CONTROL AND RELAY PANEL

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Engineering Department

WEST BENGAL STATE ELECTRICITY TRANSMISSION COMPANY LIMITED
পশ্চিমবঙ্গ রাজ্য বিদ্যুৎ সংবহন কোম্পানি লিমিটেড
(পশ্চিমবঙ্গ সরকারের একটি উদ্যোগ)

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TECHNICAL SPECIFICATION FOR CONTROL & RELAY PANEL FOR 400KV, 220 KV, 132 KV AND 33 KV SYSTEMS

1.00 SCOPE:

1.01 The specification covers design, engineering, manufacture, testing & supply delivery at site of Control and relay Board and protection relay panels inclusive of internal wiring and with arrangement for external connection to various Switchyard equipments and Control room building equipments as necessary. The Contractor has to design the Schematics for protection and Control of all equipments including monitoring indications, visual and audible alarm, interlocking schemes between different equipment. Any other requirement which are not specifically covered here but which are necessary for successful commissioning of the Sub-station are also within the scope of the Contract. The same shall be indicated by the bidder with their price for WBSETCL's consideration.

1.02 The equipment manufactured should conform to the relevant standards and of highest quality of engineering design and workmanship. The equipment manufactured shall ensure satisfactory and reliable performance throughout the service life.

2.00 STANDARDS:

2.01 Unless otherwise specified, all equipment and material shall conform to the latest IS applicable standards. Equipment complying with other internationally recognised standards will also be considered, if it ensures performance equivalent or superior to Indian standards. In the event of supply of equipment conforming to any international/ internationally recognised standards other than the standard listed below, the salient features of comparison shall be brought out and furnished along with the bid. One copy of such standard specification in English language shall be enclosed with the tender.

2.02 The equipment provided shall also comply with the latest revisions of Indian Electricity act and Indian Electricity rules and any other applicable Statutory provisions, rules and regulations.

2.03 All equipment provided under the specification shall generally conform to the latest issue of the following:

IEC/Indian Standard No.	**Title**
IS 3231 & IEC-255	Electrical relays for power system protection
IS 1248 & IS 2419	Indicating Instrument
IS 6236	Recorders
IS 722, IS 14697, IS 15959	Energy meters
IEC 679	Static TVM
IEC 337 & 337-1	Control Switches (LV Switching devices for control and auxiliary circuit)
IS 2705, IS 16227	Current Transformers
IS 3156	Voltage Transformer
IS 4237	General requirement for Switch gear and Control gear for voltage not exceeding 11 KV.
IS 375	Marking and arrangement for Switchgear Bus bars, main connection and auxiliary wiring.
IS 8686	Specification for static protective relays
CEA	CEA (Cyber Security in Power Sector) Guidelines, 2021
IEC 61850	Communication networks and systems for power utility automation

3.00 QUANTITIES:

Quantities of Control, Relay & Protection panels are to be assessed by the bidders from the Schedule enclosed with this specification/ LOA. However, if any corridor in the switchyard layout is left for future use in between two proposed bays included in the project, blank panels without any equipment, relays etc but only with matching mimic are to be supplied.

4.00 TECHNICAL PARTICULARS FOR DESIGN OF CONTROL, RELAY AND PROTECTION PANELS:

4.01 SYSTEM DETAILS:

		400KV	220KV	132KV	33KV
a)	Nominal System Voltage	400KV	220KV	132KV	33KV
b)	Highest System Voltage	420KV	245KV	145KV	36KV
c)	Number of Phases	<---------- Three ---------->			
d)	Frequency	<----------50 Hz +/- 3% ---------->			
e)	Grounding	< -------- Effectively Earthed----------> through E.Tr.			
f)	Maxm.fault Current	50KA (rms)	40KA (rms)	31.5KA (rms)	-

4.02 AUXILIARY SUPPLY:

D.C. Supply voltage shall be normally fed from Battery charger and battery connected in parallel which is 220V (or 110V in some substations) +/- 10% . In case of failure of the AC supply to battery charger, DC Supply voltage will be available automatically from Battery. The D.C Supply voltage may vary from -10% to + 10%. The D.C. system shall be 2 wire with necessary positive earth fault and negative earth fault annunciation scheme. The ripple content in the D.C. supply from charger will be less than 2%.

AC Auxiliary supply voltage for the C&R panel shall be 230V, 1-phase, 50Hz grounded with +/- 10% voltage variation.

5.00 INDICATING INSTRUMENT RANGE:

Indicating instruments (Ammeter, Voltmeter, MW meter, MVAR meter) shall have site settable/ programmable CTR and the range of CT ratios shall be in line with final approved drawing of the respective equipment for the particular project.

Voltmeter Range: -	
400kV	0-500kV
220kV	0-250kV
132kV	0-150kV
33kV	0 – 40kV

6.00 PANEL DESCRIPTION, CONSTRUCTION AND FORMATION:

6.01 GENERAL REQUIREMENT:

a) The protection, control and relay board panels for 400KV system shall be duplex/simplex type (as per the Project LOA) so as to accommodate all the control equipment, breaker relays, meters etc. and the protective relays and its aux. relays/accessories as necessary for completeness of the protection/control scheme without overcrowding and cramping.

b) The control and relay board panel for 220KV system and 132KV system shall be duplex/simplex type (as per the Project LOA) for accommodating all relays and aux. relays for protection of respective circuit along with control equipment, meters etc. as necessary for completeness of the protection/control scheme without overcrowding and cramping.

c) The 33KV C&R board panels shall be simplex type for accommodating all the control, protection and metering equipment properly.

d) Size of individual panel shall be as stated below :

Type	Depth (mm)	Width (mm)	Height (mm)
Duplex	1982	as necessary but limited to 1000 mm	2312 including channel base.
Simplex	610	-do-	2250 including channel base

There shall be a corridor of 762 mm wide and access doors of 1900 mm height with latch at two ends of duplex panel board for inspection. The door with door frame shall be detachable type so that the same can be fitted to newly erected panel of similar design if any new C&R panel is added. The access door for the simplex type panel shall be at the back side or front side as per BOQ or requirement of panel layout. Front access panels shall have additional hinged frame inside the outer glass door for mounting of equipment. The hinged frame shall be able to rotate at least 150 degree during opening. The hinged frame and outer door shall open in the same direction.

e) The front and rear parts of duplex type C&R panel shall be detachable and all interconnection between front and rear panels shall be through terminal connector and preferably underneath the top cover. The interconnection between the simplex type control and relay panel and duplex type respective C&R panels where applicable will be made through cables to be laid in the cable trenches under those panels.

f) The complete panel shall incorporate all necessary instruments, meters, relays, auxiliary relays, control switches, indicating lamps, mimic, annunciators, audible alarms, horizontal and vertical wiring trough, wiring supports, interior lighting system, terminal blocks fuses and links etc.

g) It is the responsibility of the Contractor to ensure that the equipment specified and such unspecified complementary equipment required for completeness of the protective/control schemes be properly accommodated in the panels without congestion and if necessary, either more number of panels or panels with larger dimensions shall be provided (as per panel layout requirement). No price increase at a later date on this account shall be allowed. However, the width of panels that are being offered to be placed in existing switchyard control rooms, should be in conformity with the space availability in the control room.

6.02 CONSTRUCTIONAL FEATURES:

a) The control & relay board shall comprise of cubicle type panels placed in juxta position to form a continuous board for each system voltage. If the panels are required to be aligned in right angular formation, the tenderer shall be required to arrange dummy/covering plates for the uniform formulation without any extra price.

b) The tenderer shall ensure that the equipment specified and such unspecified complementary equipment required for completeness of protection/control scheme be properly accommodated in the panels without congestion and if necessary to provide panels with larger width. No price increase at a later date on this account shall be allowed.

c) Panels shall be completely metal enclosed and shall be dust, moisture and vermin proof. The enclosure shall provide a degree of protection not less that IP-31 in accordance with IS-2147.

d) Panels shall be free standing, floor mounting type and shall comprise structural frames enclosed completely with specially selected smooth finished, cold rolled sheet steel of thickness not less than 3mm for weight bearing members of panels such as base frame, front sheets and door frames and not less than 2mm for sides, door, top & bottom portions. There shall be sufficient reinforcement to provide level surfaces, resistance to vibration and rigidity during transportation and installation.

e) All doors, removable covers and panels shall be gasketed all around with neoprene gaskets. Ventilating covers, if provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh.

f) Design, material selection and workmanship shall be such as to result in neat appearance, inside and outside with no welds, rivets or bolt head apparent front outside, with all exterior surfaces tune and smooth.

g) Cable entries to the panel shall be from the bottom. The bottom plates of the panel shall be fitted with removable gland plates and fixed with cable glands. Total area of the gland plate may preferably be divided into at least two nos. equal size gland plates for easy termination of Control cable in future, if required. Necessary number of cable glands of sizes to suit external cables to the panels shall be supplied by the bidder. Cable glands shall be screwed type made of brass and shall be suitable for PVC armoured cable.

h) Metal seals in the form of metal channels properly drilled shall be furnished by the Contractor along with anchor bolts and necessary hardware for mounting the panels. Panels shall be mounted on the other end of the channel.

6.03 MOUNTING:

a) All equipment on and inside the panels shall be mounted and completely wired to the terminal blocks ready for external connection. The equipment of panel shall be mounted flush.

b) Equipment shall be mounted such that removal and replacement can be accomplished individually without interrupting of service to adjacent devices and are readily accessible without use of special tools. Terminal marking shall be clearly visible and of permanent nature.

c) The contractor shall carry out cut out, mounting and wiring of the bought out items which are to be mounted in the panel in accordance with the corresponding equipment manufacturer's drawings.

d) The centre line of switches, push buttons and indicating lamps shall be not less than 750mm from the bottom of the panel. The centre line of relays and meters and recorders shall be not less than 450 mm from the bottom of the panel. However, the same shall be finalized during Detail Engineering.

e) The centre lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Likewise the top of all meters, relays and recorders etc. shall be in one line.

f) The control switches for circuit breakers and isolators shall be located on the mimic diagram corresponding to their exact position of the controlled equipment in the single line drawing. The location of the switches shall be within working height from the floor level for easy and comfortable operation.

g) No equipment shall be mounted on the doors.

h) All the panels in the control room shall be matched with the other panels of the same C&R board in respect of dimension, colour and appearance. Control equipment on front side of the panel shall be similarly placed.

i) All the equipment connections and cabling shall be designed and arranged to minimise the risk of fire and damage.

6.04 PAINTING:

a) All unfinished surface of the steel panels and frame work shall be sand blasted to remove rust, scale, foreign adhering material or grease.

b) A suitable rust resisting primer shall be applied on the interior and exterior surfaces of the steel, which shall be followed by of an under coat suitable to serve as base and binder for the finishing coat. The finishing coat on the exterior of the panel & on the interior faces shall be as per following table: -

Sl. No.	**Painting**		
1	Colour	a) External Colour shade	Shade RAL 7032 (Pebble Grey)
		b) Internal Colour shade	White
		c) External Finish	Texture Semi Glossy
		d) Internal Finish	Texture Semi Glossy
		e) Base Frame Colour shade	Black
2	Type of Painting	Powder Coating	
3	Thickness of Paint	Average of Powder Coating	80-100 microns
4	Phosphating	Sheet Steel shall be phosphated in accordance to IS 6005	
5	Special Instruction	Small quantity of paint shall be supplied for minor touchup work required at site.	

6.05 PANEL INTERNAL WIRING:

a) All wiring shall be carried out with 1100V grade Single core, standard copper conductor wires with PVC insulation conforming to IS 694 or equivalent International Standard.

b) The minimum size of the stranded copper shall be as follows :

i) All current transformer circuit : 2.5 sq mm per lead.

ii) Voltage transformer circuits : 2.5 sq mm per lead

iii) All other circuits : 1.5 sq mm per lead.

c) The following colour scheme shall be used for the wiring :

Circuit where used	Colour of the wire
R - Y - B phase of instrument transformer circuit.	Red, yellow and blue for respective phases.
Neutral connections of the instrument transformer circuit.	Black
Earthing connection	Green
AC control wiring circuit for auxiliary AC supply.	Black
D.C. control wiring circuit using D.C. Battery supply.	Grey

d) All wires directly connected to trip circuit breaker or device shall be distinguished by addition of red colour unlettered ferrule.

e) All internal wiring shall be securely supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters & trough shall be used for this purpose. The position of the PVC carrying troughs and having bunch of wires shall not give any hindrance for fixing or removing relay casing, switches etc.

f) Interconnection to adjacent panels shall be brought to a separate set of terminal blocks located near to the slots or holes to be provided at the top of the panel. The terminal blocks for the wires shall be with isolating links and wired such as to isolate supply to the concerned panel only keeping supply to other panels uninterrupted. Arrangements shall be made for easy connections to adjacent panels at site and wires for this purpose shall be provided and bunched inside the panel.

g) All wiring interconnecting the front cubicles with the near cubicles of duplex type panel over the access corridor shall be wired in gutters held against the ceiling of the corridor by means of screws and the interconnection shall be made through suitable terminal connectors securely fixed on the panel.

h) Longitudinal troughs extending throughout the full length of the panel shall be used for inter panel wiring. Inter connections to adjacent panels shall be brought out to a separate set of terminal blocks located near the slot of holes meant for taking the interconnecting wires. All bus wiring for interpanel connection shall be provided near the top of the panels running throughout the entire length of the panels.

i) Wiring connected to the space heaters in the cubicles shall have porcelain beaded insulation over a safe length from the heater terminals.

j) Wire termination shall be made with solder less crimping type and tinned copper lugs which firmly grip the conductor and insulation, ensuring optimum contact surface and also ease of removal of termination, if required. For stud type terminals, ring type lugs shall be used. For other equipment terminals, best suitable lugs as recommended by manufacturer of the equipment shall be used. 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 wire and shall not fall off when the wire is disconnected for any purpose. Termination shall be such that no strand of a conductor shall left loose or overhanging. Conductor termination shall be secured to the holding nuts/screws, terminal blocks etc. with washers interposed between the terminals/holding nuts/screw heads. The terminals shall be so connected that no conductor ferrule code gets masked due to overlay of conductors.

k) All spare contacts of relays shall be wired up to terminal blocks.

6.06 TERMINAL BLOCKS:

a) All internal wiring to be connected to the external equipment shall terminate an terminal blocks, preferably vertically mounted on the side of each panel. Terminal blocks shall be 1100 V grade and have 10Amp continuous rating, moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and locknuts, inserts. The stud, washers, nuts, locknuts, inserts shall be tin plated Brass/Brass. Terminal block design shall include markings of terminals and the terminals shall be provided with transparent plastic, slip on/clip on terminal covers. Markings on the terminal strip shall correspond to wire number and terminal numbers on the wiring diagram.

b) Terminal blocks for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. Also current transformer secondary leads shall be provided with short circuiting and earthing facilities of adequate rating.

c) Each terminal block shall be provided with at least 20% spare terminals on each panel and these spare terminals shall be uniformly distributed on all terminal block.

d) In case of duplex panels, separate set of terminal blocks shall be provided with separate internal cable entries for the front (control) and rear (relay) sections.

e) Terminal blocks shall be suitable for connecting the following conductors on each side.

i)	All C.T. circuits.	: Two of 4.0 sq.mm. copper.
ii)	All P.T. circuits.	: Four of 2.5 sq.mm. copper.
iii)	AC/DC Power Supply Circuit	: Four of 2.5 sq.mm. copper.
iv)	All other circuits.	: Four of 1.5 sq.mm. copper.

f) There shall be a minimum clearance of 250 mm between the first row of terminal blocks and the associated cable gland plate. Also the clearance between two rows of terminal blocks shall be minimum of 150mm.

g) The number & sizes of the multicore incoming cable will be as per approved scheme. All necessary cable terminating accessories such as gland plates packing glands, crimp type tinned copper lugs, supporting clamps and brackets, wiring troughs and gutters etc. for cable shall be included in contractor's scope of supply.

h) All studs, nuts, screw etc. shall be threaded according to IS:7684 or equivalent International Standards.

6.07 MIMIC DIAGRAM:

a) Coloured mimic diagram and symbols showing the exact representation of the system shall be provided in the front of control panels.

b) Mimic diagram shall be made preferably of anodized aluminium or plastic of approved fast colour material which shall be screwed on to the panel and can be easily cleaned. The mimic bus shall be 2mm thick. The width of the mimic bus shall be 10mm for bus bars and 7mm for other connections. Indicating lamp, one for each phase for each bus shall be provided on the mimic of Bus coupler panel of three Bus system or at Transfer bus panel of two bus system to indicate bus charged condition.

c) Colour scheme for mimic diagram.

KV Class	C o l o u r	Shade Index as per ISS
400KV	Dark Violet	796
220 KV	Light orange	557
132 KV	Signal Red	537
33 KV	Brilliant green	221
11 KV	Air Craft blue	108
400/230 V	Black	309
Earth	White	-
110 V	Canary yellow	-

d) LED Position Indicators, Round type, for all earth switches & isolators control switches and discrepancy type control switch with flash type built-in indicating lamp, for circuit breakers shall be mounted along the mimic diagram at appropriate location in 400KV, 220 KV and 132 KV duplex type C&R panels.

In 33KV simplex type C&R panels, LED Position Indicators for the position indication of isolators, earth switches and ON/OFF indication for such breaker shall be mounted along the mimic diagram at appropriate location.

6.08 NAME OF IDENTITY PLATES:

a) All instruments, relays and such other similar electrical devices mounted on the control and relay panel shall be provided with name plates bearing the manufacturer's name, serial identifying number and the Electrical rating data.

b) 25mm wide plastic plates bearing suitable identification marks shall be fixed under the terminal wiring at the test blocks, at the fuse blocks and at the cable terminals. Similar plates shall be fixed on the exterior of the switch board in appropriate places to indicate function of control switches, push button etc. such as isolator control switch, breaker control switch, DC fail test, accept reset etc. Suitable identification marks shall be provided for individual casing part of the relays and other equipment.

c) 50mm wide plastic plate bearing suitable circuit description (which will be furnished after order is placed) etched in 30 mm size letters shall be provided for each panel and mounted on the top of both outer and inner sides of the front and rear panels. These plates shall be removable type.

d) Each unit of control and relay panel shall be provided with a label located at the bottom on the front and shall contain the following details:
   i) Manufacturer's name
   ii) P.O.no. and date
   iii) Drg. ref. no. that pertains to the panel.

6.09 CONTROL AND RELAY BOARD PANEL LIGHTING & ACCESSORIES:

a) Each unit of cubicle interior (both control and relay panel) shall be illuminated by LED connected to 230V single phase AC through individual switch for duplex type panel and through Door switch for Simplex type panel. The illumination of the interior shall be free from hand shadows and shall be planned to avoid any strain or fatigue to the wireman likely to be caused due to subnormal or non-

uniform illumination. One emergency D.C. light (LED) shall also be provided for each panel with individual switch with proper identification mark.

b) Corridor of the duplex type control and relay board formation should be illuminated with adequate no. of LEDs, AC operated, through door operated push button switch provided at both sides.

c) One 15 amps. 3 pin power socket outlets together with plug pins shall be provided at convenient points in each panel with marking at the bottom for obtaining AC supply wherever required.

d) The above AC auxiliary supply and DC emergency lamp ckt. in each panel shall be HRC fuse and link protected.

6.10 SPACE HEATERS:

Tubular space heater suitable for connection to the single phase AC supply in each panel (both control and relay panel in case of duplex type) complete with switches and thermostat located at convenient position shall be provided at the bottom side of the cubicle to prevent condensation of moisture. The watt loss per unit surface temperature of the heater shall be low enough to keep surface temperature well below allowable heat. The wattage of the heater shall be such as to keep 10°C above average ambient temperature in the rainy season but the temperature shall not under any circumstances damage the insulation of the wiring of the panel.

6.11 SAFETY EARTHING:

a) All panels shall be provided with an earth bus securely fixed along with the inside base of the panel extended throughout the length of the C&R board formation. The material and size of the earth bus bar shall be 25mm x 6mm size copper. Provision shall be made for extending the earth bus bars at a future date into new adjacent panels to be installed if any. Provision shall be made at the end panels for connecting the same to the system earth grid mat.

b) Earthing of current free metallic parts or metallic bodies of the equipment provided in the switchboard shall be done with soft drawn conductor of size not less than 2.5 sq.mm.

c) The neutral point of star connected LV winding of instrument transformers and one corner of the open delta connected LV side of instrument transformers shall be similarly earthed with the main earth bar of the switchboard earthing system.

6.12 FUSES AND LINKS:

H.R.C. Cartridge fuse and link of adequate current and voltage rating shall be provided inside the cubicle in an easily accessible location. **The selection of the main and sub circuit fuse ratings shall be such as to ensure selective clearance of sub circuit faults.** Fuses shall have operation indicators for indicating blown fuse condition. Fuse carriers and bases shall have imprints of rating, voltage and circuit designation.

7.00 INDICATING LAMPS AND SEMAPHORE:

a) These lamps shall be of LED type and suitable for being operated on S/S D.C. voltage or AC voltage or P.T. secondary supply as and where applicable. All Lamps shall be interchangeable, panel mounting type with rear terminal connection and shall afford easy replacement from the front of the panel. Lamps shall have translucent lamp covers to diffuse lights and coloured Red, green, Amber, clear white or blue as specified. The lamp cover shall be of screwed type, unbreakable and mounded from heat resisting material. The indicating lamps with resistors shall withstand 120% of rated voltage on a continuous basis.

b) No tools shall be required for replacing the bulbs and lenses.

c) The colour scheme of the signal lamps shall be as follows:

Function	Colour lens
C.B. spring charged/compressor healthy indication	Blue
C.B. Trip circuit healthy	Milky White
Alarm Bus and incoming D.C. fail indication.	Amber
P.T. supply healthy indication (Bus bar healthy indication).	Red/Yellow/Blue
C.B. ON-OFF Indication (33kV & below)	Red/Green

d) LED type Semaphores are to be used for status indication of Circuit Breaker and Isolator.

8.00 CONTROL SWITCHES:

a) All control switches shall be of the rotary type provided with escutcheon plates clearly marked to indicate status of the switch. They shall be semi flush mounted with only the switch front plate and operating handle projected out. All such control switches shall be provided for remote operation of isolators and circuit breakers.

b) All Control switches shall be wire connected at the back. The contact mechanism shall be cam operated. The contacts shall be silver faced and designed for liberal rating of the duty involved. The contacts shall be provided with dust and vermin proof removable protection cover. The protection cover shall preferably be of transparent, inflammable material made of moulded dielectric material. Springs to be provided in the switch shall not be used as current carrying parts. The contacts provided in the switch shall be suitable for easy assembly/disassembly during replacement of the contacts. The control switch springs shall be strong to prevent any inadvertent operation due to a light touch on the handle.

c) Control switches for 400KV, 220KV & 132KV circuit breakers shall be of discrepancy type with built in pilot lamps and having two maintained contact positions for "ON" and "OFF" positions and two momentary contact positions for "ON" and "OFF" impulse. The built-in pilot lamp shall give a steady light when the position of the control switch corresponds to the position of the associated circuit breaker. A flickering light shall be given by the same lamp when due to hand operation or due to automatic tripping of the circuit breaker the position of the control switch does not coincide with that of the corresponding circuit breaker. The arrangement to provide the flickering voltage for the above purpose shall be made by the contractor. In order to avoid continuous burning of the aforesaid built-in lamps associated with the control switches, the said lamp shall be connected through a switch. The circuit should be such that irrespective of the position of the aforesaid switch winking of the lamp shall not be affected by change in respective control switch position. The winking of the control switch pilot lamp shall be followed by an alarm annunciation after a preset time adjustable between 0-10 secs. Switches complete with accessories for the above function shall be supplied. **In a protection panel without mimic, Control switches for 400KV, 220KV & 132KV circuit breakers shall be of pistol grip spring return type.**

d) Control switches for 33KV circuit breakers, 400KV, 220KV isolators, 132KV isolators shall be with pistol grip type operating handle having "ON & OFF" monetary operating position and an automatic return to normal neutral position on release from operated positions.

e) At bay level, Bay Control IEDs (if considered in respective LOA) shall provide all bay level functions regarding control and monitoring, inputs for status indication and outputs for commands. Bay Control IEDs shall not depend on any Numerical Protection IED or other equipment for the above functions.

f) Clear control priorities shall prevent operation of a single switch at the same time from more than one of the various control levels, i.e. remote control centre, station HMI, bay level or apparatus level. The priority shall always be on the lowest enabled control level.

9.00 SELECTOR SWITCHES AND CHANGE OVER SWITCHES:

a) Instrument selector switches shall be provided for indicating instruments while change over switches shall be provided for selective operation of controls such as auto/ non auto reclose, trip circuit transfer from main breaker to transfer breaker. Protection selector switches are to be provided in the Bus transfer bay and shall be used for adopting the bus transfer bay protection during Bay transfer condition, when line side C.T. operated protection of any bay develops any defect. All these switches shall be stay put type.

b) Voltmeter selector switch shall be suitable for reading all line to line and line to neutral voltage for effectively earthed system. This selector switch shall be of the rotary oval head or knob type.

c) Trip circuit transfer switch shall be of 3-position Normal-Inter-Transfer. Operating handle shall be pistol grip, lockable at Normal position and key trapped at transfer position having one common key for all 400KV, 220KV, 132KV and 33KV panels respectively for a particular Sub-station.

d) Protection selector in Bus Transfer bay shall be lockable type, two/three position depending upon scheme requirement.

e) One four position selector switch for setting group selection in respect of distance relay in Bus Transfer panel shall be provided.

f) One three position selector switch for setting group selection in respect of numerical over current & earth fault relay in Bus Transfer panel shall be provided.

g) One five position Selector Switch for Earthing Transformer selection in each 33KV side transformer C&R panel shall be provided.

10.00 SYNCHRONISING SWITCH:

a) Synchronising switch with lock feature two positions, "ON & OFF" shall be provided on all control panels except the 132/33KV Transformer panel and 33KV C&R panels. The switch shall be semi flush mounting type.

b) The switch shall be wired back connected. It's operation in the "ON" position shall connect the incoming and running bus potentials to the respective synchronising instrument and relay mounted in a trolley, through a synchronising socket having sufficient nos. of ways. The wiring between the synchronising switch, socket and the main breaker control switch shall be such that when the main breaker control switch is operated to close position, the breaker shall not receive a close command unless the synchronising switch is put to the 'ON' position and receives a synchronising command. If the synchronising trolley is not within the scope of supply for a particular sub-station, the terminal of the synchronising socket to be shorted through a plug to be provided to cover the socket.

11.00 PUSH BUTTON SWITCHES:

a) Push button switches, provided where required, shall be of the monetary contact type wired back connected. They shall be semi flush mounted. They shall be provided with integral inscription plates engraved with their functions.

b) All push buttons shall be with a set of NO/NC contacts as required to fulfill the scheme requirement. The contact faces shall be silver plated and shall able to make/break and carry the rated current appropriate to the duty of the desired function.

12.00 INDICATING INSTRUMENTS, RECORDERS & TRANSDUCERS:

All instruments, meters, recorders and transducers shall be enclosed in dust proof, moisture resistant, black finished cases and shall be suitable for tropical use. All megawatt, megavar, Bus voltage and frequency indicating instruments shall be provided with individual transducers and these shall be calibrated along with transducers to read directly the primary quantities. They shall be accurately adjusted and calibrated at works and shall have means of calibration check and adjustment at site.

The supplier shall submit calibration certificates at the time of delivery. However no separate transducers are envisaged for digital bus voltmeters and digital frequency meters and the indicating meters provided in the synchronising equipment. Necessary complete wiring arrangement for Intelligent Electronic Meters along with supply of TTB & De-linked type Terminal Block shall be within the scope of supply of the bidders.

For green field SAS substations without any control panel, for each bay one no. MFM is to be provided in series with BCU Metering circuit at Relay panel.

12.01 INDICATING INSTRUMENTS:

a) Unless otherwise specified, all electrical indicating instruments shall be of digital type suitable for flush mounting.
b) Instruments shall have 4-digit display; display height being not less than 25 mm
c) Instrument shall confirm to relevant IS and shall have an accuracy class of 0.5 or better. Watt and Var meters shall have an indication of (+) and (-) to indicate EXPORT and IMPORT respectively.
d) Digital voltage and frequency meters shall be of class: 0.5 and shall have digital display of 5 and 4 digits respectively, with display size, not less than 25mm (height).
e) All indicating instruments shall preferably of size 72mm X 144mm.

12.02 TRANSDUCERS:

a) Transducers (for use with Indicating Instruments and Telemetry/Data Communication application) shall in general conform to IEC:688-1
b) The transducers shall be suitable for measurement of active power and reactive power in three phase four wire unbalanced system.
c) The input to the transducers will be from sub-station current & potential transformers. The output shall be in milli ampere D.C. proportional to the input & it shall be possible to feed the output current directly to the telemetry terminal or indicating instruments.
d) The transducer characteristic shall be linear throughout the measuring range.
e) The transducer output shall be load independent.
f) The input & output of the transducer shall be galvanically isolated.
g) Each transducer shall be housed in a separate compact case and have suitable terminals for inputs & outputs.
h) The transducers shall be suitably protected against transient high peaks of voltage & current.
i) The transducer shall withstand indefinitely without damage and work satisfactorily at 120% of the rated voltage and 120% of the rated input current as applicable.
j) The active & reactive power transducer shall have dual output of 4-20mA.
k) The response time of the transducers shall be less than 1 second.
l) The accuracy class of transducers shall be 0.5 or better for watt/VAR transducer.
m) The transducers shall have a low AC ripple on output less than 1%.
n) The transducers shall be suitable for load resistance of 1000-1500Ω

13.00 TEST BLOCK:

Switch Board type, back connected, test blocks with contacts shall be provided with links or other devices for shorting terminals of CT leads before interrupting the normal circuit for injection from external source or for inserting testing instruments in the circuit without causing open circuit of the CT. The potential testing studs shall preferably be housed in block molding insulation and partition shall be provided to prevent accidental short circuit across the studs. Test blocks for meters, relays shall be placed in front and rear panel respectively.

14.00 DC, AC AUXILIARY SUPPLY AND V.T. SECONDARY SUPPLY DISTRIBUTION SCHEME:

14.01 DC SYSTEM:

DC distribution in CRP panels shall be designed with the consideration that two sets of batteries (220V), their respective chargers and DC boards shall be used for DC supply for all new substations.

14.02 INCOMING DC SCHEME:

For CRP panels of different voltage class, the Incoming DC scheme shall be as mentioned below:

400kV	Two DC incomers (220V) for panels of each bay, as DC supply - 1 and DC supply - 2.	
220kV	Two DC incomers (220V) for panels of each bay, as DC supply - 1 and DC supply - 2.	
132kV	Only two DC incomers (220V) as DC supply - 1 and DC supply - 2 for the entire panel board. One suitably rated HRC fuse unit both at +ve and -ve side shall be provided for each D.C. incomer in Bus Transfer (2 bus system)/ Bus Coupler (GIS or 3 bus AIS system) panel.	D.C. incoming buses of 132KV Panel shall run continuously in the panel board. Individual panel D.C. supply shall be teed off in each panel from the two D.C. buses.
33kV	Only two DC incomers (220V) as DC supply - 1 and DC supply – 2 for the entire panel board. One suitably rated HRC fuse unit both at +ve and -ve side shall be provided for each D.C. incomer in Bus Transfer/ Bus Section (2 bus system)/ Bus Coupler (3 bus system) panel.	D.C. incoming bus of 33KV CR Panel shall run continuously in the panel board. Individual panel D.C. supply shall be teed off in each panel from the above two D.C. buses.

Necessary arrangement for Supervision of the both the incoming DC supplies shall be made in each panel.

14.03 DC CIRCUIT IN 400kV, 220kV AND 132kV PANELS:

a) Following circuits for each bay shall be connected, as tabulated below:

Sl. No.	Feeder type	Equipment/ Circuit	Connection through	DC source	Change over
1	Line	BCU	Fuse	DC-1	Auto
		Main-1	Fuse	DC-1	Manual
		Main-2	Fuse	DC-2	
2	Transformer/ Reactor	BCU	Fuse	DC-1	Auto
		Transformer differential relay	Fuse	DC-1	Manual
		HV REF relay	Fuse	DC-2	
		LV REF relay	Fuse	DC-1	
		Over flux relay	Fuse	DC-2	
		Over current and E/F relay	Fuse	DC-1	

		Transformer trouble alarm Group-1	Fuse/ MCB	DC-1	
		Transformer trouble alarm Group-2	Fuse/ MCB	DC-2	
		Transformer trouble trip Group-1	Fuse/ MCB	DC-2	
		Transformer trouble trip Group-2	Fuse/ MCB	DC-1	
3.	Common for all feeder	CB close, synchronisation	Fuse	DC-1	No change over, direct
		CB trip trip coil-1	Fuse	DC-1	
		CB trip trip coil-2	Fuse	DC-2	
		Isolator operation	Fuse/ MCB	DC-1	Manual
		Trip relay-1	Fuse	DC-1	No change over, direct
		Trip relay-2	Fuse	DC-2	
		Ethernet Switch Supply-1	Fuse	DC-1	No change over, direct
		Ethernet Switch Supply-1	Fuse	DC-2	
		Voltage selection circuit	Fuse/ MCB	Dc-1	Manual
		Indication circuit	Fuse	DC-2	
		Annunciation circuit	Fuse	DC-1	
		CB SF6 supervision	Fuse/ MCB	DC-1	Auto

b) The above circuits, which are connected to Auto Changeover DC, will be automatically fed from healthy DC Supply, in the event of failure of the Selected DC Supply. Necessary additional high speed electrically set – reset type relays having high current carrying capacity and inductive breaking capacity shall be considered to develop this auto Changeover scheme.

c) The above circuits, which are connected to DC supply – 1, will be fed from DC Supply – 2 in the event of failure of DC Supply – 1 and vice versa. Changeover shall be Manual (by using three-position Selector switch, DC – 1 / Individual / DC – 2). Both way transition between DC1 & Individual and between DC2 & Individual shall be continuous.

d) For 400kV system, DC Supply - 1 & 2 to Protection panel of a bay shall be fed from Relay panel of that bay directly.

e) LBB protection scheme DC shall be formed in 220kV & 132kV Bus Transfer/ Bus Coupler panel, as applicable, and shall run through all panels as bus wires. In individual panels this supply will feed the LBB scheme through isolating links.

f) In case of GIS substations, from Control/ Relay panel the DC supply - 1 & 2 will be teed off from the resp. incomer D.C. bus to LCC panel. For remote operation of GIS equipment the operational DC will generate from LCC through LOCAL/ REMOTE switch of LCC. Necessary separate relays shall be considered for Supervision of both LCC DC Supply - 1 & 2.

14.04 D.C. CIRCUIT IN 33 KV C&R PANEL/ INTEGRATED SWITCHGEAR:

Following circuits for each bay shall be connected to Changeover DC supply:

CB Closing circuit	through suitable HRC fuses
CB Trip coil – 1	through suitable HRC fuses
CB Trip coil – 2	through suitable HRC fuses
Power supply circuit of individual IED	through suitable HRC fuses
Isolator control circuit	through MCB
Transformer Supervision circuit	through MCB
CB Aux. Relay circuit	through MCB
Synchronising circuit	through suitable HRC fuses
D.C. emergency lamp circuit, separately for	through suitable HRC fuses

Control and Relay panel	
Metering circuit	through suitable HRC fuses
Indication circuit	through suitable HRC fuses

Changeover shall be Manual (by using three-position Selector switch, DC – 1 / Individual / DC – 2). Both way transition between DC1 & Individual and between DC2 & Individual shall be continuous.

14.05 AC CIRCUIT:

a) 230V, single phase 50Hz AC auxiliary supply to the control, relay and protection panel board of each system voltage of 400KV, 220KV, 132KV and 33KV will be fed from AC distribution board through separate 32Amp. switch fuse units provided there.

b) The supply shall be provided in Bus coupler/ Bus Transfer/ Bus Section panel for each voltage class. One 16Amp rated HRC fuse unit shall be provided for the AC incomer. AC incoming bus shall run continuously in each voltage class panel board.

c) Individual panel AC supply shall be teed off in each panel from the AC bus. A set of fuse and link rated for 10Amps. for 3 pin plug circuit, cubicle lamp circuit, space heater circuit shall also be provided in each control, relay and protection panel.

d) Door operated corridor illumination lamp circuit of duplex type panel shall be arranged from the above incoming AC bus through suitably rated fuse and link.

e) AC circuit for incoming DC fail alarm scheme shall be provided in Bus coupler/ Bus Transfer/ Bus Section panel for each voltage class. The above circuit shall be teed off from the above respective panel AC bus through suitably rated fuse and link.

f) One supervision relay for incoming AC fail with test P.B. and reverse flag indication shall be provided for monitoring of AC supply healthiness through D.C. operated facia annunciation in Bus coupler/ Bus Transfer/ Bus Section panel for each voltage class.

14.06 V.T.SECONDARY SUPPLY DISTRIBUTION SCHEME:

PT kiosk at switchyard may be considered with sufficient terminals, fuses, links etc for protection PT secondary supply and for metering PT secondary supply to bus coupler panel through individual cable for all voltage class in a substation.

a) The bus coupler panel shall receive protection VT secondary volts through fuses and links provided in the respective VT kiosk. The protection VT supply shall run throughout entire board for each panel through VT supply selection scheme.

b) The Bus Coupler panel shall also receive Metering VT Secondary volts by at least 25Sqmm Copper/ equivalent Aluminum per phase/neutral through fuses and links provided in the respective VT kiosk. The Metering VT supply shall also run throughout entire board for each panel through VT supply selection scheme.

c) VT secondary volts from all Protection cores and Metering core shall be first terminated to de-linked type TBs in each bay panel before wiring to the VT selection scheme.

d) Selected VT secondary supply to the protective relays of each panel shall be fed through individual fuses in individual phases and link in neutral in each panel. Necessary arrangement for supervision of VT secondary supply shall be provided in numeric relay.

e) Selected VT secondary supply to metering and indicating instruments of each panel shall be fed through MCB. Proper arrangement of supervision through MCB shall also be provided.

f) For all two main bus / one bus system three sets VT selection relays shall be provided for 3 cores of VT. For single main bus system, VT selection switch is to be used. Where 3 phase Line VT / CVT is available, 4-Position VT Selector Switch (Line CVT – Inter1 – Inter2 – Selected Bus PT) is to be provided.

15.00 ANNUNCIATION SYSTEM:

15.01 INCOMING DC FAIL AND ANNUNCIATION BUS DC FAIL ALARM SCHEME:

Each voltage class system shall have alarm scheme, as follows: -

i) Incoming DC-1/ DC-2 supervision shall be provided in each panel.

ii) In Bus bar protection panel, DC fail supervision shall be provided.

iii) Audible AC alarm shall be provided for Incoming DC / Annunciation DC Fail.

iv) The "Annunciation Bus D.C. alarm scheme" shall be common to the entire C&R board and operated from 230V single phase AC auxiliary supply for audible as well as visual alarm through lamp and bell arrangement. This will be provided at the Bus Coupler/ Bus Transfer/ Bus Section panel.

The scheme shall comprise of D.C. supervision relays with test push buttons for Annunciation bus DC system, AC operated alarm accept relays, indication lamp, AC operated hooter and push button for cancellation of audible alarm, as necessary.

v) Annunciation DC and AC shall be supervised by the Annunciator through auxiliary AC supply / DC supply resp. of the Annunciator in each panel.

15.02 OTHER TRIP AND NON-TRIP ALARM SCHEME:

a) Facia annunciation system shall be provided in each control panel by means of visual and audible alarm to draw attention of the operator to the abnormal operation or operation of the protective devices. The annunciation shall be divided into the following categories:

i) Trip annunciation

ii) Non Trip annunciation

The annunciator shall be suitable for operation with the sub-station AC/ DC voltage and potential free initiation contact is to be provided. Annunciator must have communication port, suitable for SCADA/ SAS operation, and this connection is to be established during commissioning.

b) The visual facia widow shall be flush mounted at a convenient position near top row of the control panel and necessary switching relays for the same shall be mounted inside the panel or at the relay side of the panel.

c) The annunciator facia shall be provided with translucent glass or plastic cover plates of white colour with inscription in black colour. The size of facia window shall be 70mm x 35mm in general and the size of the lettering shall not less than 5 mm. Alarm inscription shall be engraved not more than three line of in each facia window and the same shall be prominently visible when facia light is ON. The cover plates of the facia window shall be easily removable to facilitate replacement of lamp when required. Annunciator of each bay must have minimum 5-6nos. spare windows available.

d) The transparency of cover and wattage of the lamp provided in the facia window shall be adequate to ensure clear visibility of the inscription from the location of the operator's table in the control room having high illumination intensity. Each facia window shall be provided with two lamps to ensure safety against lamp failure. Long life lamp shall be used having resistor of adequate rating in series.

e) Annunciator should have in-built Accept, Reset and lamp Test push buttons for acknowledgment of alarm, reset of visual indication and for checking perfectness of the lamps shall be provided below the facia window in each panel. These push buttons shall be common for both trip and warning annunciation. The sequence of operation of the annunciation shall be as follows:

Alarm Condition	Fault contact	Visual Annunciation	Audible Annunciation
Normal	Open	OFF	OFF
Abnormal	Close	Flashing	ON
Accept push button	Close	Steady ON	OFF

is pressed.	Open	Steady ON	OFF
Reset push button	Close	ON	OFF
is pressed.	Open	OFF	OFF
Lamp test push button is pressed.	Open	Steady ON	OFF

f) In case static annunciation system is used, care should be taken that no spurious alarm condition arises due to external influences on the annunciator wiring and switching disturbances from the neighboring circuits within the panels. The static relay shall be suitable for operation within a temperature range from 0°C to 55°C.

g) The annunciation scheme should be such that momentary closing of any fault contacts shall also cause operation of annunciation system as above.

h) The annunciation facia window shall be programmable between Trip annunciation and Non-trip annunciation using DIP switches at site easily.

15.02. TRIP ANNUNCIATION:

01

Trip annunciation shall be used to draw attention of the operator when the circuit breaker is tripped automatically through relay. One hooter is to be provided in each panel for audible annunciation. Visual annunciation shall be provided by flickering of a facia window.

15.02. NON-TRIP ANNUNCIATION:

02

Non-Trip annunciation shall be used to draw attention of the operator to abnormal operating condition of certain equipment for immediate action to avoid tripping of circuit breaker. One bell with different tone is to be provided in each panel for audible annunciation. Visual annunciation shall be provided by flickering of a facia window.

16.00 RELAY:

GENERAL REQUIREMENT:

The main numerical protective relays shall be of Panel manufacturer's own make or their principal company's make.

However, panel manufacturer, who are authorized by relay manufacturer to supply their relay, may also be considered for supply of C&R panel. This acceptance is subject to strict compliance to the following conditions: -

i) The panel manufacturer must be enlisted in WBSETCL maker's list as on date of NIT and meet all the Qualification Requirement to be eligible.

ii) The panel manufacturer should provide document/ certificate of guarantee from the relay manufacturer.

Live demonstration of any offered relay has to be arranged by the Party at the laboratory of Central Testing Department of WBSETCL prior to approval, if felt necessary by WBSETCL. The turn-key bidder shall be required to make necessary arrangement without any extra price.

16.01 All shall conform to the requirement of IS: 3231 / IEC 255 and shall be suitable for operation within a temperature range 0ºC to 55ºC and 50% to 95% relative humidity. Relays shall be suitable for flush/ semi flush mounting on the panel with connections from the rear, protected with dust tight cases for tropical use and with transparent cover removable from the front.

16.02 All protective relays shall be in draw out case or plug-in/modular cases with proper built in testing facilities. If testing devices are not incorporated in the relay itself separate test block and switches shall be provided. The adjusting devices shall be accessible with the relay mounted on the panel board. Flag type operating indicators and flag indicator reset devices shall be provided which shall be suitable for operation from the front of the relay case without opening the cover. **No control relay, which shall trip the power circuit breaker when the relay is de-energised, shall be employed in the circuits.**

16.03 All A.C. relays shall be suitable for operation at 50Hz.The current coils shall be rated for a continuous current of 1 amp and the voltage coil for 110V normal. The contacts of the relays shall be properly designed to prevent or minimise damage due to arcs which have to be broken successfully against 220 +/- 10% volt DC. When open the contacts shall withstand a voltage of 115% of the normal circuit voltage. The relays shall be designed for satisfactory operation between 70% and 110% of rated D.C. voltage of the sub-station. The voltage operated relays shall have adequate thermal capacity for continuous operation.

16.04 Timers shall be of static type. Pneumatic timers are not acceptable.

16.05 The sub-stations may be required to run without air-conditioning plant. Therefore, the static relays shall be designed for operating satisfactorily under the climatic conditions of ambient temperature and relative humidity variation from 0ºC to 55ºC and 50% to 95% respectively. The static relays should be capable to withstand the test voltages as stated in the relevant Indian standard or equivalent. Stringent measures including shielding of long internal wiring should be taken to make the relays insensitive to the voltage spikes. Insulation barriers shall be provided to ensure that transients present in CT & VT connection due to extraneous sources do not cause damage to static circuits.

16.06 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 D.C. Cells in the protective relays as reliable standby power supply will however not be acceptable. The DC/DC converter shall have power supply failure annunciation contact.

16.07

a) The solid state relays shall be stable and suitably protected against transient/ induced over voltages and noise signals. The bidder shall state clearly in the list of special requirement, if any, for D.C. input arrangement or cabling considered necessary for satisfactory operation of proposed solid state relays.

b) All the Numerical Relays should have setting parameter access restriction. All the numerical relay should have provision for setting all the features available in the relay and viewing those setting as well as different other parameters through both built in display unit as well as through PC. The supply of relay should be inclusive of necessary software and hardware for interfacing with a PC, to be supplied by the bidder. The bidder/manufacturer has to make arrangement for communication with all relays, along with supply of cables, connectors, communication port, converters etc. as necessary for downloading the storage data for all microprocessor/ numeric relays, disturbance recorder and fault locator etc. through a centralized PC. The necessary PC, window based Licensed software along with operating system software and all the necessary hardware for establishing the Network in latest IEC 61850, Ed - 2 platform to be considered in the scope of supply by the bidder.

The relays shall have the provision for Man to Machine Communication for local and remote control and monitoring complete with software, ports and other hardware e.g. required numbers PC hook up cable for direct communication, one for each type of relay.

Bidder shall arrange for such local man to machine communication facility for all the numerical relays inclusive of all the necessary accessories as mentioned above complete through Local Area Networking System for each 400KV, 220KV & 132KV substation wherever mentioned in the schedule.

The electronic devices on bay shall be connected to the communication infrastructure for data sharing and meet the real-time communication requirements. The communication shall be made in fault

tolerant ring in redundant mode INCLUDING the links between individual bay IEDs to switch, such that failure of one set of fiber shall not affect the normal operation. However failure of fiber shall be indicated through alarm/ annunciation. Each fiber optic cable shall have four spare fibers.

The data exchange between the electronic devices on bay and station level shall be realized using fiber optic cables, thereby guaranteeing disturbance free communication. The fiber optic cables shall be run in suitable, preferably GI, conduit pipes. Data exchange is to be realized using latest IEC 61850, Ed - 2 protocol with a external managed switched optical Ethernet communication infrastructure in decentralized ring configuration.

All the protective relays shall be numerical type and communication protocol shall be latest IEC 61850, Ed - 2 compatible with the following features:

i) All Numerical Protection IEDs as well as BCU shall be IEC 61850, Edition – 2 compliant.
ii) Peer-to-peer communication using GOOSE messages (latest IEC61850, Ed - 2) for interlocking.
iii) Interoperability with third party IEC 61850, Ed - 2 (latest version) compliant devices.
iv) Generate XML file for integration/ engineering with vendor independent SCADA systems.
v) Should be directly connected to the inter bay bus on IEC 61850, Ed - 2 (latest version) without the use of any gateways. Connections of bay protection IEDs to the IEC 61850, Ed - 2 bus (latest version) through the bay control units are not acceptable.
vi) All Numerical relays must be PRP compliant for SAS.
vii) Numeric relays with non-programmable Inputs and non-programmable outputs are not acceptable.

All the numerical relays shall have one front port for direct access with proprietary protocol, PRP compliant rear ports with latest IEC 61850, Ed - 2 protocol (Two nos. FO port). The main Numerical Protective Relays shall synchronise the internal clock with GPS based time synchronising equipment directly through,

i) IRIG-B or
ii) SNTP protocol or
iii) Minute/Second pulse through Binary I/Ps

All numerical relays shall be provided with 'Relay Failure Annunciation Contact'. Individual window is to be assigned in annunciator for each Numerical relay.

In all numerical relays, there should be at least 1 no. change-over contact or more.

c) One set of Special Tools and Tackles required for maintenance purpose, including but not limited to the following items, must be supplied for each substation:

i) Test Jacks
ii) Wire Lugs
iii) Crimper
iv) Module Extractor
v) Wire Extractor
vi) Special type of Screw Driver

d) List of software for local parameterisation, settings, logic configuration, data retrieval, disturbance evaluation, downloading of storage data and no. of license (minim. 3 for new 400KV & 220KV S/Stn, & one each for other substations involved) shall be supplied by the bidder:

i) Graphical configuration tool having all the functions used in the relay and sufficient numbers different logic gates in the inbuilt library (software)

ii) Basic application licensed software for setting change, service value monitoring etc., one each for every substation where numerical relays shall have to be provided.

iii) Software for disturbance record & event logger collection and evaluation of those records in COM TRADE format.

iv) Latest IEC 61850, Ed - 2 software for inter-operability, Goose message etc.

v) Any additional software if required for remote communication and for other facilities available in the relay.

All the above tools/software should be WINDOWS 10 operating system compatible.

e) Interconnection architecture among the relays showing details identification of all intermediate hardware including interfacing port of the monitoring PC and other hardware

f) Connectivity architecture of Disturbance recorder evaluation station of all numerical relays like numerical distance relay, numerical differential relay etc. with time synchronisation unit.

g) Interface architecture involving multiple nos. of numerical relays of respective make, with the monitoring PC.

h) Interface architecture of the above network with existing/future network of other make numerical relays with monitoring PC, wherever applicable.

i) The bidder has to furnish the **certificate for latest IEC 61850, Edition - 2 Compliance from KEMA/CPRI**, type test certificate from any Govt. recognized Test House and performance certificate from Power Utilities in India.

j) Local area networking system (if mentioned in BOQ): -

i) Shall be PRP and IEC 61850, Edition – 2 compliant.

ii) PC configuration for both local and remote end communication:

- CPU - i5 latest (3GHz Min)
- RAM – 4GB Min
- HDD 500GB, 7200 rpm
- Internal DVD combo
- 17" TFT monitor, Key board & optical mouse
- Minimum 2 nos COMPORT(RS232C)
- 8 Nos. USB Port (2 Front & 6 Rear)
- Requisite quantity of interconnecting cable
- IRIGB port if required for time synchronization with GPS clock for date and time stamping.
- Operating system – Windows 7/ WINDOWS 10
- Required software including but not limited to licensed latest version of latest Anti-Virus software, MS Office etc.

iii) External comport (RS232C) multiplier to be interfaced with the comport of PC, having minimum 8 nos interfacing port.

iv) UPS - ON LINE UPS for individual PC with minimum 15 min. battery backup.

v) Printer – Colour inkjet suitable for A3 size paper.

v) Required furniture for table top installation of PC along with Printer and two nos suitable revolving chair

vi) Other particulars, if any.

17.01 BAY CONTROL UNIT/ BAY CONTROL & PROTECTION UNIT

[The IED should be latest IEC61850, Ed - 2 compliant having rear port compatible to latest IEC 61850, Ed - 2 protocol.]

a) BCU shall be provided for supervision and control of each 132kV and above voltage class bay and BCU/ BCPU (as per the Project LOA) shall be provided for supervision and control of 66kV and below voltage class bay (a bay comprises of one circuit breaker and associated disconnector, earth switches and instrument transformer). In such case, BCPU is considered for a bay, BCPU for each bay must have six nos. Analog Current Input channels, (three nos. each for Metering core and Protection core).

b) Communication Port: BCU shall be PRP compliant for SAS with latest 61850, Ed - 2 protocol including one front port for direct access with proprietary protocol.

c) Inputs: Sufficient opto-isolated inputs. Contact bouncing in Digital inputs shall not be assumed as change of state.

d) Outputs: Sufficient potential free outputs.

e) All inputs and outputs must be user programmable. The bay control units shall be equipped with sufficient number of programmable I/O modules for interfacing with the process inputs and outputs. Extension should be possible with additional I/Os.

f) The BCU shall meet the requirements for withstanding electromagnetic interference as per relevant standard. Failure of any single component within the equipment shall neither cause unwanted operation nor lead to a complete system breakdown.

g) The IEDs should be directly connected to the switchgear without any need for additional interposition or transducers.

h) A graphic user interface (GUI) display shall be provided in each bay control unit. The GUI display in the BCU shall display the status of the bay devices (breakers, isolators, switches etc) in real time. All alarms related to the respective bay shall be displayed in the BCU through its LED's or in its GUI display as an alarm list/scroll.

i) Analog inputs for voltage and current measurements shall be connected directly to the voltage transformers and the current transformers without intermediate transducers. The values of active power (MW), reactive power (MVAR), Frequency (Hz) and the RMS values for Voltage and Current shall be calculated.

j) Each bay control IED shall be independent from each other and its functioning shall not be affected by any fault occurring in any of the other bay control units of the station. Bay Control IEDs shall not depend on any Numerical Protection IED or other equipment to perform control, protection, and monitoring functions and for acquisition of any bay equipment associated data.

k) Connections from BCU to switchgear should not be terminated directly on I/O boards but should be routed through Terminal Boards (TB). 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.

l) The protection functions are independent of bay control function. The protection shall be provided by separate protection IEDs (numerical relays) and other protection devices, guided by the respective section of Relay & Protection.

m) Self-monitoring of components, modules and communication shall be incorporated to increase the availability and the reliability of the equipment and minimize maintenance.

n) Functions for BCU:

   i) Control mode selection
   ii) Select-before-execute principle
   iii) Command supervision
   iv) Interlocking and blocking
   v) Double command
   vi) Synchro-check, voltage selection

(BCU of Bus Coupler bay must have six numbers Analog voltage Input Channels)

vii) Run Time Command cancellation
viii) Transformer Tap Changer Control (Raise & Lower of tap) (for Power Transformer bays)
ix) Operation counters for circuit breakers
x) Breaker position indication per phase
xi) Alarm annunciation
xii) Measurement display of Vrms, Irms, HZ, W, Var for each phase and for 3phase
xiii) Local HMI (local guided, emergency mode) with Graphic display
xiv) Interface to the station HMI.
xv) Data storage for at least 200 events
xvi) Capability to implement bay level interlocks

o) Bay wise Typical I/O requirement (not exhaustive) of BCU is tabulated here under. The exact number and description of digital inputs shall be as per detailed engineering requirement because some of the I/Os may be deleted or added during detailed engineering. Apart from the above mentioned I/Os, 50% spare I/Os BCU wise for all BCUs shall be kept spare for WBSETCL use in future.

Status	**DI Hard Wired**	**AI Hard Wired**	**DO**	**Remarks**
Common status for each bay				
220V DC -1 source fail	✓			
220V DC -2 source fail	✓			
220V LCC DC -1 source fail	✓			
220V LCC DC -2 source fail	✓			
Current -R Phase		✓		
Current -Y Phase		✓		
Current -B Phase		✓		
Current Neutral		✓		
CB Local Mode	✓			
CB Remote Mode	✓			
CB R-Ph Open position	✓			
CB R-Ph Close position	✓			
CB Y-Ph Open position	✓			
CB Y-Ph Close position	✓			
CB B-Ph Open position	✓			
CB B-Ph Close position	✓			
CB Pole Discrepancy operated	✓			
CB Spring Charged	✓			
CB SF6 Gas Pr. Low Alarm	✓			
CB lockout	✓			
CB Trip Coil-1 R-Ph Faulty	✓			
CB Trip Coil-1 Y-Ph Faulty	✓			
CB Trip Coil-1 B-Ph Faulty	✓			
CB Trip Coil-2 R-Ph Faulty	✓			
CB Trip Coil-2 Y-Ph Faulty	✓			
CB Trip Coil-2 B-Ph Faulty	✓			
CB Open Order 1			✓	
CB Open Order 2			✓	
CB Close Order			✓	
Sync OK			✓	
86-A Master trip Relay Operated	✓			
86-B Master trip Relay Operated	✓			

Status	**DI Hard Wired**	**AI Hard Wired**	**DO**	**Remarks**
86-A Master trip Relay Faulty	✓			
86-B Master trip Relay Faulty	✓			
Reset Order for Master-86A			✓	
Reset Order for Master-86B			✓	
96 Trip Relay Operated	✓			
96 Trip Relay Faulty	✓			
Reset Order for 96			✓	
75A OPTD	✓			
75B OPTD	✓			
GIS Auxiliary Status e.g. gas low and lockout of various gas sections, L/R/E Switch status, N/M Switch status, MCB trip condition etc.	✓			(Exact nos. of signals need to be assessed from final approved GIS LCC drawing)
33kV Indoor Switchgear Auxiliary Status e.g. Test position, Service position, Local mode, Remote mode, MCB Trip etc.	✓			(Exact nos. of signals need to be assessed from final approved Indoor Switchgear drawing)
CB Auxiliary Status (Minimum 8nos for 220kV and above, minimum 6nos for 132kV and below)	✓			For AIS CBs
Relay Faulty status	✓			Separately for each Numerical IED
PT MCB Trip	✓			Separately for each Metering and Protection circuit
Common status for each equipment				
Isolator Local Mode	✓			
Isolator Remote Mode	✓			
Isolator Open position	✓			
Isolator Close position	✓			
Isolator Open Order			✓	
Isolator Close Order			✓	
Earth Switch Open position	✓			
Earth Switch Close position	✓			
Earth Switch Interlock permissive	✓			
SF_6 CT R-Ph Gas Low	✓			For AIS SF_6 CTs
SF_6 CT Y-Ph Gas Low	✓			
SF_6 CT B-Ph Gas Low	✓			
SF_6 CT R-Ph Gas Lockout	✓			
SF_6 CT R-Ph Gas Lockout	✓			
SF_6 CT R-Ph Gas Lockout	✓			
Additional bay specific status				
Bus Coupler bay/ Bus Transfer bay				
Bus1 Voltage- R - Y Phase		✓		
Bus1 Voltage- Y - B Phase		✓		
Bus1 Voltage- B - R Phase		✓		
Bus1 Voltage - Neutral		✓		
Bus1 Frequency		✓		

Status	DI Hard Wired	AI Hard Wired	DO	Remarks
Bus2 Voltage- R - Y Phase		✓		
Bus2 Voltage- Y - B Phase		✓		
Bus2 Voltage- B - R Phase		✓		
Bus2 Voltage - Neutral		✓		
Bus2 Frequency		✓		
All Bays except Bus Coupler bay/ Bus Transfer bay				
Selected Bus R -Y Phase		✓		
Selected Bus Y - B Phase		✓		
Selected Bus B - R Phase		✓		
Selected Voltage Neutral		✓		
Line bay				
Autoreclosure - CB Healthy	✓			
CVT Voltage Phase		✓		
~~CVT Voltage Neutral~~		✓		
Transformer bay				
Other side Voltage Phase		✓		
~~Other side Voltage Neutral~~		✓		
Other side CB Open Order 1			✓	
Other side CB Open Order 2			✓	
WTI Temperature of **each** winding		✓		Normally this I/O should be in RTCC panel BCU/ digital RTCC relay
OTI Temperature		✓		
OLTC Main Supply ON	✓			
OLTC Main Supply OFF	✓			
OLTC Tap Position Indication		✓		
Tap Changer Out of Step	✓			
Tap Changer in progress	✓			
Tap Changer ON LOCAL	✓			
Tap Changer ON REMOTE	✓			
Tap Changer in Independent mode	✓			
Tap Changer in master mode	✓			
Tap Changer in follower mode	✓			
OLTC Tap Raise			✓	
OLTC Tap Lower			✓	
Cooler control Main AC Supply Fail	✓			
Cooler control S/By AC Supply Fail	✓			
Cooler Control Auto	✓			
Cooler Control Manual	✓			
Cooler control Main Oil Pump ON	✓			
Cooler control Main Oil Pump OFF	✓			
Cooler control Main Oil Pump STUCK	✓			
Cooler control S/By Oil Pump ON	✓			
Cooler control S/By Oil Pump OFF	✓			
Cooler control S/By Oil Pump	✓			

Status	DI Hard Wired	AI Hard Wired	DO	Remarks
STUCK				
Cooler control Main Fan ON	✓			
Cooler control Main Fan OFF of **each** Fan	✓			
Cooler control S/By Fan ON	✓			
Cooler control S/By Fan OFF	✓			
Buchholz Trip	✓			
Buchholz Alarm	✓			
PRV Trip	✓			
OSR Trip	✓			
Oil Temp. High Trip	✓			
Oil Temp. High Alarm	✓			
Oil Level Low Alarm	✓			
Winding Temp. High Trip of each winding	✓			
Winding Temp. High Alarm of each winding	✓			
MOG Alarm	✓			
Diverter Tank MOG Alarm	✓			
RTCC in AUTO	✓			
RTCC in MANUAL	✓			

17.02 EVENT LOGGER (if mentioned in BOQ):
[The IED should be latest IEC61850, Ed - 2 compliant having rear port compatible to latest IEC 61850, Ed - 2 protocol.]

a) Stand-alone type Event logger to be considered with external triggering facility. The event list shall contain events that are important for the control and monitoring of the substation.

b) The event logger shall be mounted in a separate Simplex type panel.

c) The events shall be registered in a chronological event list in which the type of event and its time of occurrence are specified. It should be possible to get the chronological event list at any time for the whole substation or sections of it. Filters for selection of a certain type or group of events shall be available. The filters shall be designed to enable viewing of events grouped per:
   i) Date & Time
   ii) Bay
   iii) Device
   iv) Functions e.g. Trips, Protection operations etc.
   v) Alarm class

d) The chronological event list shall contain:
   i) Position changes of Circuit Breakers, Isolators and Earthing devices
   ii) Indication of Protective relay operations
   iii) Fault signals from the switchgear
   iv) Indication when analog measured values exceed upper and lower limits. Suitable provision shall be available to define two level of alarm on either side of the value, which shall be user defined for each measurands.
   v) Loss of communication

e) Event Logger shall fetch events from IEDs (including BCU) through soft signals. It shall also fetch events from potential free contacts through BI (5 inputs per bay + 20% spare).

f) All recorded/stored events shall be date and time tagged followed by a message describing the points which have been operated. The time resolution shall be 1 milli second.

g) Number of time tagged events in the event list should be sufficient enough to record/store all possible sorts of events of the switchyard, equipments, relays etc.

h) Event Recorder buffer memory shall be of non-volatile type and shall not require the use of batteries.

i) The printout of events shall contain at least the station & feeder identification, date and time (in hour, minute, second and millisecond), event number and event description. The event list and its print out may be available from S/S; PC and its printer to be supplied by the bidder for a complete S/Stn. The timing of each event shall be as per GPS based time synchronising equipment to be supplied by the bidder, wherever applicable & mentioned in the schedule.

All the necessary software for the event logger function and download the event list shall be within the scope of the bid.

17.03 NUMERICAL TYPE DISTANCE PROTECTION SCHEME RELAY:
[The relay should be latest IEC61850, Ed - 2 compliant having rear port compatible to latest IEC 61850, Ed - 2 protocol.]

a) The distance protection shall be a microprocessor based high speed non-switched distance relay suitable for all phase to phase faults and phase to earth faults based on numerical principles. It shall also have necessary phase selection and direction selection facilities. The relay shall be field selectable for various permissive over reaching, permissive under reaching and for blocking/ direct-trip through communication schemes.

b) The relay shall have polygonal/ quadrilateral characteristics with a facility to set resistance and reactance characteristics independently.

c) The relay shall have three forward and one reverse zone of protection for each PH-PH & PH-E fault loop with sufficient impedance or reactance and resistance reach of each zone. It shall have three zone time stepped characteristics. The second and third zone elements shall provide backup protection in the event of the carrier protection on the first zone element failing to clear the fault.

d) It shall be compatible with the PLCC equipment to be procured separately under separate contract. The distance protecting scheme shall be suitable for any length (short length also i.e. Minimum Settable value should be 1Ω Primary) of transmission line. Any limitation in this regard shall be clearly specified by the bidder.

e) The relay shall have numerical filtering and measuring techniques. It shall have individual measuring element for each phase to phase fault and each phase to earth fault. It should ensure a maximum operating time from the relay to the trip coil of CB within 40 ms for all types of faults at 50% of the set zone 1 relay reach with CVT being used on the line for a System Impedance Ratio (SIR) of 4 and the same shall be 45 millisecond for an SIR of 15. However, a relaxation of 5millisecond is allowed for the relays being used for 132 KV.

f) It shall be provided with continuous self supervision features along with self diagnostic feature, having output IRF contact for annunciation purpose.

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

h) It shall be suitable for single and three phase tripping mode to be scheduled by WBSETCL depending upon their application along with necessary trip relays.

i) The scheme for 400KV & 220 KV system shall be suitable for single phase or/and three phase Auto-reclosing. It shall have in built features of weak end in feed, switch on to fault, fuse failure supervision and instantaneous blocking of voltage dependent protection in the event of fuse failure and should remain inoperative for system earth fault, Power Swing blocking with zone selection facility for such blocking, broken conductor detection and different indications for relay monitoring operations.

j) The relay should have the facility to switch over to settable non-directional O/C during loss of voltage.

k) The relay shall have inbuilt single phase & three phase auto reclose scheme, disturbance recorder, event logger facility and additional features shall also be indicated over and above the features already specified.

l) The relay shall have online type fault location function along with built-in parallel line mutual compensation facilities having accuracy of ±3% of line length. The above accuracy should not be impaired in presence of severe CVT transient or high fault arc resistance.

m) Relay should be blocked in case of momentary dropping off of PT switching Relays to avoid mal-operation, if there be any. The VTF protection should be incorporated.

n) The numerical distance relay should have in built directional sensitive earth fault element for high resistance fault.

o) The relay shall have suitable number of potential free contacts for carrier aided tripping, auto reclosing, event logger, disturbance recorder and data acquisition system.

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

q) The relay shall have at least 16nos (for upto 132kV) and 20nos (for 220kV and above) of individually site selectable Binary Inputs and 24 nos separate Binary Outputs having no DC mixing (rating of Binary Input shall be 240V DC but they should not pick up at less than 150V). Latching option for B/O shall have to be provided. Output contact of the protective relay should operate single phase trip relay which will have sufficient contact to give trip command to main breaker & TBC breaker & for LBB protection initiation and other purpose.

r) Relay should have following in-built features-

- Back-up Over Current (Directional and Non-directional)
- CB Failure with Re-trip and Back-trip option
- Synchronisation.

17.03. AUTO-RECLOSE RELAY

01

Auto reclose feature should an integral part of main line protection relay if not separate AR relay is mentioned in BOQ and should meet following requirements:

a) The scheme shall be compatible with the distance relaying scheme. It shall be suitable for single shot, single and/or three phase auto-reclosing feature. The bidder shall coordinate the auto-reclose relaying scheme with that of the circuit breaker so as to ensure satisfactory and reliable operation of the auto reclosing scheme.

b) The auto reclose relays shall have independently adjustable dead timers for single phase and three phase reclosures and an adjustable reclaim timer.

c) It shall also be possible to lock out the auto-reclosing scheme relays when the carrier protection associated with distance protection scheme is out of service or faulty.

d) It shall have auto-reclose mode selection facilities as required.

e) It shall have facilities for selecting check synchronising or dead line charging feature. It shall be possible at anytime to change the required feature as required.

f) It shall be built-in with the main distance relay.

g) The autoreclose relay along with necessary check synchronising or dead line charging facilities and other associated features shall be in built in the Main-1 & Main-2 protection. Any one shall be activated during operation and the other shall be kept as stand by. The two inbuilt autoreclose relays should be well coordinated so that autoreclose command/ definite trip command etc may be initiated from either of the two units at the discretion of WBSETCL personnel. The autoreclose element of the distance relay shall also be suitable for triggering from other external protections.

h) In One and Half breaker system, while reclosing the Main breaker & Tie breaker for the Line bay, a priority shall be assigned. The Main breaker shall be allowed to reclose first and only after its

successful recloser, the Tie breaker shall be allowed to reclose. If the fault persists after reclosing of the Main breaker, reclosing of the Tie breaker is blocked.

17.03. FAULT LOCATOR (in-built feature of main line protection relay if not specifically mentioned in BOQ):

02

The distance to fault locator shall be provided for all 400KV, 220KV and 132KV lines. It shall comply with the following requirements: -

a) Microprocessor based "on-line" type.
b) suitable for breaker operating time.
c) have built in display unit.
d) the display shall be directly in kilometers without requiring any further calculations.
e) have an accuracy of 3% of the line length for which the fault locator is installed or better for all type of faults and fault levels.
f) the above accuracy should not be impaired under the following conditions:
   i) presence of remote end in feed.
   ii) Predominant d.c. component in fault current.
   iii) high fault arc resistance.
   iv) severe CVT transients.
g) have facility for remote data transmission.
h) **shall be in-built in distance relay and Line Differential Relay with facility for triggering from external protection**.
i) shall have built in mutual compensation facility for using in double circuit lines and this parallel line compensation shall not be used for protection purpose.

17.03. DISTURBANCE RECORDER:

03 [The DR should be latest IEC61850, Ed - 2 compliant having rear port compatible to latest IEC 61850, Ed - 2 protocol.]

a) Disturbance Recorder shall be used for 400KV, 220KV and 132KV system to record the graphic forms of instantaneous/ rms values of voltages and currents, in all phases, open delta voltage and neutral current, open or closed position of relay/ breaker contacts just prior to, during and immediately after a system disturbance to provide information necessary to ascertain the causes of disturbance and performance of relays, breakers etc. The system shall start only on the occurrence of a system abnormality.
b) The disturbance recorder shall be inbuilt function of numerical distance/ differential relay. The channels and trigger sources shall be user configurable. Program for disturbance records and event logger collection and evaluation of those records shall be provided. Also the software shall be capable of carrying out Fourier /harmonic analysis of the current and voltage waveform. Disturbance shall also be available in COMTRADE format.
c) Number of Channels required for each feeder bay :
   i) Analog channel: 8 nos.
   ii) Digital channel: 32 nos.
d) The relay shall have the disturbance recording function with at least 8nos analog channels and 32nos binary channels having total recording memory of at least 15secs divided in to 8 records, each having at least a memory of 100ms for pre-fault analysis, and recording bandwidth may please be indicated. It should have on line pre and post fault disturbance recording facility. There should be provisions for interfacing all the digital channels both internally and externally.
e) The disturbance recorder shall be suitable for working with 220V DC available at the Sub-station.
f) Each Relay & Disturbance Recorder shall have the facility to synchronise the internal clock with GPS based time synchronising equipment directly through,

a. IRIG-B or
b. SNTP protocol or
c. Minute/Second pulse through Binary I/Ps

g) The accuracy of the internal clock shall be indicated by the bidder. The drift is limited to ±0.5sec per day, if allowed to run without synchronisation. The recorder shall give annunciation in case of absence of synchronising pulse within a specified time.

h) Substation where time synchronisation equipment is not available, time generator of any one of the disturbance recorder can be taken as master and the time generator of other disturbance recorder and event logger in the substation shall be synchronized to follow the master.

i) The recorder shall have facility for automatic uploading of, remote data transmission. Scan rate of D R shall be at least 1KHZ per channel or better. Facility for triggering of disturbance recorder from external protection shall also be provided. Acquisition units shall acquire the fault data for the prefault and post fault period and can be transferred on demand to connected PC.

17.04 NUMERICAL TYPE LINE DIFFERENTIAL PROTECTION RELAY:

[The relay should be latest IEC61850, Ed - 2 compliant having rear port compatible to latest IEC 61850, Ed - 2 protocol.]

The line current differential relay with built-in distance protection function shall be capable of being selected to differential function with back up distance function or shall activate back up distance automatically when the differential relay is out of service. The relay shall fulfil the requirement specified for distance relay function. Further, the line current differential function shall conform to the following main requirements:

i. The current differential shall be a unit system of protection.
ii. The line Current differential Protection shall comprise a well proven high-speed phase segregated numerical current differential protection scheme, which shall be designed for the selective protection of the EHV network.
iii. The High speed numerical current differential protection shall be suitable to work through directly connected fiber optics and the relay shall have the requisite teleprotection communication capability.
iv. Shall have built-in signalling modules for communication with the remote end relay via direct optical fiber cables.
v. The contractor shall coordinate the requirements of the current differential relay with the communication system in order to ensure compatibility between the two.
vi. The relay shall incorporate inter-tripping, VT Supervision functions and heavy duty contacts for tripping of the feeder circuit breaker as well as provide all flagging, alarms etc.
vii. Shall have high-speed fault detection capability with typical relay operation time of less than **30** ms for 400kV/220kV line faults and less than 40 ms for 132kV & below.
viii. Shall have high sensitivity for all types of faults.
ix. Shall detect and clear faults along the whole length of the feeder within the specified operating time when the remote end breaker is open or there is a weak in feed.
x. Shall remain stable for fault on a parallel feeder under subsequent current reversal in the healthy feeder due to slow opening of one of the faulty feeder's circuit breakers.
xi. Shall not be affected by heavy load transfer, power swings, CT saturation, distorted primary currents and voltages, VT fuse failure, line charging currents external switching, arc or tower footing resistance, sudden power reversal, zero sequence mutual coupling, fault resistance and out of phase source at the two line terminals producing misleading apparent fault reactance, power frequency variations, collapse of voltage on the faulted phase(s), etc.
xii. Shall have features to clear close in faults at high speed in the event of failure of signalling channel.
xiii. Shall have features to test at one end all the functions associated with the protection, without the presence of personnel at the remote end.

xiv. Shall have features to block relay in case of signalling channel failure or remote relay out of service / block or setting mismatch or dc failure etc., to avoid inadvertent tripping and shall produce alarm during blocking.
xv. Shall have inter-tripping compliant with IEC60834-1 and IEC60834–2 respectively for signalling as appropriate.
xvi. The line differential device address shall be settable and shall be suitable to set for no. of feeders shown in SLD.
xvii. CT supervision / VT Supervision shall be configured to initiate alarm locally and to sub-station automation system or event recorder as per requirement.
xviii. Shall have single pole/three pole tripping feature.
xix. Shall have built-in SOTF logic feature.
xx. Shall have features to block auto-reclose internally or externally at local end and facility to send blocking signals to remote end relay internally (through FO communication channels) during SOTF trips.
xxi. Shall have facility to configure signal transferred between local and remote end relays in the internal event recorder and disturbance recorder.
xxii. Shall have configurable time delayed thermal protection element and back up earth fault protection element.
xxiii. Shall have following features:
- Satisfactory Performance of relay under CT saturation during through faults.
- Satisfactory Performance of relay under conditions of CT saturation for in zone faults.
- Satisfactory Performance of relay during transient (jitter) and permanent changes in signalling propagation delays. Shall include necessary Optical fibre cable & associated accessories for connection between the current differential relay panel and existing Fibre optic distribution panel (FODP).

xxiv. Shall have minimum 20 nos. BI and 24 nos. BO (without DC mixing) separately, or as per scheme requirement.

17.05 TIME SYNCHRONISATION EQUIPMENT:

The time synchronisation equipment shall receive the coordinated Universal Time (UTC) transmitted through Geo Positioning Satellite system (GPS) and synchronise equipments to Indian Standard time in a substation. It will also synchronise the substation PC through necessary software to be supplied by the bidder.

a) Time synchronising equipment shall include antenna, all special cable and processing equipments& the same shall be housed in a separate simplex type panel.
b) For all new substations, if specified in LOA, GPS shall be redundant, i.e. Two nos of Clock & Antenna should be considered.
c) It shall be compatible for synchronisation of event loggers, disturbance recorder and SCADA at a substation.
d) Equipment shall operate upto the ambient temperature of 50°C and 100% humidity.
e) Equipment shall meet the requirement of IEC 60255 for storage and operation.
f) Equipment shall have real time display in hour, minute, sec (24 hr. mode) and have a separate time display unit to be mounted on the top of the control panels or any suitable location having display size of approximately 100mm height.
g) Equipment offered shall have six output ports .Various combinations of output ports shall be selected by the customers, during detailed engineering from the following:
    i) Voltage signal: Normally 0 – 5 V with 50ms minimum pulse duration. In case any other voltage signal required it shall be decided during detailed engineering.
    ii) Potential free contact (minm. pulse duration of 50ms).
    iii) IRIG-B
    iv) RS232C

h) The synchronisation equipment shall have 2micro second accuracy. Equipment shall give real time corresponding IST (taking into consideration all factors like voltage and temperature variation, propagation and processing delays etc.).

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

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

k) The equipment shall be suitable to operate from 220V DC ± 10% as available at the substation.

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

m) Time synchronization equipment consisting of :

i) GPS antenna,
ii) GPS receiver with detail of output & ports,
iii) Requisite quantity of interconnecting cable with matching connector,
iv) Master clock with display unit, power supply unit,
v) Battery charger if required, time synchronization panel etc.
vi) Necessary converter arrangement for deriving Power supply DC voltage from 220V DC supply from our substation battery.
vii) Synchronisation panel etc.
viii) Other particulars if any.

17.06 TRANSFORMER DIFFERENTIAL RELAY:
[The relay should be latest IEC61850, Ed - 2 compliant having rear port compatible to latest IEC 61850, Ed - 2 protocol.]

a) The protection shall be provided at the HV side panel of the transformers to be protected. It shall be numerical type adjustable/variable percentage biased differential relay.

b) Necessary softwares, cables, connectors and other accessories as required in compatible with Sub-station PC shall be provided by the Tenderer as described under clause 16.07 above.

c) The relay shall be very fast in operation with an operating time less than **40** millisec at 5 times setting.

d) The relays shall be inherently stable for external through fault conditions (up to at least 10 times of relay basic current) without affecting the speed of operation for internal faults.

e) The relay shall have built in facility of: -

i) Ratio and phase angle correction.
ii) Amplitude matching feature by means of reference power common to all winding.
iii) Zero sequence filtering of relay currents depending of relevant chosen vector group.

f) The relay shall be provided with 2nd harmonic restraint (having site selectable setting facilities of 10% to 40% of I_2/I_1) or any other inrush proof feature to prevent operation due to magnetising in rush current when the transformer is charged either from HV or LV side. But this shall not affect the speed of operation for internal fault.

g) It shall be provided with 5th harmonic restraint features (having site selectable setting facilities of 10% to 40% of I $5^{th}/I_{fund}$) to prevent operation due to possible over excitation of the transformer. This shall also not affect the speed of operation for internal fault.

h) It shall have site selectable high set **differential tripping facilities** (8 to 15 times of relay basic current) for clearing heavy internal faults.

i) The bias-operating characteristic of differential protection device shall have at least two knees. The relay shall have adjustable bias setting range 20% to 50% and adjustable operating setting range of 10% to 50% at zero bias.

j) The relay shall be with 3-bias winding for 400/220/33KV and 220/132/33KV transformers and 2-bias winding for 220/33KV, 132/33KV and 10MVA and above 33/11KV transformers.

k) The relay shall be such that there will not be any necessity of changing the setting of the relay whenever the transformer taps are changed.

l) The relay shall be provided with GPS based time synchronized disturbance recorder with date and time tagged records with the facility of triggering from other external protective relays of the transformer as well as date & time tagged event logger function. The disturbance recorder shall be capable of recording graphic form of values of currents each phase, differential currents of each phase etc. and store them in the memory which can be downloaded both from local and remote end PC. Memory size and number of disturbances stored in the relay shall be clearly indicated in the offer.

m) The in-built disturbance recorder shall have the facility to record the following external digital signal apart from the digital signals pertaining to differential relay.

i) REF protection operated
ii) Over flux relay operated
iii) Dir/ Non-Dir O/C relay operated
iv) HV breaker status(Main & Tie)
v) LV breaker status
vi) Buchholz/OLTC Buchholz alarm/trip
vii) WTI/OTI/PRD alarm/trip of transformer

n) The relay shall have the disturbance recording function with at least 12nos analog channels and 16nos digital channels having total recording memory of at least 15secs divided in to 8 records, each having at least a memory of 100ms for pre-fault analysis, and recording bandwidth may please be indicated. It should have on line pre and post fault disturbance recording facility. There should be provisions for interfacing all the digital channels both internally and externally.

o) The relay shall have at least 8nos of individually site selectable Binary Inputs and 8nos Binary Outputs (rating of B/I shall be 240V DC but they should not pick up at less than 150V). Latching option for B/O shall have to be provided. Output contact of protective relay should operate trip relay which will have sufficient contact to give trip command to main breaker, TBC breaker & for LBB protection initiation and other purposes.

p) The relay shall have 4 - 20mA Analog Input card having sufficient provision to record the data from one no. OTI, three nos. WTI and Tap Position Indicator.
Necessary hardware and software for downloading the data captured by disturbance recorder to the personal computer available in the substation shall be included in the scope.

17.07 RESTRICTED EARTH FAULT PROTECTION:

The Relay shall comply with the following requirements: -

a) stand-alone numerical type, which will have 4 nos. current coils and 4 nos. voltage coils.
b) both high impedance and low impedance features must be available inside the relay.
c) must have under-voltage / over-voltage feature.
d) shall have three nos. voltage coils to identify the faulty phase.
g) tuned to the system frequency.
e) have suitable nonlinear resistor to limit the peak voltage.
f) operating time shall be less than 45 ms.
g) have suitable stabilizing resistor to prevent mal-operation during external faults.
h) Minimum no. of digital output contact required – 8 nos (separate contacts without DC mixing)
Minimum no. of digital input required – 8 nos

17.08 CIRCULATING CURRENT PROTECTION:

The protection shall be responsive for both phase and earth fault of the transformer and reactor winding. The relay shall comply with the following requirements: -

a) stand-alone numerical type, which will have 4 nos. current coils and 4 nos. voltage coils.
b) both high impedance and low impedance features must be available inside the relay.
c) must have under-voltage / over-voltage feature.
d) tuned to the system frequency.
e) have suitable nonlinear resistor to limit the pick voltage.
f) operating time shall be less than 45 msec.
g) have suitable stabilizing resistor (in each phase) to prevent mal-operation during external faults.
h) Minimum no. of digital output contact required – 8 nos (separate contacts without DC mixing)
Minimum no. of digital input required – 8 nos

17.09 OVER FLUXING PROTECTION:

The relay shall comply with the following requirements: -

a) Stand alone Numerical type.
b) The relay shall operate on the principle voltage to frequency ratio.
c) It shall have characteristics compatible with transformer over fluxing withstand capability.
d) Input shall be 110V, 50Hz, Auxiliary Volt 220V DC ± 20%
e) Over Flux relay characteristics should be suitable for: -
   i) 110% continuous
   ii) 125% for 1min.
   iii) 140% for 5sec.
f) Alarm : - Settable between 100% - 130% with Definite Time delay, settable from 0.5 – 30 sec.
g) Drop Off/ Pick Up ratio should not be less than 99.6%.
h) The relay shall have the disturbance recording function with at least 4nos analog channels and 8nos digital channels.

17.10 OVER LOAD PROTECTION:

This protection shall be used for 400/220/33kV & 220/132/33kV Auto-transformer and shall be located at HV side protection panel of respective transformer. The relay shall comply with the following requirements: -

a) definite time, single pole type.
b) have a variable and continuously adjustable current setting range of 50% to 200% of rated current and variable time setting 2.5 to 25sec. of the timer unit.
c) included hand reset flag indicator.
d) the relay shall provide alarm only.
e) have a drop off/pick up ratio greater than 95%.
f) May be in built feature of numerical differential relay.

17.11 OVER VOLTAGE PROTECTION:

This protection shall be used for 400kV Feeder. The relay shall comply with the following requirements: -

a) stand-alone type & connected to Line CVT.
b) monitor all three phases.

c) be connected between Phase to Phase in Delta configuration.
d) have two stages.
e) have an adjustable setting range of 100 - 170% of rated voltage with an adjustable time delay range of 1 to 60secs for the first stage.
f) have an adjustable setting range of 100 – 170% of rated voltage with a delay of 100 – 200msec for the second stage.
g) have power frequency filters.
h) have a drop off to pickup ratio greater than 99%.
i) provide separate output contact for each 'Phase' and stage for breaker trip relays, event logger and other scheme requirement.

17.12 NUMERICAL DIRECTIONAL/NON-DIRECTIONAL OVER CURRENT & EARTH FAULT PROTECTION:

The relay shall comply with the following requirements: -

a) Minimum two characteristics, one IDMT of 3sec and the other one of DMT characteristic with instantaneous high set and the same should be site selectable.
b) Wide range of time and current setting in very small steps without sacrificing the relay characteristics.
c) There should be provision for configuring the output contacts and LEDs as latched or unlatched individually. Reset of the outputs and LEDs shall be possible from a logic input and the front panel operator interface.
d) Continuous self supervision along with self diagnostic feature for faults within the relay and the relay should have potential free 'change over' contact for annunciation in the event of internal failure.
e) DC auxiliary voltage – 220V±20%, 110v. ±20%
f) Rated current – 1A.
g) Frequency – 50Hz.
h) Digital input voltage range shall be identical to the DC voltage range.
i) Thermal withstand capability – 100A for 1Sec/ 4A continuous.
j) Output contacts having sufficient current rating to directly energize trip coil of circuit breaker.
k) LED indication facility for visual annunciation of different type of faults including phase identification. Fault indication should be displayed in the stand-by screen.
l) Individually site selectable both binary Output & Input and latching option for binary Output.
m) Relay should show fault current with time stamping.
n) The relay shall have more than one selectable setting group.
o) The setting group can be changed by binary inputs.
p) The relay shall have a non volatile memory for -
    i) Event recorder - shall have the facility of recording up to 75 events with time stamping.
    ii) Setting values.
    iii) Disturbance recorder data - Recorded data of 5 last events with time stamp. The disturbance recording function is triggered either by any of programmed threshold or by an external input. All logic and analog information can be transferred using communication port to an external data analyzer. Current waveforms shall be captured.
q) Fault records - At least five nos fault records shall be available with the following indications:
    i) Fault indication.
    ii) Current values.
    iii) Tripping time.
r) Measurement -Instantaneous three phase current values and residual current value. All the measured and derived values can be displayed on the front panel LCD.
s) Minimum no. of digital output contact required – 8 nos (separate contacts without DC mixing)

Minimum no. of digital input required – 8 nos

t) The numerical directional shall have built in feature for derivation of zero sequence voltage internally. The MTA of numerical directional relay shall be 45ºlag for earth fault and 45ºlead for over current. Any extra feature like time synchronization, LAN compatibility with other numerical relays shall be mentioned specifically.

u) The relay must have in-built following requirements:-

- Directional O/C and E/F (67 & 67N) – IDMT & DMT
- Non-directional O/C and E/F (51 & 51N) and (50 & 50N) – IDMT & DMT
- Over-voltage and Under-voltage (59 & 27) and Over-frequency and Under-frequency (81)
- Negative Sequence Over Current (46)
- CB Failure with Re-trip and Back-trip
- Check sync.
- Inrush restriction

17.13 CURRENT UNBALANCE PROTECTION:

This protection shall be used for 33kV Capacitor bank. The relay shall comply with the following requirements: -

a) Shall be stand-alone Numerical type.
b) Shall have SEF element suitable for capacitor bank (double star) unbalance current protection.
c) SEF (unbalance current) element should be settable up to 2 times rated current. This element will be fed from neutral CT of low primary current rating (eg. 2A).
d) SEF (unbalance current) element shall have minimum 2 stages with definite time characteristics.
e) Shall have three phase current based overload protection element. This element shall be used for overload protection of capacitor bank due to over voltage as well as harmonic content of current.
f) Over load protection element should operate considering the current, without suppression of harmonics.
g) Characteristics of over load element shall be definite time. Setting range should cover up to 2 times relay rated current.
h) Shall have built-in three-phase under-current element (fed from phase current) with definite time characteristics to prevent closing operation of circuit breaker, immediately after tripping, to allow discharging of capacitor bank. Time setting range of this element shall be minimum 10 minutes.

17.14 OVER VOLTAGE AND UNDER VOLTAGE PROTECTION:

This protection shall be used for 33kV Capacitor bank. The relay shall comply with the following requirements: -

a) Shall be stand-alone Numerical type.
b) Shall be connected between Phase to Phase in Delta configuration and monitor all three phases.
c) Both the under-voltage element and the over-voltage element shall have two stages.
d) Over voltage element shall have an adjustable setting range of 100 - 170% of rated voltage with an adjustable time delay range of 0 to 60secs for both stages.
e) Under voltage element shall have an adjustable setting range of 10 - 90% of rated voltage with an adjustable time delay range of 0 to 60secs for both stages.
f) Shall have power frequency filters.
g) Shall have a drop off to pick up ratio greater than 99%.

17.15 AUXILIARY RELAY FOR INTERNAL TROUBLE:

DC voltage operated auxiliary relays provided with mechanically operated hand reset indicator and sufficient number of hand-reset contacts (Minimum 3 NO contact per coil) shall be provided for protection and supervision against internal troubles/faults of GIS bay, Transformer, Reactor, Circuit Breaker and CT. Number of element and number of relays shall be as per requirement of individual equipment.

17.16 MASTER TRIP RELAY:

Master trip relay shall be provided to cause tripping of all the associated breakers. This relay shall also be provided in other bays for closing lock out of breaker. Master trip relay coil supervision shall be provided. The relay shall comply with the following requirements: -

a) Shall have fast operating attracted armature multi-contact relay coil assembly, operating time should be less than 15ms.
b) Shall be provided with electrical reset as well as hand reset arrangement.
c) Shall have cut-off contact with relay operating coil.
d) Shall have high burden and high degree of mechanical stability.

17.17 DC SUPPLY SUPERVISION RELAY:

The relay shall monitor D.C. Supply continuously, as specified in resp. Clause. The de-energization of this relay will indicate the DC Supply failure. Auxiliary supply for the relay is 220V DC. The relay shall have a time delay on drop off of not less than 100 milli second. The relay shall be provided with operation indicators (Reverse flag) self reset. Sufficient number of contacts potential free may be provided. Separate relays for dual source are to be provided.

17.18 LOCAL BREAKER BACK UP PROTECTION:

The above protection shall be stand alone type or built in function of bus bar protection scheme and shall be provided for 400KV, 220KV & 132kV bays. The protection scheme shall be so designed that if any circuit breaker fails to trip in the event of a fault, then after a short time delay all the adjacent circuit breakers connected in the same bus will be tripped. The circuit breaker failure shall also block auto-reclosing scheme. The scheme shall be complete with timer and auxiliary relays as necessary including remote end tripping facility. The relay shall comply with the following requirements: -

a) be triple pole type.
b) Have an operating time less than 15millisecond.
c) have an resetting time less than 15millisecond.
d) have three over current element with facility for phase wise initiation.
e) have a current setting range 20 to 320% of rated current for over current.
f) have a continuous thermal withstand of two times rated current irrespective of the setting.
g) have timer suitable for sub-station D.C. with a continuously adjustable setting range of 0.1 to 1sec.
h) be of solid state/ numerical type.
i) trip and lock out all the local breakers. Simultaneously direct trip signal shall be sent to remote end circuit breakers (through both channels in case of 400KV system) and lock out its auto-reclosing feature.
j) have necessary auxiliary relays to make a comprehensive scheme.
k) Trip all the breakers on the particular bus in a One & Half breaker system, when any bus breaker fails to trip in faulty condition. However, when a Tie Breaker fails to open, the LBB relay shall trip the adjacent bus breakers as well as both the breakers at the remote end of the bays.
l) LBB for Tie breaker shall be standalone type.

17.19 TRIP CIRCUIT SUPERVISION RELAYS:

a) DC supply to each trip coil of the circuit breakers shall be supervised with an independent trip circuit supervision relay. These relays shall be mounted in the relay panel associated with the circuit breaker. No chattering of the relay is acceptable.

b) The relays shall supervise the healthiness of trip circuit continuously (Both pre-closing and post-closing conditions of the circuit breakers). Healthiness of each phase trip coil and associated circuits of the circuit breaker during "ON and OFF" conditions shall be monitored by the relays and give an alarm for the (i) loss of D.C. supply or (ii) for faults in the trip coil or for faults in the trip circuit leads or for faults in the breaker auxiliary contacts or faults in the supervisory relay itself.

c) The relay shall have adequate contacts for providing connection to alarm and event logger, self reset. The relay shall have a delay in drop off at least 200ms to avoid a false alarm during a normal tripping operation. The short circuiting of any series resistance provided in this relay or short circuiting the coil of the relay should not energize the trip coil of the breaker.

17.20 NUMERICAL BUS BAR PROTECTION

[The relay should be latest IEC61850, Ed - 2 compliant having rear port compatible to latest IEC 61850, Ed - 2 protocol.]

a) The bus bar protection relay should support various bus architectures selectable by means of the relay configuration (Single bus bar, Double bus bar, Breaker and a half bus bar, two section bus bar with a bus tie, Double bus bar with transfer bus and tie breaker) for its bus bar protection. Bus Bar protection scheme should operate selectively for each bus bar.

b) The relay must have rejection and shall not operate on second and third harmonics. Second harmonic rejection ratio 2:1 minimum, third harmonic rejection ratio 40 : 1 minimum.

c) The relay shall incorporate dynamic bus replica and provide necessary end zone/ blind zone fault protection depending on the bus bar protection CT's location.

d) The relay should have provision to configure split zone protection using section isolator status, if the system requires. Implementation shall be WBSETCL discretion.

e) Facility to monitor the bus differential currents and bus restraint current for each zones shall be supported in the relay display as well as through configuration tools.

f) Built-in Local Breaker Backup protection feature as a part of bus bar protection scheme shall also be acceptable.

Bus bar protection scheme: -

a) shall be phase segregated and triple pole type with separate relay for each phase and provide independent zone of protection. If bus section is provided, then each side of the bus section shall have separate set of bus bar protection scheme.

b) The bus section breaker and bus coupler breakers shall be covered by overlapping bus bar protection scheme of respective buses.

c) incorporate check zone feature for each phase and clear zone indication. The check zone shall be without any switching. Also check zone shall not over stabilize during internal fault due to unequal source & load distribution.

d) shall include one overall check zone protection in addition to single/multiple zones specified.

e) be transient free in operation

f) Shall have maximum operating time up to trip impulse to trip relay for all types of faults of 20milli seconds at 5 times setting value.

g) The bus bar protection of respective bus sections shall trip respective set of bus bar lockout relays and shall initiate BF of respective CB. The bus bar protection scheme shall include individual high speed hand reset tripping relays alongwith stand-alone supervision relay for each bay.

h) No inter-trip initiation is permitted between 86 circuit and 96 circuit. Sufficient contacts are to be considered for 96 relays of Transformer bays so that individual contact of 96 relay can be assigned for trip initiation to the Trip coil – 1, Trip coil – 2 of the other side Main Circuit Breaker as well as Transfer bay Circuit Breaker (if available).

i) not give false operation during normal load flow in bus bars. not cause tripping for the differential current below the load current of heaviest loaded feeder. Bidder shall submit application check for the same.

j) Shall 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

k) include continuous D.C. supplies supervision.

l) include protection 'IN/OUT' switch for each zone

m) The scheme should be equipped completely for supporting **four** numbers spare circuits (having maximum no. BI and BO, which is used for a particular bay in present scope) in addition to the circuits for feeders/ bays in the single line diagram. Central unit shall be compatible for minimum 24 bays.

However for extension of bus bar protection scheme (if specified in BPS) in existing substations, scope shall be limited to the bay or breakers covered under this specification. Suitable panels to mount these are also included in the scope of the work.

n) At existing substations, Bus-bar protection scheme with independent zones for each bus, will be available. All necessary co-ordination for 'AC' and 'DC' interconnections between existing schemes (Panels) and the bays proposed under the scope of this contract shall be fully covered by the bidder. Any auxiliary relay, trip relay, flag relay and multi tap auxiliary CTs (in case of biased differential protection) required to facilitate the operation of the bays covered under this contract shall be fully covered in the scope of the bidder.

17.20. For 400KV substation:

01

a) For 400KV bus bar protection two redundant full scheme of Bus Bar protection incorporating individual buses and transfer bus is to be provided. The tripping logic should be 'AND Logic' in case when both the bus bar protection relay is available. In case of non availability of one bus bar relay, the tripping logic will be based on available relay.

b) The Central Processing Unit of bus bar protection & Bay Unit of numerical bus bar protection scheme shall be housed in a separate set of simplex type panel along with equipment/relays.

c) One Bus bar protection scheme shall be provided for each main and transfer bus for 220KV and 132 KV voltage levels.

d) Bus Bar protection scheme shall give hundred percent security up to 50KA for fault level for 400KV

17.20. For 220KV AND 132KV substation:

02

a) Bus bar protection scheme shall be provided for both 220KV and 132kV system.

b) Bus bar protection relaying scheme shall be provided in a separate simplex type panel with all bus differential relays and trip relays etc. as required considering future bays.

c) Bus Bar protection scheme shall give hundred percent security up to 40 KA fault level for 220KV.

17.21 TEE DIFFERENTIAL PROTECTION

Duplicated differential protection scheme namely Tee Differential protection shall be provided for One and Half Breaker system. This scheme shall protect the circuit between the Main breaker & the tie breaker. Two separate differential relays on different hardware platform shall be used for Main I and Main II protection.

17.22 STUB PROTECTION

Stub protection scheme shall be applicable for one and half breaker system. This protection shall protect the part of one & half breaker system, not covered by distance protection.
Stub protection scheme shall be: -

i) active only when Line isolator is open & there is no voltage from CVT for distance protection relay.
ii) the inbuilt function of the main Numerical Protection relay.
iii) Able to sense the fault through an overcurrent sensing element & trip bus breaker under fault condition.

17.23 CONFIGURATION AND MONITORING TOOLS FOR ALL NUMERICAL RELAYS:

The manufacturer/bidder has to provide configuration and monitoring tool for all type of numerical relays used for a particular sub-station without any price implication.

a) PC hook-up cable for direct communication in sufficient quantity for each substation.
b) Graphical configuration tool having all the functions used in the relay and sufficient nos. of different logic gates in the in built library (software).
c) Basic application software for setting change, service value monitoring etc.
d) Programme for disturbance record collection and evaluation of those records.
e) Any additional software, if required, for remote communication and for other facilities available in the relay.

All the above tools/software should be WINDOWS 7/ WINDOWS 10 Operating system compatible.

18.00 PROTECTION PHILOSOPHY:

The bidder has to design the protection scheme for lines, transformers, Bus coupler, Bus Transfer bay of 400KV, 220KV, 132KV and 33KV system as applicable depending upon the substation layout arrangement and the schemes are to be submitted along with their offers for acceptance of the same by WBSETCL. All the protective relays etc. of each bay shall be mounted in the respective bay panel. Similarly for 400/220/33KV, 220/132KV and 132/33KV transformer protection, relay of each system voltage shall be located in the respective panel. However, the protection schemes shall be generally based on the requirement listed below:

18.01 LINE PROTECTION:

a) Main – 1 distance protection by microprocessor based numerical distance relaying scheme with carrier aided distance protection scheme.
b) Main – 2 distance protection by microprocessor based numerical distance relaying scheme but of a different make with carrier aided distance protection scheme (For 400kV, 220kV & 132kV).
c) For 220kV & 132kV Line, where the line length is less than **10** km, and for 220kV & 132kV cable line and if specifically asked for in Tender LOA, Main – 1 and Main – 2 Line Differential protection scheme numerical relays of different make are to be considered. Both relays should work in same wavelength.
d) Auto reclosing, fault locator and disturbance recorder scheme, event logger etc. shall be built in with Distance relay/ Line Differential relay as specified in resp. Clause.
e) Local breaker back up protection scheme.

f) Direct tripping command from remote end through carrier channel.
g) Line CVT operated two stage over voltage protection (For 400kV only).

18.02 PROTECTION OF AUTO TRANSFORMER:

h) Percentage biased differential protection (three winding).
i) Circulating current protection responsive to both phase faults and earth faults. (For 315MVA, 400 / 220 / 33 KV AUTO TRANSFORMER only)
j) Restricted earth fault protection. (For 220/132/33KV AUTO TRANSFORMER only)
k) Numerical Directional Back up protection having voltage polarised three element IDMT overcurrent with directional high set instantaneous element and single element earth fault protection with necessary P.T. fuse failure monitoring scheme for both at HV side and MV side.
l) Over load protection alarm on HV side.
m) Transformer over flux protection on HV side & MV side.
n) Flag relays for transformer mounted protection like buchholtz, winding temperature, oil temperature, pressure relay device etc. **These protections shall be divided in two groups and fed from two different dc source (both alarm and trip).**
o) Local breaker back up protection at HV side & MV side.
p) Numerical stand-alone type neutral displacement relay with stage operation for tertiary winding protection either by external open delta connection or by internally derived open delta voltage in relay. PT connection will be via 2A MCB.
q) Numerical Non-directional, IDMT, three over current protection with high set instantaneous unit (for loaded tertiary of 220/132/33KV AUTO TRANSFORMER only).

18.03 400KV BUS REACTOR PROTECTION:

a) Differential protection.
b) Restricted earth fault protection.
c) Back up single step distance protection.
d) Reactor internal trouble i.e., buchholz, winding temperature etc. protection.
e) Local breaker back up protection.

18.04 132/33 KV STAR-DELTA TRANSFORMER PROTECTION:

a) Percentage biased differential protection (Two winding).
b) Restricted earth fault protection both at HV and LV side.
c) Numerical Directional Back up protection having voltage polarised three element IDMT overcurrent with directional high set instantaneous element and single element earth fault protection with necessary P.T. fuse failure monitoring scheme for both at HV side and LV side.
    i) One no. separate Numerical relay shall be considered for HV side.
    ii) For LV side, if BCPU is considered in the respective Tender LOA, then Over current protection feature of BCPU shall be used for LV side. Else One no. separate Numerical relay shall be considered for LV side.
    iii) The Earth Fault coil of the LV side Numerical relay shall be utilized as Overall REF protection using Earthing Transformer Neutral CT and Bay CT of 33kV side of the Power Transformer. For this Overall REF protection, separate suitable nonlinear resistor to limit the pick voltage and stabilizing resistor to prevent mal-operation during external faults shall be considered.
d) Stand-alone Numerical type relay with stage operation (setting range of 10-40%) to be considered for Earthing transformer neutral C.T. operated definite time earth fault protection. System Earth Fault Relay shall have three nos. voltage coils to identify the faulty phase.
The earthing transformer location shall be as per the project SLD.
e) System Earth Fault protection scheme shall be achieved by five-position selector switch.

The Five-position Selector Switch is to be wired assuming a 33kV system having three Bus Section and two Bus Section Circuit Breakers. Each Bus Section shall have one Power Transformer and one Earthing Transformer, i.e. total three nos. Power Transformers and three nos. Earthing Transformers shall be present in the complete 33kV system.

System Backup Earth Fault Protection shall also be achieved without using 5-position switch, i.e. segregated tripping of each section by using time stage contacts of 50N relay, scheme of which will be dealt during approval of engineering drawing. For this purpose, 50N relays must have minimum 8 nos. BI and 8 nos. BO (without DC mixing) separately. In 50N relay, there should be at least 1 no. change-over contact or more.

f) Flag relays for both Power Transformer and Earthing Transformer mounted protection like buchholtz, winding temperature, oil temperature, pressure relay device etc.

g) This earth fault relay will trip HV breaker/breakers after a preset time delay. The switches shall be having sufficient number of contacts. The trip relays shall have sufficient number of contacts for extending the trip pulse to other 33KV feeders connected with generating stations.

h) Trip transfer scheme for both HV & LV side shall be provided with two separate trip transfer switch.

18.08 BUS COUPLER BAY PROTECTION:

The protection scheme of 400kV, 220kV and 132kV bus coupler bay shall be as follows: -

a) Over Current & Earth Fault Protection with Check-Sync facility.

b) Local breaker back up protection.

The protection scheme of 33kV bus coupler bay (in case of Indoor Switchgear) shall be as follows: -

a) Non-directional, IDMT, three over current protection with high set instantaneous unit.

b) Non-directional, definite time earth fault protection.

c) Under frequency relay (1 no. for each Bus Section) of setting range 45 to 55 HZ in adjustable steps and with timer relay of 0 to 20 second adjustable setting range with sufficient number of contacts shall be provided from tripping of all 33 KV outgoing breakers. Moreover, sufficient nos. of multiplier relays (flush mounted) are to be installed for tripping of all 33 KV outgoing feeders including future bays, in case of both Under frequency Stage-1 and Stage-2 separately.

18.09 TRANSFER BUS BAY PROTECTION:

The breaker shall be used for transfer of any circuit (except the 33KV Shunt Capacitor bay) through transfer bus in case of necessity. During the period of transfer the line side CT operated protection of transferred circuit will trip the transfer bus breaker in place of respective bay circuit breaker through trip transfer switch. Normally, the protection scheme provided in transfer bus bay, except the LBB protection, shall be kept inoperative with the help of protection IN/ OUT selector switch (for 400 & 220kV) or 3-position make before break type protection selector switch having selection for Feeder, transformer and off position (for 132kV & 33kV). However, its own protection shall be used when there is trouble in the protection system of transferred circuit.

The protection scheme of 400kV, 220kV and 132kV transfer bus bay shall be as follows: -

a) Single distance protection scheme for transferred feeder protection. The transfer bay numerical distance relay should be identical to the Distance relays used in the feeder protection for easy replacement of the same in future, if required.

b) Numerical Directional Back up protection having voltage polarised three element IDMT overcurrent with directional high set instantaneous element and single element earth fault protection with necessary P.T. fuse failure monitoring scheme (For 132kV Feeder bay only).

c) Numerical Non-directional, IDMT, three over current and one earth fault protection for 132/33 KV transformer protection. The relay plug setting should be judged properly for protecting rated to 100% loading (For 132kV side bay of 132/33kV Transformer only).

d) Local breaker back up protection.

The protection scheme for the 33kV transfer bus bay shall be -

d) Non-directional, IDMT, three over current protection with high set instantaneous unit with protection selector switch.

e) Non-directional, definite time earth fault protection with protection selector switch.

f) Under frequency relay (1 no. for each Bus Section) of setting range 45 to 55 HZ in adjustable steps and with timer relay of 0 to 20 second adjustable setting range with sufficient number of contacts shall be provided from tripping of all 33 KV outgoing breakers. Moreover, sufficient nos. of multiplier relays (flush mounted) are to be installed for tripping of all 33 KV outgoing feeders including future bays, in case of both Under frequency Stage-1 and Stage-2 separately.

18.10 33KV FEEDER PROTECTION:

a) If BCPU is considered in the respective Tender LOA, then Over current protection feature of BCPU shall be used. Else One no. Numerical relay shall be considered for Directional, IDMT, three over current protection with high set instantaneous unit.

b) Directional, definite time sensitive earth fault protection.

c) Under frequency relay operated CB tripping scheme.

d) One no. 96 relay alongwith 95/96 relay for Phase Overcurrent LBB protection.

18.11 33/11KV TRANSFORMER PROTECTION (DELTA-STAR):

a) Percentage bias differential protection (Two winding) for 10MVA and above 33/11KV transformers.

b) For Transformer rating less than 10MVA, space to be kept for installation of Numerical Differential relay in future.

c) Non-directional, IDMT, three over current protection with high set instantaneous unit at HV side.

d) Restricted Earth fault protection for HV & LV.

e) Flag relays for transformer mounted protection like buchholtz, winding temperature, oil temperature, pressure relay device etc.

f) Under frequency relay operated CB tripping scheme.

g) One no. 96 relay alongwith 95/96 relay for Phase Overcurrent LBB protection.

18.12 33kV SHUNT CAPACITOR BANK PROTECTION:

a) Non directional IDMTL Overcurrent & Earth Fault protection relay.

b) Unbalance Protection scheme relays for double star connected capacitor bank with floating neutral. The relay used shall detect two current levels, one for alarm & another for tripping. It shall be able to provide alarm in the event of failure of one or two units before tripping.

c) Over voltage & Undervoltage protective relay with both Definite time and Inverse time characteristics as well as provision for Line and Phase voltage setting.

d) CB closing shall have interlock with a timer as per Capacitor discharge time so that the CB cannot be closed within the capacitor discharging time.

e) One no. 96 relay alongwith 95/96 relay for Phase Overcurrent LBB protection.

18.13 BUS CONFIGURATION FOR 400KV, 220KV, 132KV AND 33KV SYSTEM OF DIFFERENT S/S.:

Bus configuration for various voltage class shall be as per respective Tender document.

18.14 Approximate route length of different circuits of 400KV, 220KV and 132KV system controlled by different feeder bays are as stated in GCC under "Scope of work".

19.01 SYNCHRONISATION:

For sub-station equipped with sub-station Automation system, the requirement of synchronisation is specified in the respective section under Sub-station Automation System and the same shall prevail. For other sub-station which is not equipped with Sub-sub-station automation system following shall be applicable as per requirement.

In such cases, where Trolley cannot be used for Synchronisation, Synchro check function should be part of the main relay (if available) else stand-alone Synchro-check relay is to be considered. The relays equipped with synchronism and energizing check shall comply with the requirements as mentioned below:

i) Settable voltage, phase angle, and frequency difference.
ii) Energizing for dead line - live bus, live line - dead bus or dead line– dead bus with no synchro-check function
iii) Synchronising between live line and live bus with synchro-check function

One synchronising panel mounted on a movable trolley shall be provided for use in **400KV system** and **another one** for both in **220KV & 132KV system**, wherever mentioned in the schedule. For 400KV synchronization shall be achieved by comparing between phase to phase voltage and for 220KV & 132KV, synchronization shall be achieved by comparing between phase to neutral voltage.

At existing sub-stations, the synchronising scheme shall be engineered to be compatible with the existing synchronising scheme and synchronising socket/switch on the panel.

The trolley shall be equipped with –

a) Two Analog voltmeters for running & incoming, each having scale suitable for 400KV, 220KV & 132KV system and also suitable for operation with CVT/ EMVT secondary voltage of 110v phase to phase.
b) Two Analog frequency meters each having scale range 45 to 55Hz, indicating type.
c) One suitable synchroscope with cut – off switch.
d) One suitable auxiliary voltage transformer for synchronising condition.
e) One synchronising bypass switch with necessary under voltage relaying scheme of running system and incoming system to check inadvertent circuit breaker closing under synchronising bypass condition.
f) One check synchronising relay with necessary auxiliary equipment which shall permit the circuit breaker to close after checking the requirement of synchronising of incoming and running supply.
g) One guard relay to prevent the closing attempt by means of synchronising check relay when control switch is kept in close position long before the two systems are in synchronism.
h) Two synchronizing lamps of white colour.
i) One green LED indicating lamp to indicate check synchronism in limit.
j) One red LED indicating lamp to indicate check synchronism by pass.
k) Any other equipment required to render satisfactory operation of synchronism.

20.00 SCHEDULE OF EQUIPMENT OF DIFFERENT PANELS:

Though the Bidder has to design the Control Panel and Protection Schemes for all the bays, which are within the scope of the tender, as per the protection philosophy specified in the specification under Cl. No. 18.00., the lists of equipment is given below **for general guidance of the bidder**. The actual requirement for different substations is to be assessed by the bidder and to be quoted accordingly for successful operation of the control and protection scheme. **Same shall be finalized during detailed engineering and if any additional equipment be found necessary for proper operation, match and coordination with the existing panel, the same shall also be arranged by the bidder without any extra price.**

20.01 CONTROL PANEL EQUIPMENTS FOR DIFFERENT VOLTAGE CLASS:

Name of Equipment	Quantity	Name of Panel	Remarks
Digital Ammeter	3nos	Each bay	
Digital Wattmeter with Transducer	1set	Each Line bay, Trafo bay, Tie bay (in case of One & Half Breaker system), Bus Transfer bay, Bus Coupler bay	
Digital Varmeter with Transducer	1set	Each Line bay, Trafo bay, Tie bay (in case of One & Half Breaker system), Bus Reactor bay, Capacitor bank bay, Bus Transfer bay, Bus Coupler bay	
Digital Voltmeter	2no	Each Bus Coupler bay (in case of 2M1T system or 2M system) and in any one bay (in case of One & Half Breaker system)	If Two nos PTs are used in 1M system with Bus Section CB, two separate voltmeters are to be considered.
Digital Voltmeter Selector switch (8 – position)	2no	Each Bus Coupler bay (in case of 2M1T system or 2M system) and in any one bay (in case of One & Half Breaker system)	If Two nos PTs are used in 1M system with Bus Section CB, two separate voltmeter selector switches are to be considered.
Digital Voltmeter	1no	Each Line bay (400kV only) and Bus Transfer bay (in case of 1M1T system) and Capacitor Bank bay	
Digital Voltmeter Selector switch (8 – position)	1no	Each Line bay (400kV only) and Bus Transfer bay (in case of 1M1T system) and Capacitor Bank bay	
Power Factor Meter	1no	Capacitor Bank bay	
Digital Frequency Meter	2no	Each Bus Coupler bay (in case of 2M1T system or 2M system) and in any one bay (in case of One & Half Breaker system)	
Digital Frequency Meter	1no	Each Bus Transfer bay (in case	

		of 1M1T system)	
Recording Voltmeter (Digital)	2no	Each Bus Coupler bay (in case of 2M1T system or 2M system) and in any one bay (in case of One & Half Breaker system) (400kV only)	
Recording Frequency meter (Digital)	2no	Each Bus Coupler bay (in case of 2M1T system or 2M system) and in any one bay (in case of One & Half Breaker system) (400kV only)	
Multi-function Meter	1no	Each bay	To be considered only in SAS substations having only Relay panel, no Control panel.
CB Control Switch (Discrepancy type/ pistol grip type as per requirement)	1no	For each Circuit Breaker (132kV & above)	
CB Control Switch (Pistol grip type)	1no	For each Circuit Breaker (33kV & below)	
Control Switch (Pistol grip type)	1no	For each Isolator & Earth Switch	
Trip Transfer Switch	1no	Each Line bay, Trafo bay, Bus Reactor bay (in case of 2M1T system or 1M1T system)	
DC supply selector switch (DC1-Independent-DC2)	1no	Each bay (132kV & above)	
Bus VT selector switch (Bus VT 1 / Bus VT 2)	1 no.	Each bay (in 1M1T system)	
VT selector switch (Line VT / Inter1 / Inter2 / Selected Bus VT) and Bus VT selection Relays	In required nos.	Each Line bay with 3-phase CVT (in 2M1T and 2M system) and Each 33 KV Incomer bay (in Integrated switchgear)	As detailed in PT LV side distribution given above.
Discrepancy Switch Steady Lamp cut-off Switch	1no	Each Bus Coupler bay (in case of 2M1T system or 2M system), Each Bus Transfer bay (in case of 1M1T system) and in any one bay (in case of One & Half Breaker system)	
Under Frequency protection ON-OFF Selector Switch	1no.	For each 33kV panel (Feeder bay and 33/11kV Trafo bay)	
Back-up Earth Fault protection ON-OFF Selector switch	1no.	For each 33kV panel (Feeder bay and 33/11kV Trafo bay)	
Earthing Transformer Selection Switch (5-position)	1no.	For each 33kV panel (33kV side bay of 132/33kV Trafo & 220/33kV Trafo)	
LED Semaphore	1no	For each Isolator & Earth Switch	
LED Semaphore	1no	For each Circuit Breaker (33kV & below)	

Amber LED Indicating Lamp	As Reqd.	For DC Fail indication	
White LED Indicating Lamp	As Reqd. (One no for each pole for Single pole operated CBs)	For CB Trip coil healthiness indication	
Blue LED Indicating Lamp	As Reqd.	For CB Spring Charged indication	
Phase Healthy Indicating Lamp	6nos	Each Bus Coupler bay (in case of 2M1T system or 2M system)	
Phase Healthy Indicating Lamp	3nos	Each Bus Transfer bay (in case of 1M1T system)	
Yellow LED Indicating Lamp	As Reqd	For CB Auto Trip indication (33kV & below)	
Red LED Indicating Lamp	As Reqd	For CB ON indication	
Green LED Indicating Lamp	As Reqd	For CB OFF indication	
Annunciation windows wih associated lamps etc.	As per scheme requirement (Minimum 20nos.)	For each Control panel	
Push button for Annunciator Alarm accept/ reset/ test	3nos	For each Control panel	
AC buzzer for DC fail alarm and associated relays for Annunciation scheme	1set	Each Bus Coupler bay (in case of 2M1T system or 2M system) and Each Bus Transfer bay (in case of 1M1T system)	
DC bell for trip alarm, DC hooter for non-trip alarm, associated relays for Annunciation scheme	1set	For each Control panel	
Push Button for Protection DC Fail check, CB Spring Charge check, CB Trip Coil Healthy check, DC Fail Alarm accept, AC Fail check etc.	As Reqd	For each Control panel	
One no. push button each for Main DC Fail Test, Annun DC Fail Test, Main DC/ Annun DC Fail Accept, AC Fail Test and one no. LED indicating lamp (amber) each for Main DC Fail, Annun DC Fail visual indication.	1set	Each Bus Coupler bay (in case of 2M1T system or 2M system) and Each Bus Transfer bay (in case of 1M1T system)	

Synchronising Socket and Synchronising selector Switch	1no each	Each Line bay, Trafo bay, Bus Coupler bay, Bus Transfer bay, Tie bay (in case of One & Half Breaker system),	Not required for 132kV side of 132/33kV Trafo
RWTI with Selector switch	1no each	Each Bus Reactor bay	
ROTI	1no	Each Bus Reactor bay	
TTB with wiring for intelligent electronic computer compatible energy meter (0.2 class)	1no	Each Line bay, Trafo bay, Tie bay (in case of One & Half Breaker system)	
Common items e.g. Mimic; Circuit Label; Label indicating Manufacturer's Name, P.O. details, Drg. Ref. nos etc.; internally mounted equipments like Heater with Switch &Thermostat, AC Cubicle lamp with On/Off switch, DC Emergency Cubicle lamp with On/Off switch, Corridor Illumination lamps with door switches at both ends ofthe corridor, 5/15A Power Socket with On/Off switch, Switches, Fuses, Links etc. as per Tech Spec.	As Reqd	For each panel	

20.01 COMMON RELAY/ PROTECTION PANEL EQUIPMENTS FOR DIFFERENT VOLTAGE CLASS:

Name of Equipment	Quantity	Name of Panel	Remarks
Common items e.g. Circuit Label; Label indicating Manufacturer's Name, P.O. details, Drg. Ref. nos etc.; internally mounted equipments like Heater with Switch &Thermostat, AC Cubicle lamp with On/Off switch, DC Emergency Cubicle lamp with On/Off switch, Corridor Illumination lamps with door switches at both ends ofthe corridor, 5/15A Power Socket with On/Off switch, Switches, Fuses, Links etc. in line with Tech Spec.	As Reqd	For each panel	
Bus PT selection scheme	1set	For each panel (2M1T system &	Except Bus Coupler

with bi-stable relays for Double Bus arrangement		2M system)	bay
Stand-alone Supervision Relays for CB Trip coils, 86 relay, 96 relay	As Reqd	For each Circuit Breaker	
LBB protection scheme with stand-alone 96 relay, aux relay etc.	1set	For each Circuit Breaker (132kV & above)	
Phase Overcurrent LBB protection with stand-alone 96 relay, aux relay etc.	1set	For each 33kV Feeder bay, Capacitor bay and 33kV side bay of 33/11kV Trafo	
Auxiliary relays for C.B. Closing/Tripping, if necessary	1set	For each Circuit Breaker	
CB Monitoring scheme with Flag Relays/Aux. Relays	1set (Minimum 6nos.)	For each Circuit Breaker	Each coil should have minimum 3NO contacts. Multiplier for CB SPRING CHARGE status should also have an NC contact for SPRING CHARGE FAIL annunciation.
GIS Monitoring scheme with Flag Relays/ Aux. Relays	As Reqd	For each GIS bay	
Stand-alone Protection DC Supply Supervision Relay	1 No each for DC-1 & DC-2	For each bay	
Main DC (for both DC-1 & DC-2), Annun DC, AC Supervision Relays	1 No. each	Each Bus Coupler bay (in case of 2M1T system or 2M system) and Each Bus Transfer bay (in case of 1M1T system)	
Stand-alone Bus Bar Protection DC supply Supervision Relay	1 No	Busbar protection panel	
Main DC, Annun DC Fail Alarm Accept Relay	1 No.	Each Bus Coupler bay (in case of 2M1T system or 2M system) and Each Bus Transfer bay (in case of 1M1T system)	
CB Discrepancy scheme with Flasher relay & Timer	1set	Each Bus Coupler bay (in case of 2M1T system or 2M system) and Each Bus Transfer bay (in case of 1M1T system)	
Test Terminal Block	As Reqd	For each bay	
Bus Transfer Bay Protn. IN/OUT Selector Switch	1 No.	Each Bus Transfer bay	
Distance Relay Setting Group Selector Switch, 4 – position	1 No.	Each Feeder bay & Bus Transfer bay (132kV & above)	

O/C & E/F Relay Setting Group Selector Switch, 3 – position, TRAFO – OFF - LINE	1 No.	Each Bus Transfer bay	
'Bay transfer sequence Incomplete' alarm scheme with Timer	1set	For each bay (in case of 2M1T system or 1M1T system)	
One no. push button each for LED reset of Numerical relay, reset of 86 relay and reset of 96 relay	1set	For each bay	
Annunciation windows with associated lamps etc. (In case of absence of separate control panel)	As per scheme requirement (Minimum 20 nos.)	For each panel	
Push button for Annunciator Alarm accept/ reset/ test (In case of absence of separate control panel)	3 nos	For each panel	

Notes:

i) 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 shall also be considered for the same and if required, necessary panel shall be supplied to accommodate the same.

ii) The above list of equipments mentioned for control panel is generally applicable unless it is defined elsewhere and in case of bay extension in existing substations, necessary equipments for matching the existing control panel shall be supplied.

20.02 RELAY/ PROTECTION PANEL EQUIPMENTS FOR DIFFERENT VOLTAGE CLASS:

FEEDER BAY					
	400kV	220kV	132kV	33kV	11kV
One no. Numerical relay for Main – I Distance Protection scheme/ Line Differential Protection scheme, as applicable as per resp. Clause	✓	✓	✓	---	---
One no. Numerical relay for Main – II Distance Protection scheme/ Line Differential Protection scheme, as applicable as per resp. Clause	✓	✓	---	---	---
One no. Numerical relay for Directional O/C & E/F Protection scheme/ Distance Protection scheme, as applicable as per resp. Clause	---	---	✓	---	---
Single and Three Phase Auto-reclosing scheme including aux. relays & tripping relays	✓	✓	✓	---	---
Auto Reclose Selector switch	✓	✓	✓	---	---
One no. Numerical relay for Directional O/C & E/F Protection scheme	---	---	✓	✓	✓ (Non Dir)
One no. Numerical relay for Over Voltage Protection scheme	✓	---	---	---	---
One no. Line CVT operated Under Voltage relay	✓	✓	✓		
Flag relays, Carrier Receive relays, Carrier Healthy relays, DT Receive relays, Aux. relays, Timers etc. as per scheme requirements (each coil having minimum 6nos. NO contact)	As Reqd.	As Reqd.	As Reqd.	As Reqd.	As Reqd.
Master Trip relays (86A and 86B)	✓	✓	✓		
Master Trip relay (only 86)				✓	✓
Carrier Selector Switch (One no. for each Distance protection relay)	✓	✓	✓		
Auto Reclose Selector Switch (ON-OFF)	✓	✓	✓		
Auto Reclose Selector Switch (Main I-Main II)	✓	✓			
Selected Bus VT/ Line CVT Selector scheme and associated Relay, as finalized during detail engineering	✓	✓	✓ (If Line CVT is available)		
Carrier Received LED Indicating Lamp	✓	✓	✓		
DT Received LED Indicating Lamp	✓	✓	✓		

HV SIDE OF TRAFO BAY				
	400kV side of 400/220kV Trafo	220kV side of 220/132/33kV Trafo	132kV side of 132/33kV Trafo	33kV side of 33/11kV Trafo
Numerical Differential Protection scheme	✓	✓	✓	✓ (10MVA & above)
Numerical Directional O/C & E/F Protection scheme	✓ (with Check-Sync facility)	✓ (with Check-Sync facility)	✓ (with Check-Sync facility)	✓ (Non Dir)
Numerical Over Flux Protection scheme	✓	✓		
Overload Protection scheme	✓	✓		
REF Protection scheme	✓	✓	✓	✓
Numerical Neutral Displacement Protection scheme	✓	✓		
Power Transformer Auxiliary Protection scheme with Flag Relays/Aux. Relays (Minimum 8 nos. Flag relays, each having minimum 6nos. NO contact for Power Transformer trouble trip status and Minimum 6nos Flag relays, each having minimum 3nos. NO contact for Power Transformer trouble alarm status)	✓	✓	✓	✓
Master Trip relays 86A and 86B	✓	✓	✓	
Master Trip relay (only 86)				✓

LV SIDE OF TRAFO BAY						
	220kV side of 400/220kV Trafo	132kV side of 220/132kV Trafo	33kV side of 220/132/33kv Trafo	33kV side of 132/33kV Trafo	33kV side of 220/33kV Trafo	11kV side of 33/11kV Trafo
Numerical Directional O/C & E/F Protection scheme	✓ (with Check-Sync facility)	✓ (with Check-Sync facility)	✓ (Non Dir)	✓	✓	✓ (Non Dir)
Numerical Over Flux Protection scheme	✓	✓				
REF Protection scheme				✓	✓	✓
Definite time Numerical E/F relay for ET protection scheme (For Yd Transformer)			✓	✓	✓	

Earthing Transformer Auxiliary Protection scheme with Flag Relays/Aux. Relays (Minimum 3 nos. Flag relays, each having minimum 3nos. NO contact)				✓		
Master Trip relays 86A and 86B	✓	✓				
Master Trip relay (only 86)			✓	✓	✓	✓
P.T. selection scheme with bi-stable relays for Double Bus arrangement	✓	✓				
BUS SECTION / BUS COUPLER BAY						
	400kV	220kV	132kV	33kV	11kV	
Numerical Non-Directional O/C & E/F Protection scheme with Check-Sync facility	✓	✓	✓			
Under Frequency protection scheme				✓		
Master Trip relays 86A and 86B	✓	✓	✓			
Master Trip relay (only 86)				✓	✓	
BUS TRANSFER BAY						
	400kV	220kV	132kV	33kV	11kV	
Numerical Distance Protection scheme	✓	✓	✓			
Numerical Directional O/C & E/F Protection scheme	✓	✓	✓	✓		
Selected Bus VT/ Line CVT Selector Switch (Line VT- Inter1-Inter2-Selected Bus VT)	✓	✓	✓			
Master Trip relays 86A and 86B	✓	✓	✓			
Master Trip relay (only 86)				✓	✓	
Under Frequency protection scheme				✓		

	TIE BREAKER BAY
Main – I Numerical Teed Protection scheme with aux relays, trip relays etc.	✓
Main – II Numerical Teed Protection scheme with aux relays, trip relays etc.	✓
Master Trip relays 86A and 86B	✓
	400kV Reactor bay
Numerical Differential Protection scheme	✓
REF Protection scheme	✓
Back-up Impedance Protection scheme	✓
Reactor Auxiliary Protection scheme with Flag Relays/Aux. Relays	✓
Master Trip relays 86A and 86B	✓
	33kV Capacitor Bank bay
Numerical Non-Directional O/C & E/F Protection scheme	✓
Numerical Under voltage/ Over-voltage Protection scheme	✓
Numerical Unbalance Protection scheme	✓
Time delay relay	✓
Master Trip relay (only 86)	✓

Notes:

i) In a substation where 400kV and 220 KV lines are under the scope of the contract, bidder is required to give identical Main-1 and Main-2 distance protection schemes for all voltage levels.

ii) These are the main protections. However, other auxiliary relays required for the respective C&R panel viz. Trip Circuit supervision relay, Direct Trip Command relay, Transformer trouble relay, High speed trip relays, contact multiplication relay etc shall be as per tender technical specifications.

iii) If mentioned in LOA BOQ, spare numerical IEDs / relays, identical to the supplied CRP IEDs / relays, are to be delivered and tested at Central Testing Department, WBSETCL, Abhikshan Bhaban, and will be accepted subject to successful performance of the relay.

20.03 BUS ZONE PROTECTION FOR 400KV, 220KV & 132KV SYSTEM:

All Equipment/ relays, trip relays with trip coil supervision relay, Local Breaker Back-up protection relay, CT Switching relay etc for all connected bays and bus extension bays with the provision of future bays along with CPU & Bay unit for the bus bar protection scheme as required for busbar protection as per resp. Clause shall be provided in one set of separate simplex type panel.

21.00 DEVIATION:

Normally the offer should be as per technical specification without any deviation. For any deviation in the tender quoted by the tenderer, the same shall be clearly indicated in the deviation sheet, clause by clause, indicating reason and advantage for such deviation. Such deviations may or may not be accepted. Deviation not indicated in the deviation sheet will not be considered.

22.00 RECOMMANDED SPARES:

A list of spares recommended by the bidder for ten years satisfactory performance along with item wise unit price shall be furnished with the tender. The purchaser will decide the actual quantity of spares to be ordered on the basis of the list and item wise prices quoted. This shall not be taken into consideration for the purpose of evaluation of bid.

23.00 TENDER DRAWING, LITERATURE AND TEST CERTIFICATES BOTH FOR ROUTINE TESTAND TYPE TEST:

Following drawings, literatures, filled up GTP and test certificates shall be submitted with the tender for evaluation:

a) Principal dimensioned details of each unit cubicle and complete assembly of panel board.
b) Front and rear views of the panel board with instrument and device positions marked.
c) Details of protection scheme of lines, transformers and other bays including annunciation, monitoring, supervision etc. offered.
d) Literature describing the instruments, switches, relays and their characteristics, technical details, relay setting calculation, operating manual etc.
e) Routine and type test certificates of all the protective relays carried out as per relevant IEC/ IS from a recognised laboratory shall be furnished. Performance certificate of all protective relays from Power Utilities in India shall also be furnished.

24.00 CONTRACT DRAWING AND LITERATURE:

24.01 The following drawings in six (6) copies of each are to be submitted by the successful bidder for approval of the purchaser before starting manufacturing of the same.

a) Detailed dimensional drawings of control and relay panel including foundation drg. with cable slots showing all equipment mounted on them along with complete panel wise list of equipmentand list of Name Plates. Weight of these panels with all the equipment mounted on these shall also be furnished in the Drg.
b) Contact development drawings of all switches, relays etc.
c) All internal configuration logic built-up in Numerical IEDs/ BCUs.
d) Outlined drawings of internal wiring diagram of the instrument, relays, meters, annunciator and other equipment showing external terminal connections with the equipment terminal number.
e) Complete AC and DC Schematic diagram of all panels of control and relay board to indicate the followings:
    i) Annunciator circuit
    ii) Protection and control circuit
    iii) Indication and Supervision circuit
    iv) Synchronising circuit
    v) Other circuits as necessary

These drawings shall show AC power connection and Secondary connections for relays, meters, terminal blocks with their number etc. interconnection diagram between control and relay board and circuit breaker, Power and Instrument Transformer and other equipment as necessary.

24.02 After approval of above drawings ten sets of those drawings for each set complete set of C&R board and wiring schedule including bus wire diagram for each panel are to be supplied by the contractor.
One set of reproducible of the above drawings for each C&R board formation shall also be supplied.

24.03 Six copies of the following literatures shall be supplied along with the approved drawings and **one set of the same (soft copy) shall be supplied along with the drawing in the first submission**:

a) Literature describing construction, operation, adjustment and rating specification of all theprotective and auxiliary relays, recording instruments, metering instruments, control and other switches, annunciators, fault locator, disturbance recorder and other equipments which are used in the C&R panel.
b) List of spare parts, identification number of renewable parts of relays, instruments, switches and other equipments with the help of which the purchaser will be able to procure spare parts from the contractor at any subsequent line.
c) Commissioning, operating, maintenance instruction manual for each relay and equipment of the panel.

25.00 TEST AT FACTORY:

The following tests shall be carried out and six (6) copies of test certificates along with test result shall be supplied for approval.

a) Visual checking of C&R panel.
b) Checking wiring of circuits and continuity.
c) One minute applied voltage test. All equipments on panel and wiring shall be tested for a withstand voltage of 2 KV between different circuits shorted and earth.
d) Insulation resistance of the complete wiring, circuit by circuit with all equipment mounted on the board before and after HV test.
e) Routine tests according to the relevant standards on the instruments, relays and other devices.

26.00 INSPECTION/ TEST WITNESS:

a) Tests shall be performed in presence of the purchaser's representative, if so desired by the purchaser. The contractor shall give at least 21 (twenty one) days advance notice of the date when the tests are to be carried out at manufacturer’s works.

b) Relays and meters may be further tested at our testing laboratory. If any equipment is found to be not in conformity with the specification by our testing engineers during testing, the same shall be replaced by you at your cost immediately.