogue signal transfer – Minimum 3 Nos.

10. Binary signal transfer - Minimum 8 Nos

11. Remote Communication module

Dual modules suitable for

a) 1300 nm - multi-mode

OR

b) 1300 / 1550 nm – mono-mode

(finalized during detailed engineering)

12. Synchronization mode - GPS / Echo (finalized during detailed engineering)

13. Time delay alarm - 5 to 500 ms, step 5 ms (for communication fail)

14. Time delay - 5 to 500 ms, step 5 ms (for switching to redundant channel)

15. Asymmetric delay - - 20 to +20 ms, step 1 ms (When echo mode is used)

16. Max. Transmission delay – 0 to 40 ms, step 1 ms

Distance Protection Relay

i) The distance protection relay shall be fully numerical using microprocessors and be based on a non-switched scheme.

ii) The distance protection relay shall have at least three completely independent non switched forward directional zones, one extended zone and a reverse directional zone protection.

iii) Have non-switched measurement, which implies processing of six possible fault loops (six –loop measurement).

iv) The protection algorithm shall utilize fault voltages and currents, as well as the superimposed voltages and currents to arrive at a secure trip decision in the shortest possible time with reliability, selectivity and full sensitivity to all types of faults online.

v) Have polygonal characteristics with independently adjustable reactive and resistive reaches for maximum selectivity and maximum fault resistance coverage. The zones shall have independent settable earth fault compensation factors to cater to adjacent lines with different zero sequence to positive sequence ratios.

vi) Selection shall be so that the first zone of the relay can be set to about 80% - 85% of the protected line without any risk of non-selective tripping.

The second and third zone elements shall provide backup protection in the event of the carrier protection or the first zone element failing to clear the fault, zone-2 shall cover full protected section plus 50 % of the next section, zone-3 shall normally cover the two

adjacent sections completely. The zones must have independent time settings.

Shall have resetting time of less than 55 milli-seconds (including the resetting time of trip relays)

All the zones shall have setting such that they can detect the fault online from minimum 0.3 km to 500 km.

The maximum fault current could be as high as 63kA but the minimum fault current could be as low as 20% of rated current. The starting and measuring relays characteristics should be satisfactory under these extreme varying conditions.

The relay shall use the memory voltage for proper directional discrimination at close in 3 phase fault which shall be based on positive sequence voltages. The directional discrimination and phase selection based on negative sequence measurement techniques is not acceptable.

Have adequate number of forward zones (minimum three) and a reverse zone. The zone reach setting ranges shall be sufficient to cover line lengths appropriate to each zone. Carrier aided scheme options such as permissive under reach, overreach, & blocking and non-carrier aided schemes of zone 1 extension and Loss of load accelerated tripping schemes shall be available as standard. Weak in feed logic and current reversal guard also shall be provided.

In case the carrier channel fails, one out of the non-carrier-based schemes cited above should come into operation automatically to ensure high speed and simultaneous opening of breakers at both ends of the line.

Shall have suitable number of potential free contacts for Carrier Aided Tripping, Auto Reclosing, CB Failure, Disturbance/Fault recorder and Data Acquisition System.

Have a maximum operating time up to trip impulse to circuit breaker (complete protection time including applicable carrier and trip relay time) for SIR 0.01-4: as 40ms at the nearest end and 60ms at the other end of line & for SIR 4-15: as 45ms at the nearest end and 65ms at the other end of line with carrier transmission time taken as 20ms. Isochronic curves shall be provided in support of operating times.

Shall have an independent Directional Earth Fault (DEF) protection element to detect highly resistive faults as a built in feature. This element shall have an inverse time/definite time characteristic.

Has logic to detect loss of single /two-phase voltage input as well as three-phase voltage loss during energisation and normal load conditions. The voltage circuit monitoring logic in addition to blocking the distance protection element, enable an emergency over current element to provide a standby protection to the feeder until the re-appearance of voltage signal.

The VT fuse failure function shall function properly irrespective of the loading on the line. In other words, the function shall not be inhibited during operation of line under very low load conditions.

Have necessary logic to take care of switch-on-to-fault condition. Energisation of transformers at remote line ends and the accompanying inrush current shall not cause any instability to the operation of relay.

Have power swing blocking and Out of Step protection feature, with facilities for fast detection of power swing selective blocking of zones settable unblocking criteria for earth faults, phase faults and three phase faults. It shall be on the principle of measurement of the rate of impedance vector change and monitoring of the vector path. It should have the Earth fault detection feature, which shall override power swing blocking and allow the relay to operate for trip as per zone detection. The relay shall be blocked for the set time for the first PS sensed and remain unblocked for the set time for the successive PS.

Be suitable for single pole or three pole tripping. However, relays offered for 132 kV lines provided with mechanically ganged circuit breakers, single pole tripping need not to be provided.

Be suitable for both bus PT or Line PT/ CVT supply.

Shall have in built Trip circuit supervision facility to monitor both pre- and post close supervision facilities. An alarm shall be generated.

Shall have in built broken conductor detection by way of level detector or negative sequence measurement.

Shall have df/dt functions.

Shall have multistage under frequency setting options.

The sensitivity of the logic shall not be affected during operation under low load.

Shall have a fault locator with an accuracy of ±3%. The display should be in kilometres and preferably in percentage impedance too. The fault locator should have built in mutual compensation for parallel circuit.

Have mutual zero sequence compensation factor setting. The relay shall have facility to select different group settings to cater for mutual coupling on account of multi circuit line conditions. The minimum no. of group should be four.

xxxii Have at least 24 no of programmable BI and 32 no of programmable BO contact to cater for DR/SER carrier aided tripping auto re-closing etc.

The distance relays shall have a built-in auto-reclose function with facilities for single pole / three pole / single and three pole tripping. It shall be possible to trigger the A/R function from an external protection. A voltage check function which can be programmed for deadline charging/dead bus charging / check synchronising shall be included. However, the relay shall support independent A/R scheme.

Shall have additional features to provide under/ over voltage protection.

Shall have additional features to provide under frequency protection

Shall have memory circuits with defined characteristics in all three phases to ensure correct operation during close-up 3 phase faults and other adverse conditions and shall operate instantaneously when circuit breaker is closed to zero-volt 3 phase fault.

The protective relays shall be suitable for use with capacitor voltage transformers having non electronic damping and transient response as per IEC.

Shall have a continuous current rating of two times of rated current. The voltage circuit shall be capable of operation at 1.2 times rated voltage. The relay shall be also capable of carrying a high short time current of 70 times rated current without damage for a period of 1 sec.

Must have a current reversal guard feature.

Shall have Stub Protection function with current setting minimum range of 1 to 3 pu with definite time delay setting, minimum range of 0 to 100 msec

Have feature of load encroachment blinder to safeguard the protection trip during heavy line loading condition.

Integrated Numerical Transformer Protection Relay

GENERAL REQUIREMENTS:

i) Shall be stable during magnetising inrush and over fluxing conditions. Stabilization under inrush conditions shall be based on the presence of second harmonic components in the differential currents.

ii) Shall have saturation discriminator as an additional safeguard for stability under through fault conditions.

iii) Shall have zero sequence current filtering, which may be deactivated separately for each winding, for special applications.

iv) Shall have software to take care of the angle & ratio correction of CT inputs.

v) Shall have all output relays suitable for both signals and trip duties

FUNCTIONAL DESCRIPTIONS:

The integrated Numerical Transformer Protection Scheme shall have following functional qualities:

Differential protection:

The relay shall be biased differential protection with triple slope tripping characteristics with faulty phase identification / indication. The range for the differential pick-up shall be from 0.1 to 2.5 p.u. Its operating time shall not exceed 30 ms at 5 times rated current.

The relay shall have two adjustable bias slopes from 20 % to 150 % and slope from 40% to 150 %, to provide maximum sensitivity for internal faults with high stability for through faults

The relay shall have an unrestrained high set element to back up the biased differential function and the setting range for it shall have a minimum setting of 5pu and a maximum setting of 30pu.

The relay shall have the second harmonic restraint feature for stability under transformer inrush condition. The setting shall be 15-25%.

Further, the fifth harmonic blocking for stability under transient over fluxing condition shall be provided.

Have suitable non-linear resistors along with stabilizing resistor for CT Circuit to limit peak voltage during in-zone faults in case of high impedance type.

Have a fault recording feature to record graphic form of instantaneous values of following analogue channels during faults and disturbances for the pre fault and post fault period: Current in all three windings in nine analogue channels plus three analogue channels for Backup protection in case of 400kV class/ 220kV Class (In case of loaded tertiary) or 9 analogue channels for lower voltage transformers and voltage in three channel.

The Disturbance recorder function built in the Differential Protection IED shall have the facility to record the following external digital channel signals associated with transformer which shall be wired to differential relay apart from the digital signals pertaining to differential relay:

REF Protection Operated

HV Breaker Status (Main &Tie/Transfer both separately)

IV/LV Breaker status (Main & Tie/Transfer both separately)

Bucholz/OLTC/OTI/WTI alarm

Bucholz/ PRD/ SPR Trip

Group-A/ Group-B lockout relay trip

Necessary hardware and software, for automatic up loading of the data captured by disturbance recorder to the personal computer (DR Work Station) available in the sub station, shall be included in the scope.

ix) The Relay shall have Reverse Power Protection feature.

x) The Differential Relay shall be designed for the protection & control of 3 winding Transformer

Restricted Earth fault Protection:

The scheme shall have in-built restricted earth Fault (REF) for both the windings. The REF function shall be configurable to Auto Transformer also. This function should be provided to maximise the sensitivity of the protection of earth faults. Both the Differential relay shall have inherent high impedence REF element. The REF function should be able to share Current Transformers with the bia sed differential function. As in traditional REF protections, the function should respond only to the fundamental frequency component of the currents. For star/star transformer, both the windings shall be protected through REF, as such relay shall have sufficient analo gue channels to accommodate the same.

Over fluxing Protection:

The over fluxing protection shall be built in the relay. By pairs of V/f and t, it shall be possible to plot the over fluxing characteristics so that accurate adaptation of the power transformer data is ensured.

In addition, the relay should have a definite time element for alarm.

The relay should monitor all the three phase voltages for calculation of V/f and should take the highest voltage for V/f calculation.

Thermal Overload Protection:

Shall have two stages of thermal overload protection for alarm and trip condition with continuously adjustable setting range of 100-400% of rated current and time constant setting range of 1.0 to 10.00sec continuously.

Shall be single pole type.

Shall have a drop off/pick up ratio greater than 95%.

Shall have separately adjustable time delay relays for alarm having a setting range of 1to 10 seconds continuously.

Over Current and Earth fault protection:

The relay shall have three stages of definite time Directional over current protection as backup operating with separate measuring systems for the evaluation of the three phase currents, the negative sequence current and the residual current.

In addition, the relay shall have three stages of Inverse time Directional over current protection operating based on one measuring system each for the three phase currents, the negative sequence current and the residual current.

Shall have additional features to provide under/ over voltage protection.

Shall have additional features to provide under frequency protection.

The Earth fault relay shall have directional IDMT characteristic with a definitive minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 20-80% of rated current. (with selectable IEC Curves).

The Earth fault relay shall have low transient, overreach high set instantaneous unit of continuously variable setting range 200-800 % of rated current.

Transformer Neutral Current relay (for 400 KV class transformer only) shall

Have directional IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 20-80% of rated current. (with selectable IEC Curves)

Over Current and Earth Fault Relays

These relays shall be of numeric, single/multi pole, directional /non-directional type with high set element as specified. These relays shall have the following features/characteristics:

(i) IDMT characteristic with definite minimum time of 3 second at 10 times setting.

(ii) Other operating curves such as inverse, very inverse shall be selectable

(iii) Adjustable setting range of 50-200 % and 20-80% of rated current for over current and earth fault relays respectively.

(iv) The directional relays shall have a Maximum torque angle of 45° current leading for directional over current unit & 30 lag for directional earth fault. Other MTAs should be settable

(v) Voltage polarizing coil: 63.5 or 110volt

(vi) Must have faulty phase, type of fault identification

(vii) The directional relays shall have over voltage/ under voltage & under frequency built in protection

(viii) The relay shall have blocking scheme on Reverse Power Flow.

(ix) Include LED indicators.

Reactor Protection

REACTOR DIFFERENTIAL PROTECTION RELAY Shall

Be triple pole type.

Have operation time less than 25 milli-seconds at 5 times setting

Be tuned to system frequency.

Have an operating current sensitivity of at least 10% of nominal current

Have current setting range of 10 to 40% of 1 Amp. or a suitable voltage setting range

Be high impedance / biased differential type.

Have suitable non-linear resistors along with stabilizing resistor for CT Circuit to limit peak voltage during in-zone faults in case of high impedance type.

Be stable for all external faults.

REACTOR RESTRICTED EARTH FAULT PROTECTION RELAY shall

Be single pole type.

Be of current/voltage operated high impedance type.

Have a current setting of 05-40% of 1 Amp. / have a suitable voltage setting range

Be tuned to system frequency

Have a suitable non-linear resistor to limit the peak voltage to 1000 Volts.

REACTOR BACK UP IMPEDANCE PROTECTION RELAY shall

Be triple pole type, with faulty phase identification/ indication.

Be single step polarized 'mho' distance/ impedance relay suitable for measuring phase to ground and phase to phase faults

Have adequate ohmic setting range to cover at least 60% of the impedance of the reactor and shall be continuously variable

Have an adjustable characteristic angle of 30-80 degree

Have a definite time delay relay with a continuously adjustable setting range of 0.2-2.0 seconds

Include VT failure relay which shall block the tripping during VT fuse failure condition.

Have Back Up over Current and Earth fault protection as built in function.

Circuit Breaker Protection

a) LOCAL BREAKER BACK-UP PROTECTION SCHEME shall

Be triple pole type.

Have an operating time of less than 15 milli seconds

Have a resetting time of less than 15 milli seconds

Have three over current elements

Be arranged to get individual initiation from the corresponding phase of main protections of line for each over current element. However, common three phase initiation is acceptable for other protections and transformer /reactor equipment protections

Have a setting range of 10-80% of rated current

Have a continuous thermal withstand two times rated current irrespective of the setting

Have a timer with continuously adjustable setting range of 0.1-1 seconds

Have necessary auxiliary relays to make a comprehensive Scheme

Shall have re-trip feature for tripping its own CB after initiation with a set time delay.

Be acceptable as Built-in protection function of distributed bus bar protection scheme only; however in that case separate LBB relay shall be provided for tie bays.

b) NUMERICAL AUTO RECLOSING FUNCTION (where specified) shall be an in built feature of Main-I and Main-II protection relay. The Auto Reclose shall

Have single phase and three phase reclosing facilities.

Have a continuously variable single-phase dead time range of 0.1-2 Seconds

Have a continuously variable three phase dead time range of 0.1-2 Seconds

Have a continuously variable reclaim time range of 5-300 seconds

Incorporate a four-position selector switch/ from which single phase/three phase/single and three phase auto-reclosure and non-auto reclosure mode can be selected. Alternatively, the mode of auto reclosing can be selected through HMI of the relay or BCU & SAS.

Have facilities for selecting check synchronizing or dead line charging features. It shall be possible at any time to change the required feature by reconnection of links.

Be of single shot type

Have priority circuit to closing of both circuit breakers in case one and half breaker arrangements to allow sequential closing of breakers

Include check synchronizing relay which shall

Have a time setting continuously variable between 0.5-5 seconds with a facility of additional 10 seconds

Have a response time within 200 milli seconds with the timer disconnected.

Have a phase angle setting not exceeding 35 degree

Have a voltage difference setting not exceeding 10%

Include deadline charging relay, which shall

Have two sets of relays and each set shall be able to monitor the three-phase voltage where one set shall be connected to the line CVTs with a fixed setting of 20% of rated voltage and the other set shall be connected to the bus CVTs with a fixed setting of 80% of rated voltage.

Incorporate necessary auxiliary relays and timers to give comprehensive scheme.

Auto Reclose function shall be an in-built feature of the BCU and the signal exchange for auto-reclose function from BCU to main relays and vice versa shall be achieved through hard wiring and GOOSE parallelly.

Bus Bar Protection Relay

These relays shall also be of numeric type.

Redundant (1+1) numerical low impedance biased differential Bus Bar protection scheme for each bus system (Bus1 +Bus2) for 400kV shall be provided. The scheme shall be engineered so as to ensure that operation of any one out of two schemes connected to main faulty bus shall result in tripping of the same.

Single bus bar protection scheme shall be provided for each main bus (Main I/Main II) and transfer bus (as applicable) for 220KV and 132kV voltage level.

Each Bus Bar protection scheme shall

Have maximum operating time up to trip impulse to trip relay for all types of faults of 25 milli seconds at 5 times setting value.

Operate selectively for each bus bar

Give hundred percent security up to 63 KA for fault level for 400 KV , 50kA for 220 KV and 40 KA for 132 KV

Incorporate continuous supervision for CT secondary against any possible open circuit and if it occurs, shall render the relevant zone of protection inoperative and initiate an alarm

Not give false operation during normal load flow in bus bars

vi) Incorporate clear zone indication

e) It shall have End fault Protection & LBB function

f). Be of phase segregated and triple pole type. The bus bar scheme may be Centralized or De-Centralized type and it must accommodate all future bays as per Project along with tripping relays.

g) Provide independent zones of protection (including transfer bus if any). If the bus section is provided, then each side of bus section shall have separate set of bus bar protection schemes

h) Include individual high speed electrically reset tripping relays for each feeder. However, in case of distributed Bus bar protection, individual trip relay shall not be required if bay unit is having trip duty contacts for breaker tripping.

i) Be transient free in operation

j) Include continuous D.C. supplies supervision

Not cause tripping for the differential current below the load current of heaviest loaded feeder. Contractor shall submit application check for the same.

Shall include necessary C.T. switching relays wherever C.T. switching is involved and have 'CT' selection incomplete alarm

Include protection 'IN/OUT' switch for each zone

Shall include trip relays, CT switching relays (if applicable) , auxiliary CTs (if applicable) as well as additional power supply modules, input modules etc. as may be required to provide a Bus bar protection scheme for the complete bus arrangement i.e. for all the bays or breakers including future bays as per the Single line diagram for new substations. However, for extension of bus bar protection scheme in existing substations, scope shall be limited to the bay or breakers covered under this specification. Suitable panels (if required) to mount these are also included in the scope of the work.

In case of distributed Bus bar Protection, the bay units for future bays may be installed in a separate panel and the same shall be located in switchyard panel room where bus bar protection panel shall be installed.

Tee Differential Protection Relays (If Applicable)

TEE-1 DIFFERENTIAL (BIAS) PROTECTION RELAY shall

(a) be triple pole type

(b) have an operating time less than 30 milliseconds at 5 times the rated current

(c) have three instantaneous high set over current units

(d) have an adjustable bias setting range of 20-50%

(e) have an operating current setting of 15% of 1 Amp or less

TEE-2 DIFFERENTIAL (HIGH IMPEDANCE) PROTECTION RELAY shall

(a) be triple pole type

(b) have operating time less than 25 milliseconds at 5 times setting

(c) be tuned to system frequency

(d) have current setting range of 20 to 80% of 1 Amp

(e) be voltage operated, high impedance type

(f) be stable for all external faults

(g) be provided with suitable nonlinear resistors across the relay to limit the peak voltage to 1000 volts

Trip Circuit Supervision Relay

Trip circuit supervision relay shall be provided for each pole of the breaker for both trip coils with separate DC source.

The relay shall be capable of monitoring the healthiness of each 'phase' trip-coil and associated circuit of circuit breaker during 'ON' and 'OFF' conditions.

The relay shall have adequate contacts for providing connection to alarm and event logger.

The relay shall have time delay on drop-off of not less than 200 milli seconds and be provided with operation indications for each phase.

Master Trip Relay

High Speed Tripping Relay shall be instantaneous (operating time not to exceed 10 milli-seconds

The relays shall reset within 20 milli seconds

The relay shall be re-settable/configurable from local SCADA.

The relays shall be D.C. operated

The relays shall have adequate contacts to meet the requirement of scheme, other functions like auto-reclose relay, LBB relay as well as cater to associated equipment like event logger, Disturbance recorder, fault Locator, etc.

The relays shall be provided with operation indicators for each element/coil.

Other Trip Relays

For transformer protection other trip relays for Buchholz, winding & oil temperature high, PRD etc. shall be provided as per requirement.

These High-Speed Tripping Relays shall be instantaneous (operating time not to exceed 10 milli-seconds)

The relays shall have adequate contacts to meet the requirement of scheme

DC Supply Supervision Relay

The relay shall be capable of monitoring the failure of D.C. supply to which, it is connected.

It shall have adequate potential free contacts to meet the scheme requirement.

The relay shall have a 'time delay on drop-off' of not less than 100 milli seconds and the relays shall be provided with operation indicator/flag.

TIME SYNCHRONISATION EQUIPMENT:

The equipment must be Type tested for Shock, Vibration, Dry heat, Radiated Emission, Electromagnetic field immunity, Electrostatic discharge immunity test in a Standard Laboratory. Type test report shall be submitted along with the bid. Type tests shall be more than five years as on opening of this bid.

The equipment shall be compliant to IEC 61850 Protocol. It shall also support the network protocols like NTPv4, SNTP, SNMPv1,2,3, SNMP Trap, SSH2, Ipv6, DHCP, HTTP (S), eMail, FTP, TELNET and Syslog

The Time synchronisation equipment shall receive the coordinated Universal Time (UTC) transmitted through Geo Positioning Satellite System (GPS) and synchronise equipment to the Indian Standard Time in a substation.

Time synchronisation equipment shall include antenna, all special cables and processing equipment etc.

It shall be compatible for synchronisation of Event Loggers, Disturbance recorders and SCADA at a substation through individual port or through Ethernet realised through optic fibre bus.

Equipment shall operate up to the ambient temperature of 50 degree centigrade and 100% humidity.

The synchronisation equipment shall have 20 nano second accuracy. Equipment shall give real time corresponding to IST (taking into consideration all factors like voltage, & temperature variations, propagation & processing delays etc.) including communication time for satellite link to achieve real time signal.

Equipment shall meet the requirement of IEC 60255 for storage & operation.

The system shall be able to track the satellites to ensure no interruption of synchronisation signal.

The output signal from each port shall be programmable at site for either one hour, half hour, minute or second pulse, as per requirement.

The equipment offered shall have six (6) output ports. Various combinations of output ports shall be selected by the customer, during detailed engineering, from the following:

1) Voltage signal: Normally 0-5V with 50 milli Seconds minimum pulse duration. In case any other voltage signal required, it shall be decided during detailed engineering.

2) Potential free contact (Minimum pulse duration of 50 milli Seconds.)

3) IRIG-B

4) RS232C

5) RJ 45

6) SNTP

7) Optical

8) IEEE 1588 PTP (Applicable only for process bus automation station)

The equipment shall have a periodic time correction facility of one-second periodicity.

Time synchronisation equipment shall be suitable to operate from 80V-250V DC supply available at the sub-station with voltage variation of + 10% and -15%.

. Equipment shall have real time digital display in hour, minute, second (24-hour mode) & have a separate time display unit to be mounted on the top of control panels/SAS Panels having display size of approx. 100 mm height.

The cable connecting Antenna and Time Synchronising unit should be run through HDPE pipe or GI pipe from the location of Antenna fixing to Time Synchronising panel with suitable fixtures and no provision to enter rainwater and should not be affected by atmospheric conditions.

Time Synchronisation software shall be window base and it should be provided free of cost after commissioning.

BAY CONTROL UNIT (BCU)

The BCU must be type tested at KEMA/Internationally or nationally acreditted other testing laboratories for IEC 61850 and other tests as per relevant IEC standards. The bidder is to submit type test reports along with the bid. The validity of type test report shall be as per Clause 14.4.2(iii).

The bay unit shall use industrial grade components. The BCU shall be modular type. The bay level unit, based on microprocessor technology, shall use numerical techniques for the calculation and evaluation of externally input analogue signals. These shall incorporate select- before-operate control principles as safety measures for operation via the HMI. These shall perform all bay related functions, such as control commands, bay interlocking, data acquisition, data storage, event recording and shall provide inputs for status indication and outputs for commands. These shall be directly connected to the switchgear. The bay unit shall acquire and process all data for the bay (Equipment status, fault indications, measured values, alarms etc.) and transmit these to the other devices in sub-station automation system. In addition, these shall receive the operation commands from station HMI and SLDC. The bay unit shall have the capability to store all the data for at least 24 hours even if there is any power off conditions during the day. The BCU shall have Auto Reclose, LBB, U/O voltage and Synchronization function. The BCU shall have redundant power supply card i.e. in case of failure of one source/Card fail, the redundant shall pick up instantly. Power supply card failure shall generate necessary alarm to local SCADA.

The BCU must have metering functions like phase current, phase voltages, active & apparent power, power factor, frequency etc. The metering functions shall be accurate for a minimum of 1% of rated current.

BCU HMI shall display complete mimic of the respective bay, and operator shall be able to select the equipment in the mimic diagram for which operation of equipment is required. The control operation shall be password protected. For 33kV, the HMI should display one bay and control thereof.

The mimic diagram shall indicate the live & dead portion of the Bay.

The BCU shall be capable to generate password for maintenance shutdown.

One Bay level unit shall be provided for supervision and control of each 400KV, 220KV, 132kV and 33kV bay (a bay comprises of one circuit breaker and associated disconnectors, earth switches and instrument transformer). If the 33kV bus section comprises isolator only, then the isolator shall be controlled from the transformer LV side bay and same is the case for Bus PT Isolator which shall be controlled by Transformer LV side BCU. The Bay level unit shall be equipped with analogue and binary inputs/outputs for handling the control, status monitoring and analogue measurement functions. All bay level interlocks are to be incorporated in the Bay level unit so as to permit control from the Bay level unit/ local bay mimic panel, with all bay interlocks in place, during maintenance and commissioning or in case of contingencies when the Station HMI is out of service.

The BCU shall have sufficient number of BI/BO as per the scheme requirement with additional 30% spare BI/BO.

The Bay level units shall be installed in the control and relay panels located in the control room.

The Bay level unit shall meet the requirements for withstanding electromagnetic interference according to relevant parts of IEC 61850. Failure of any single component within the equipment shall neither cause unwanted operation nor lead to a complete system breakdown.

Input / Output (I/O) modules

The I/O modules shall form a part of the bay level unit and shall provide coupling to the substation equipment. The I/O modules shall acquire all switchgear information (i.e. data coming directly from the switchgear or from switchgear interlocking devices) and transmit commands for operation of the switchgear.

The measured values of SF6 Gas Pressures, Operating Mechanism Pressures, WTIs, OTI etc. are received through transducers to Bay Level Unit

The digital inputs shall be acquired by exception with 1 ms resolution. Contact bouncing in digital inputs shall not be assumed as change of state.

Operator Interface

The HMI of BCU shall display the following informations

i) the bay name

ii) the date and time

iii) the Local / Remote/Maintenance bay mode

iv) the auto-recloser function status (on / off),

v) the synchrocheck function status (on / off),

vi) the interlock function status (on / off),

vii) a list of measurements (in real value)

viii) the bay graphical representation

ix) the bay events classified in a chronological order

x) the bay alarms

xi) the list of disturbance records available

xii) Bay interlock diagram

In addition, it shall be possible to plug a PC laptop on the Bay and get the full substation operator interface.

SWITCHED ETHERNET COMMUNICATION INFRASTRUCTURE:

The bidder shall provide the redundant managed switched optical Ethernet communication infrastructure for SAS against PRP architecture. The necessary switches are provided for communication infrastructure as follows.

One switch shall be provided to connect all IEDs for 1 Bay in LAN –I and the second optical port of Bay IEDs shall be connected to other Ethernet Switch in LAN-2. The maximum number of bays may be connected to these Ethernet Switch shall be two bays for 400KV, 220kV and 132kV. However, for 33kV, 3 numbers bay may be connected to one Ethernet Switch in this PRP architecture. The exact no of Ethernet switches required for complete implementation of the scheme shall decided during detailed engineering.

The managed Ethernet switch shall have minimum 20% port redundancy (Both Fibre & Copper ports).

Ethernet Switches shall have redundant power card.

Port monitoring softwares for Ethernet Switches are to be provided.

The make of the Ethernet switches shall be Ruggedcom/Hirschman/ABB.

FAULT RECORDER:

The fault recorder shall be provided for transmission line and the fault recorder as in-built feature of line distance relay is also acceptable provided the requirements of following clauses are met.

Fault recorder shall be capable to record the graphic form of instantaneous values of voltage and current in all three phases, open delta voltage & neutral current, open or closed position of relay contacts and breakers during the system disturbances.

The Fault recorder shall consist of individual acquisition units, one for each feeder and an Evaluation unit (as described in section sub-station automation through bus conforming to IEC 61850) which is common for the entire Substation. Necessary hardware and software shall also be supplied for online transfer of data from all acquisition units to Evaluation unit.

Fault recorder shall have at least 8 analogue and 16 digital channels for each feeder.

Acquisition units shall acquire the Disturbance data for the pre fault and post fault period and transfer them to Evaluation unit automatically to store in the hard disk. The acquisition units shall be located in the protection panels of the respective feeders.

The acquisition unit shall be suitable for inputs from current transformers with 1A rated secondary and capacitive voltage transformers with 63.5V (phase to neutral voltage) rated secondary. Any device required for processing of input signals in order to make the signals compatible to the Fault recorder equipment shall form an integral part of it. However, such processing of input signals shall in no way distort its waveform.

The equipment shall be carefully screened, shielded, earthed and protected as may be required for its safe functioning. Also, the Fault recorder shall have stable software, reliable hardware, simplicity of maintenance and immunity from the effects of the hostile environment of EHV switchyard which are prone to various interference signals typically from large switching transients.

The evaluation unit hardware shall be as described in clause no. 4.0 of section sub-station automation.

Necessary software for transferring the data automatically from local evaluation unit to a remote station and receiving the same at the remote station through owner's PLCC/VSAT/LEASED LINE shall be provided.

Evaluation software shall be provided for the analysis and evaluation of the recorded data made available in the PC under WINDOWS environment. The Software features shall include repositioning of analog and digital signals, selection and amplification of time and amplitude scales of each analogue and digital channel, calculation of MAX/MIN frequency, phase difference values, recording of MAX/MIN values etc. of analogue channel, group of signal to be drawn on the same axis etc, listing and numbering of all analogue and digital channels and current, voltage, frequency and phase difference values at the time of fault/tripping. Also, the software should be capable of carrying out Fourier /Harmonic analysis of the current and voltage wave forms. The Disturbance records shall also be available in COMTRADE format (IEEE standard- Common Format for Transient data Exchange for Power System)

The Evaluation unit shall be connected to the printer to obtain the graphic form of disturbances whenever desired by the operator.

Fault recorder acquisition units shall be suitable to operate from 220V DC as available at sub-station Evaluation unit along with the printer shall normally be connected to 230V, single phase AC supply. In case of failure of AC supply, Evaluation unit and printer shall be switched automatically to the station DC through Inverter of adequate capacity which shall form a part of Distance recorder system. The inverter of adequate capacity shall be provided to cater the requirement specified in section sub-station automation clause no. 8.0 and DR evaluation unit.

The acquisition unit shall have the following features:

Facility shall exist to alarm operator in case of any internal faults in the acquisition units such as power supply fail, processor / memory fail etc. and same shall be wired to annunciation system.

The frequency response shall be 5 Hz on lower side and 250 Hz or better on upper side.

Scan rate shall be 1000 Hz/channel or better.

Pre-fault time shall not be less than 100 milliseconds and the post fault time shall not be less than 2 seconds (adjustable). If another system fault occurs during one post-fault run time, the recorder shall also be able to record the same. However, the total memory of acquisition unit shall not be less than 5.0 seconds.

The open delta voltage and neutral current shall be derived either through software or externally by providing necessary auxiliary transformers.

The acquisition unit shall be typically used to record the following digital channels:

Main CB R phase open

Main CB Y phase open

Main CB B phase open

Main-1 carrier received

Main-1 protection operated

Main/Tie /TBC Auto reclosed operated

Over Voltage -Stage-1 /2 operated

Reactor / Stub/TEE-1/2/UF protection operated

Direct Trip received

Main-2 carrier received

Main- 2/ Back Up protection operated

Bus bar protections operated

LBB operated of main /tie/TBC circuit breaker

Tie/TBC CB R phase open

Tie/TBC CB Y phase open

Tie/TBC CB B phase open

In case the Fault recorder is in-built part of line distance protection, above digital channels may be interfaced either externally or internally.

Any digital signal can be programmed to act as trigger for the acquisition unit. Analogue channels should have programmable threshold levels for triggers and selection for over or under levels should be possible.

The printer shall be compatible with the desktop PC and shall use Plain paper. The printout shall contain the Feeder identity, Date and time (in hour, minute and second up to 100th of a second), identity of trigger source and Graphic form of analogue and digital signals of all the channels. Two packets of paper (500 sheets in each packet) suitable for printer shall be supplied.

Each Fault recorder shall have its own time generator and the clock of the time generator shall be such that the drift is limited to +0.5 seconds/day, if allowed to run without synchronization. Further, Fault recorder shall have facility to synchronize its time generator from Time Synchronization Equipment having output of following types.

Voltage signal: (0-5V continuously settable, with 50m Sec. minimum pulse duration).

Potential free contact (Minimum pulse duration of 50 m Sec.)

IRIG-B/SNTP

RS232C/RS485/RJ 45/Optical port.

The recorder shall give annunciation in case of absence of synchronizing within a specified time.

DISTANCE TO FAULT LOCATOR:

The Distance to Fault Locator shall be provided for transmission line and the fault locator as in-built feature of line distance relay is also acceptable provided the requirements of following clauses are met.

Distance to Fault Locator shall be electronic or microprocessor based and ‘Online’ type with built-in display unit.

The display shall be directly in percent of line length or kilometers without requiring any further calculations.

It shall have an accuracy of 3% or better for the typical conditions defined for operating timings measurement of distance relays. The accuracy should not be impaired under the following conditions:

presence of remote end in-feed

predominant D.C. component in fault current

high fault arc resistance

severe CVT transients

It shall have mutual zero sequence compensation unit if fault locator is to be used on double circuit transmission line.

PROTECTION SCHEME FOR PANELS:

400KV Line Panel

The following protections scheme shall be provided for Panels for 400 KV Transmission lines:

Main Protection Scheme I & II:

Distance protection scheme using Numerical Relay as specified in detail in Clause 14.15 and 14.16.2 shall be implemented. The summary of the scheme detailed in the above clauses have the following feature:

Permissive under reach/over reach/ blocking communication mode.

Suitable for single cum three phase tripping.

Power swing blocking and out of step protection.

Single shot single-cum-three phase auto re-closing with check synchronising and deadline charging features.

Fuse failure protection.

Weak end in feed feature.

Over/Under Voltage Protection

Directional Over current and Earth Fault protection

Current reversal guard feature

Stub protection function

Load encroachment blinder feature.

Switch on to fault feature.

In built Broken Conductor detection feature.

Shall have df/dt functions

Under frequency protection

Carrier Aided Tripping

Main 1 and Main 2 relay shall of different make and model.

220 KV Line Panel

The following protections scheme shall be provided for Panels for 220 KV Transmission lines:

Main Protection Scheme I & II:

Distance protection scheme using Numerical Relay as specified in detail in Clause 14.15 and 14.16.2 shall be implemented. The summary of the scheme detailed in the above clauses have the following feature:

Permissive under reach/over reach/ blocking communication mode.

Suitable for single cum three phase tripping.

Power swing blocking and out of step protection.

Single shot single-cum-three phase auto re-closing with check synchronising and deadline charging features.

Fuse failure protection.

Weak end in feed feature.

Over/Under Voltage Protection

Directional Over current and Earth Fault protection

Current reversal guard feature

Stub protection function

Load encroachment blinder feature.

Switch on to fault feature.

In built Broken Conductor detection feature.

Shall have df/dt functions

Under frequency protection

Main 1 and Main 2 relay shall of different make and model.

132 KV Line Panel

The following protections scheme shall be provided for Panels for 132 kV Transmission lines:

a) Main Protection Scheme I:

Distance protection scheme using Numerical Relay as specified in Clause 14.15 and 14.16.2.

Backup Protection:

The backup protection shall be provided with directional single/ multi pole relays as specified in Clause 14.16.4. One triple pole over current relays for phase faults and one Earth Fault Relay for Earth Faults without high set elements shall be provided.

33KV Feeder Protection Panel

The 33kV Feeder Panels shall be provided non directional single/ multi pole relays as specified in Clause 14.16.4. One triple pole over current relays for phase faults and one Earth Fault Relay for Earth Faults with high set elements shall be provided.

Power and Auto Transformer Protection Panel

Integrated Transformer protection scheme as detailed in Clause 14.16.3 of the BID shall be provided for Panels for all Power and Auto Transformers:

(a) Main Protection -1

Biased transformer differential protection employing relay type specified in Clause 14.32. The scheme shall include also following:

(i) Second and fifth harmonic restraint feature.

(ii) The relay shall also provide Restricted Earth Fault Protection

(iii) The scheme shall have suitable input and output for transformer auxiliary protection like Buchholz, oil temperature, winding temperature etc.

(iv) Over-fluxing protection

(v) The relay shall have Back up protection features i.e Directional over current and earth fault with high set element. The high set unit should not operate due to transformer in-rush current.

(b) Main Protection - 2

Protection function shall be same as Main Protection – I.

(c) Backup Protection: The backup protection shall be provided with Directional relays as specified in Clause 14.16.3. One triple pol e over current relays for phase faults and one Earth Fault Relay for Earth Faults with high set elements shall be provided. The high s et unit should not operate due to transformer in-rush current.

Bus Bar Differential Protection Panel:

The Bus Bar Protection shall be provided as detailed in Clause 14.17 of the BID for 400kV, 220kV and 132kV Voltage Level.

Reactor Protection Panel:

The Reactor Protection shall be provided as detailed in Clause 14.16.5 of the BID.

RELAY MAINTENANCE TOOL KIT

MAINTENANCE TOOL KIT

The bidder shall supply a complete maintenance tool kit set. The tool kit shall have generally current jack, card extender, card puller, required crimping tool, screw drivers, pliers etc.

The tool kit shall contain test plugs, test leads, clips for maintenance and testing of relays supplied. Further detailing will be done during detail engineering.

The Maintenance Tool Kit shall be of Universal type.

TESTS

The supplier shall carryout all tests as per relevant standards as all associated equipment including relays, meters, instruments etc. The supplier shall submit all that reports to Employer for approval before despatching the control and relay panels. The Bidder shall also submit along with the bid type test reports for relays instruments, meters and other devices of the type and class being offered. Bidder has to submit KEMA test certificate for Numeric relay on interoperability compliance of IEC 61850 in general and GOOSE messaging and publishing in particular along with the bid.

Control and relay panels shall be subjected to the following tests:

a. Mechanical operation test.

b. Verification of degree of protection.

c. High voltage test (2000 volts for 1 minute)

d. Electrical control interlock and sequential operation test.

e. Verification of wiring as per approved schematic.

f. Interoperability test as per IEC 61850 (interoperability with ABB, AREVA, SIEMENS, GE and SEL)

PRE-COMMISSIONING TESTS

The contractor shall have to perform following minimum Pre-commissioning tests for commissioning of the C&R panels. For this purpose, the contractor shall arrange all required tools and testing equipment at site

(i). IR values of all circuits

(ii). Measurement of burden in CT & PT circuits

(iii). Primary current injection of CT circuits with connected burden

(iv). Energisation of PTs at suitable low voltage and measurement of PT inputs at all measuring points

(v). Secondary ac current injection of relays, dynamic testing of all numeric relays. Tracing of zone curves, limits. Checking of relay timings, inherent or set values. For this testing, the contractor shall bring ‘Omicron’ or equivalent test kit.

(vi). Testing of voltage related elements like directional element, over fluxing, over/ under frequency, over/ under voltage features, tracing of curves and checking limits of set values and associated timings

(vii). Checking of Boolean logic gates, BI/BO points of the numeric relays, checking conformity to specification and checking of set logics

(viii). Checking of stability and sensitivity of differential zones by suitably applying 3-phase low voltages and shorting of primary circuits. Measurements of voltage and current inputs to all relays.

(ix). Checking stability & sensitivity of bus differential relay zones by suitably injecting current

(x). Primary injection of REF connected CTs, measurements of relay inputs and checking of stability and sensitivity of REF scheme

(xi). Checking registration of event and disturbance records in the numeric relays and downloading

(xii). Testing of carrier aided protection schemes and simulation with regard to transmission and receipt of protection signalling

(xiii). Testing of AR schemes

(xiv). Checking of healthiness of each dc circuit of panels

(xv). Simulation of faults like Buchholz, OTI, WTI and other relays and checking of tripping of breaker and connected annunciation

(xvi). Operation of master trip relays, tripping of breaker through each trip coil and checking of interlocks

(xvii). Simulation of faults like low gas, air pressure and checking operation of interlocks. Checking anti pumping scheme of CB

(xviii). Simulation to Check Checking of PT selection schemes

(xix). Simulation to Check interlocks of all CB and isolator interlocks

(xx). Simulation to Check annunciation of all events in BCU (Bay control unit) as well as SAS (Sub-station Automation System)

(xxi). Simulation to Check of logic of BCU

(xxii). Operation of tap changing of transformer through SAS

(xxiii) The pre-commissioning checklist will be further developed by the contractor and will seek approval prior to commencement of pre-commissioning tests from the DGM, MRT Circle, AEGCL. The tests will be witnessed and approved by him or by his authorized officers.

TECHNICAL DATA SHEET FOR THE RELAY AND CONTROL PANELS

Features to be provided in various Relay and Control panels are indicated below. Description below are only indicative; the Contractor shall ensure that all items are included in their offer to complete the schemes described in the Specification whether such items are specifically mentioned or not.

400kV and 220kV Feeder Panels:

SL NO	ITEM	RATINGS AND PARTICULARS	
		400KV Panel with 1 1/2 Breaker Scheme	220KV Panel with Main I & Main II
I	II	III	IV
A	LINE PANELS		
1	Protection and relays:		
	(a) Distance Protection Scheme I	1 No.	1 No.
	(b) Distance Protection Scheme II	1 no	1 no
	(c) LBB Protection Scheme.	Can be function of BCU/IEDs	Can be function of BCU/IEDs
	(d) Trip Circuit Supervision Relay for pre and post-closing	Supervision for 6 trip coils (2 trip coils per pole or phase)	Supervision for 6 trip coils (2 trip coils per pole or phase)
	(e) DC Supply healthy monitoring scheme for two separate DC source	2 No.	2 No.
	(e 1)DC Changeover Relay	2 Nos	2 Nos
	(f) AC Supply healthy monitoring scheme	1 No.	1 No.
	(g) High Speed Trip relay (1 & 3 pole)	2 sets.(each set will comprise of 3 Nos of 1ph trip relay and 1 No of 3ph trip relay)	2 sets.(each set will comprise of 3 Nos of 1ph trip relay and 1 No of 3ph trip relay)
	(h) PT -CVT Selection Scheme with PT1-PT2 – CVT selection relay	1 Set. Complete Bus PT1-Bus PT2-CVT Selection Scheme	1 Set. Complete Bus PT1-Bus PT2-CVT Selection Scheme
	(i) Auxiliary relay, timer relay for healthiness of relays, auto reclose communication link etc.	As required (Can be function of BCU)	As required (Can be function of BCU)
	(j) Trip Transfer Relay	-	2 sets
	(j) Fault Recorder	1 set (shall be function of IED)	1 set (shall be function of IED)
	(k) Distance to fault locator	1 set (shall be function of IED)	1 set (shall be function of IED)

SL NO	ITEM	RATINGS AND PARTICULARS	
	(l) Under Voltage protection relay for isolator/earth switch Interlock	2 nos	2 nos
	(m) Over Voltage Protection Scheme	1 set (maybe function of IED)	1 Set (maybe function of IED)
2	Meters		
	(a) ABT tri-vector Meter (SAMAST Compliant) with TTB	1No	1No
3	Controls/ Status indication/ Annunciation		
	Bay control unit (IED)	1No. (Function of BCU/ SAS)	1No. (Function of BCU/ SAS)

132kV and 33kV feeder Panels:

SL NO	ITEM	RATINGS AND PARTICULARS		
		132 kV Panel with Main & Transfer Bus Scheme	33 kV feeder panel with single bus system	
		V	VI	
A	LINE PANELS			
1	Protection and relays:			
	(a) Distance Protection Scheme	1 No.	-.	
	(b) Back up directional over current and earth fault scheme	1 Set	-	
	(c) Back up non directional over current and earth fault scheme	-	1 set	
	(d) LBB Protection Scheme.	Can be function of BCU/IEDs	Can be function of BCU/IEDs	
	(e) Trip Circuit Supervision Relay for pre and post-closing	Supervision for 2 trip coils	Supervision for 2 trip coils	
	(f) DC Supply healthy monitoring scheme, for two DC source	2 No.	2 No.	
	(f 1) DC Changeover	2 Nos	2 Nos	
	(g) AC Supply healthy monitoring Scheme	1 No.	1 No.	
	(h) High Speed Trip relay	2 No.	2 No.	
	(h1) High Speed Trip Relay for LBB	1 No	1 No	
	(i) Auxiliary relay, timer relay for healthiness of relays, auto reclose communication link etc.	As required (Can be function of BCU)	As required (Can be function of BCU)	
	(j) Trip Transfer Relay	2 sets	2 sets	
	(j) Line CVT-Bus PT selection relay	1 No	-	
	(k) 33kV Incomer PT selection	-	-	
	(l) Distance to Fault Locator	1 set (shall be function of IED)	-	
	(m) Fault Recorder	1 set (shall be function of IED)		
	(l) Under Voltage protection relay for isolator/earth switch Interlock	2 nos (function of IED)		
	(m) Over Voltage Protection Scheme	1 set (maybe function of IED)		
2	Meters			
	(a) ABT tri-vector Meter (SAMAST Compliant) with TTB	1 No	1 No	
3	Controls/Statusindication/ Annunciation			
	Bay Control Unit (IED with HMI)	1No. (Function of BCU/ SAS)	1No.	

Transformer Protection Panels

SL NO	ITEM	RATINGS AND PARTICULARS			
		400/220/33 kV Transformer Panel	220/132 kV Transformer Panel	220/33 kV Transformer Panel	132/33 kV Transformer Panel
		VII	VIII	IX	X
B	TRANSFORMER PANELS				
1	Protection and Relays:				
	(a) Differential Protection Scheme	2 No.	2 No.	2 No.	2 No.
	(b) Restricted Earth Fault Protection Scheme	(inherent High imp REF)	(inherent High imp REF)	(inherent High imp REF)	(inherent High imp REF)
	(c) Back up directional over current scheme and earth fault scheme for HV side.	Could be feature of relay	Could be feature of relay	Could be feature of relay	Could be feature of relay
	(d) Back up directional over current and earth fault scheme for MV/LV Side.	Could be feature of relay	Could be feature of relay	Could be feature of relay	Could be feature of relay
	(e) LBB Protection Scheme.	Can be function of BCU/IEDs	Can be function of BCU/IEDs	Can be function of BCU/IEDs	Can be function of BCU/IEDs
	(f) Over Fluxing Protection scheme	Can be function of IED	Can be function of IED	Can be function of IED	Can be function of IED
	(g) Overload protection scheme	Can be function of IED	Can be function of IED	Can be function of IED	Can be function of IED
	(g.1)Tertiary Side O/C and Open Delta Voltage Protection	1 set	1 set	-	-
	(h) Trip Circuit Supervision Relay Scheme for ascertaining pre and post-closing healthiness.	Supervision for 4/12 trip coils(2trip coilsper pole/ breaker on each side)	Supervisi onfor 4/8 trip coils(2 tripcoils per pole/ breaker on each side)	Supervisi onfor 4/8 trip coils(2 tripcoils per pole/brea ker on each side)	Supervision for 4 trip coils(2 tripcoils per breaker on each side)
	(i) DC Supply healthy monitoring scheme	2 No.	2 No..	2 No.	2 No.
	(i1)DC Changeover Relay	2 No.	2 No.	2 No.	2 No.
	(j) AC Supply healthy monitoring scheme	1 No.	1 No.	1 No.	1 No.
	(k) High Speed Trip relay (HV Side)	2 No.	2 No.	2 No.	2 No.
	(l) High Speed Trip relay (MV/LV Side)	2 No.	2 No.	2 No.	2 No.
	(m) Trip Transfer Relay	2 sets	2 sets	2 sets	2 sets
	(m) PT Selection Scheme on HV / MV/LV Side as applicable	1No. Complete Bus PT Selection Scheme (Can be function of BCU)	1No. Complete Bus PT Selection Scheme (Can be function of BCU)	1No. Complete Bus PT selection scheme (can be function of BCU)	1No. Complete Bus PT selection scheme (can be function of BCU)
	(m1) PT Selection Relay	3 Nos for HV/ 2 Nos for LV	2 Nos for HV/ 2 No for MV	2 Nos for HV/ 2 No for LV	1 No for HV/ 2 No for LV
	(n) Tripping relay for Bucholtz, PRD, WTI,OTI , OSR etc.	As required	As required	As required	As required
	(o) Alarm auxiliary for Bucholtz, PRD, WTI,OTI, MOG , Air Cell leakage etc.	As required (Can be a function of BCU)	As required (Can be a function of BCU)	As required (Can be a function of BCU)	As required(Can be a function of BCU)
	(p) Transformer tap position status/ raise & lower	Can be a function of BCU	Can be a function of BCU	Can be a function of BCU	Can be a function of BCU
	(q) Reverse Power Protection	Can be function of IED	Can be function of IED	Can be function of IED	Can be function of IED
2	Meters				

SL NO	ITEM	RATINGS AND PARTICULARS			
	(a) ABT tri-vector Meter (SAMAST Compliant) With TTB	2 No. (on 400kV and 220 kV side)	2No. (on 220 kV and 132 kV side)	2No. (on 220 kV and 33kV side)	2 Nos. (132 kV & 33 kV side)
3	Controls / interlocks / Status indication/ Annunciation				
	Bay Control Unit (IED), one no each for HV & LV side.	2 Nos. (Function of BCU/ SAS)	2 Nos. (Function of BCU/ SAS)	2 Nos. (Function of BCU/ SAS)	2 Nos. (Function of BCU/ SAS)

Reactor Protection Panel

The Reactor Protection Panel shall consist of following protection features/schemes:

SL. NO	Description	400 kV
		XI
1	Reactor Differential Protection scheme	1 No
2	Restricted Earth fault Protection scheme:	1 No
3	Reactor back up impedance protection scheme	1 Set
4	Three phase trip relays (Only for Bus Reactor)	2 Nos.
5	CVT selection relay as per scheme requirement	Lot

400kV, 220 kV and 132 kV Bus Coupler / Bypass Breaker Panel

SL NO	ITEM	RATINGS AND PARTICULARS		
			220 kV Panel with Main I & Main II Scheme	132 kV Panel with Main 1 & Transfer Bus Scheme
			XII	XIII
A	BUS COUPLER PANEL			
1	Protection and relays:			
	(a) Back up directional over current and earth fault scheme		1 Set	1 Set
	(b) Bus Bar differential protection	Main 1	Main I and Main II	Applicable, where specified in BoQ
	(c) LBB Protection Scheme.		Can be function of BCU/IEDs	Can be function of BCU/IEDs
	(d) Trip Circuit Supervision Relay for pre and post-closing		Supervision for 6 trip coils (2 trip coil for each Phase)	Supervision for 2 trip coils
	(e) DC Supply healthy monitoring scheme		2 No.	2 No.
	(e)DC Changeover Relay		2 No.	2 No.
	(f) AC Supply healthy monitoring scheme		1 No.	1 No.
	(g) High Speed Trip relay		2 Sets. .(each set will comprise of 3 Nos of 1ph trip relay and 1 No of 3ph trip relay)	2 No.
	(h) PT Selection Scheme		1No. Complete Bus PT Selection Scheme (Can be function of BCU)	Not applicable
	(i) Auxiliary relay, timer relay scheme		As required	As required
2	Metering		Function of BCU/ SAS	Function of BCU/ SAS
3	Controls/Annunciation/Statusindication			
	Bay control unit (IED)		1 No. (Function of BCU/ SAS)	1 No. (Function of BCU/ SAS)
400kV Tie Breaker Panel				

SL NO	ITEM	RATINGS AND PARTICULARS		
SL NO	ITEM	Ratings and Particulars		
		4000 kV Panel with 1 1/2 Breaker Scheme		
		XIV		
B	TIE PANEL			
1	Protection and relays:			
	(a) Back up directional over current and earth fault scheme			
	(b) Bus Bar differential protection			
	(c) LBB Relay.	1 No		
	(d) Trip Circuit Supervision Relay for pre and post-closing	Supervision for 6 trip coils (2 trip coils per pole or phase)		
	(e) DC Supply healthy monitoring scheme	2 No.		
	(f) DC Changeover Relay	2 No		
	(f) AC Supply healthy monitoring scheme	1 No.		
	(g) High Speed Trip relay	2Sets. (each set will comprise of 3 Nos of 1ph trip relay and 1 No of 3ph trip relay)		
	(h) Auxiliary relay, timer relay scheme	As required		
2	Metering	Function of BCU/ SAS		
3	Controls/Annunciation/Status indication			
	Bay control unit (IED)	1 No.		

Monitoring, Control & Protection for Auxiliary Transformer

Suitable monitoring, control (operation of associated Circuit breaker and isolator) and protection for LT Auxiliary Transformer, connected to tertiary winding of auto transformer for the purpose of auxiliary supply shall be provided by the contractor. Overcurrent and open delta protection is required to be provided for the auxiliary transformer. These control and protection shall also be acceptable as built in feature either in the bay controller to be provided for the auxiliary system or in the control and protection IEDs to be provided for the auto transformer.

NOTE: 1) The relays (main / auxiliary) not covered within the above table shall be considered for complete commissioning of the protection scheme.

2) In Case of incomplete Diameter (D and I type layouts), control panel shall be equipped fully as if the Diameter is complete, unless otherwise specified. Annunciation relays shall also be provided for the same and if required, necessary panel shall be supplied to accommodate the same.

3)Relay setting template (in editable document format) shall be provided by the Contractor for each typical protection IEDs for relay setting purpose.

4)For GIS Sub Stations, GIS Gas Zone trip signals, if provided, for each gas tight compartments (gas zone) in the GIS LCC shall be integrated in the protection schematics to provide electrical isolation of faulty Gas Zone by tripping/ inter tripping its adjacent circuit breakers. The scheme shall be implemented through protection IEDs and auxiliary relay as required.