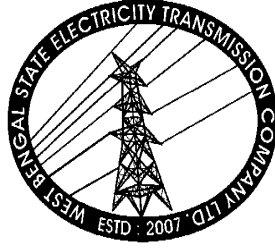


CONTROL & RELAY PANEL



September 2017

Engineering Department

WEST BENGAL STATE ELECTRICITY TRANSMISSION COMPANY LIMITED

পশ্চিমবঙ্গ রাজ্য বিদ্যুৎ সংবহন কোম্পানি লিমিটেড
(পশ্চিমবঙ্গ সরকারের একটি উদ্যোগ)

Regd. Office: VidyutBhawan, Block – DJ, Sector-II, Bidhannagar, Kolkata – 700091.

CIN: U40101WB2007SGC113474; Website: www.wbsetcl.in

**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 equipment and Control room building equipment as necessary. The Contractor has to design the Schematics for protection and Control of all equipment 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:

<u>IEC/Indian Standard No.</u>	<u>Title</u>
IS 3231 & IEC-255	Electrical relays for power system protection
IS 1248 & IS 2419	Indicating Instrument
IS 6236	Recorders
IS 722	Static Energy meters
IEC 679	Static TVM
IEC 337 & 337-1	Control Switches (LV Switching devices for control and auxiliary circuit)
IS 2705	Current Transformers
IS 3156	Voltage Transformer
IS 4237	General requirement for Switch gear and Control gear for voltage not exceeding 1 KV.
IS 375	Marking and arrangement for Switchgear Bus bars, main connection and auxiliary wiring.
IS 8686	Specification for static protective relays

3.00 REQUIRED QUANTITIES:

Quantities of C & R panels are to be assessed by the bidders from the Schedule enclosed with this specification. 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 to be considered for Design of Control and relay board, and protection panels:

4.01 SYSTEM DETAILS :

	<u>400KV</u>	<u>220KV</u>	<u>132KV</u>	<u>33KV</u>
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 +/- 10%. In case of failure of the AC supply to battery charger, DC Supply voltage will be available automatically from lead acid 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 in line with the following table:

Ammeter Range: -					
400kV AIS		400kV (GIS)		220kV (AIS & GIS)	
Feeder	2000A	Line side	3000A	Feeder	800A
315MVA Transformer, 400kV side	1000A			160MVA Transformer, 220kV side	800A
Reactor	200A	---		50MVA Transformer, 220kV side	300A
Bus Transfer	2000A			Bus Transfer (for AIS only)	800A
Bus Coupler	2000A			Bus Coupler	1600A

132kV AIS		132kV GIS		33kV AIS & Indoor Switchgear	
Feeder	600A	Feeder	800A	Feeder	400A
160MVA Transformer, 132kV side	800A	160MVA Transformer, 132kV side	800A	50MVA Transformer, 33kV side	1000A
50MVA Transformer, 132kV side	300A	50MVA Transformer, 132kV side	300A	Bus Transfer (for AIS only)	1000A
Bus Transfer	800A	Bus Coupler	1600A		

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

Wattmeter & VARmeter Range: -		
	MW	MVAR
400kV		
Feeder	0 to ±1400	0 to ±1400
Bus Tr		
Bus Coupler		
315MVA Trafo	0 to ±800	0 to ±800
Reactor	---	0 to ±100
220kV		
Feeder	0 to ±300	0 to ±300
160MVA Trafo	0 to ±400	0 to ±400
315MVA Trafo		
Bus Trf		
Bus Coupler	0 to ±600	0 to ±600
One & Half Breaker System		
Feeder	0 to ±600	0 to ±600
160MVA Trafo		
132kV		
Feeder	0 to ±200	0 to ±200
160MVA Trafo		
Bus Trf		
Bus Coupler		
50MVA Trafo	0 to ±100	0 to ±100
33kV		
Feeder	0 to ±25	0 to ±25

6.00 PANEL DESCRIPTION, CONSTRUCTION AND FORMATION:

6.01 GENERAL REQUIREMENT:

- a) The control and relay board panels for 400KV system shall be duplex/simplex type (as applicable as per Bus configuration) so as to accommodate all the control equipment, breaker relays, meters etc. excepting the protective relays and its aux. relays/accessories as necessary for completeness of the protection/control scheme without overcrowding and cramping. Separate protection panels of simplex type (minimum 2 nos) shall be provided for accommodating the protective relays and its aux. relays/accessories as required to fulfill the scheme requirement.
- b) The control and relay board panel for 220KV system and 132KV system shall also be duplex type 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. However, the 33KV C&R board panels shall be simplex type for accommodating all the control, protection and metering equipment properly.
- c) 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 and of 1900 mm height.

- d) 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.
- e) 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.

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 than 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 3 mm 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 of 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) 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.
- h) 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. 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.

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.
- 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 :
- | <u>Circuit where used</u> | <u>Colour of the wire</u> |
|---|---|
| Red, yellow and blue phase of instrument transformer circuit. | Red, yellow and blue for respective phases. |
| Neutral connections earthed or not earthed in 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 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.
- e) All wiring interconnecting the front cubicles with the rear 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.
- f) 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.
- g) Wiring connected to the space heaters in the cubicles shall have porcelain beaded insulation over a safe length from the heater terminals.

- h) Wire termination shall be made with solder less crimping type and tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the 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.
- i) 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.

<u>KV Class</u>	<u>C o l o u r</u>	<u>Shade Index as per ISS</u>
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:

- 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 :

<u>Function</u>	<u>Colour lens</u>
C.B. spring charged/compressor healthy indication	Blue
C.B. Trip circuit healthy	White

Alarm Bus and incoming D.C. fail indication.	Amber
P.T. supply healthy indication (Bus bar healthy indication).	Red/Yellow/Blue
Isolator ON-OFF Indication	Red/Green

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.
- 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 shall provide all bay level functions regarding control and monitoring, inputs for status indication and outputs for commands.
- 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 to be provided in the Bus transfer bay 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 be 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.

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 conform 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

12.03 INTELLIGENT ELECTRONIC METER:

Supply of Intelligent Electronic Meters of different classes and different voltage levels shall not be within the scope of supply of the bidders. However necessary complete wiring arrangement for Intelligent Electronic Meters along with supply of TTB & Terminal Block shall be within the scope of supply of the bidders. Terminal Block to be provided for Meter connection should be De-linked type.

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:

Two sets of batteries (220V), their respective chargers and DC boards shall be used for DC supply for all new substations.

14.02 DC CIRCUIT FOR 400KV CRP PANELS:

- a) There shall be two DC incomers (220V) to each 400KV control relay and protection panels as DC supply –1 and DC supply-2. Necessary arrangement for Supervision of both the incoming DC Supplies shall be made.
- b) In each duplex type 400KV C&R panel, following circuits shall be connected to DC Supply 1 through suitable MCBs/ HRC fuses:
 - i) Isolator control circuit
 - ii) Synchronising circuit
 - iii) Metering circuit
 - iv) Indication circuit
 - v) Annunciation circuit
 - vi) CB Closing circuit
 - vii) VT Selection circuit & CB Aux. Relay circuit
 - viii) Individual DC emergency lamp circuit with HRC fuses for Control panel, Relay panel and Protection panel.

In case of failure of DC Supply 1, the above circuits will be fed from DC Supply 2. Changeover can be Manual (by using Selector switch).

- c) DC supply – 1&2, drawn to each duplex type 400KV C&R panel, shall be divided into the following sub circuits. Each sub circuit shall be controlled and monitored with the help of suitable MCBs/HRC Fuses.
 - i) CB Trip coil –1 shall be fed from DC supply – 1.
 - ii) CB Trip coil –2 shall be fed from DC supply – 2.
- d) DC Supply -1&2 shall be fed to Protection panel from C&R panel directly. Necessary arrangement for Supervision of both the incoming DC Supplies shall be made. DC supply – 1&2 shall be divided into the following sub circuits. Each sub circuit shall be controlled and monitored with the help of suitable HRC Fuses.
 - i) Circuitry for Main –1 protection, over voltage protection and reactor gr.-A protection shall be fed from DC supply – 1.
 - ii) Circuitry for Main – 2 protection and reactor gr. –B protection shall be fed from DC supply –2.
- e) Annunciation DC shall be supervised by the Annunciator through auxiliary AC supply of the Annunciator in each panel.

14.03 D.C. CIRCUIT FOR 220 KV AND 132kV C&R PANEL:

- a) There shall be only two DC incomers (220V) as DC supply –1 and DC supply-2 for the entire control and relay panel of 220kV and 132kV system voltage fed from D.C. distribution board through individual 32Amp. switch fuse unit provided there. Necessary arrangement for Supervision of the both the incoming DC supplies shall be made.

One 16Amp. rating 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 (3 bus system) panel of each system.

The above D.C. incoming buses of 220kV and 132kV CR Panel shall run continuously in the control and relay board of each system voltage. Individual panel D.C. supply shall be teed off in each panel from the above two D.C. buses through set of links.

- b) In each duplex type 220kV & 132kV C&R panel, following circuits shall be connected to DC Supply - 1 through suitable MCBs/ HRC fuses:
- i) Isolator control circuit through MCB
 - ii) Synchronising circuit
 - iii) Metering circuit
 - iv) Indication circuit
 - v) CB Closing circuit
 - vi) VT Selection circuit & CB Aux. Relay circuit
 - vii) LBB circuit (in 220kV & 132kV Bus Transfer/Bus Coupler panel, as applicable). DC supply for LBB protection scheme selective DC shall run through all panels as bus wires. In individual panels this supply will feed the LBB scheme through isolating links.
 - viii) Individual DC emergency lamp circuit with HRC fuse for Control panel and Relay panel.
- In case of failure of DC Supply 1, the above circuits will be fed from DC Supply 2. Changeover shall be Manual (by using Selector switch).
- c) In case of GIS substations, from control panel the DC supply will be teed off from the 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.
- d) DC supply – 1 & 2, drawn to each duplex type 220kV and 132kV C&R panel, shall be divided into the following sub circuits. Each sub circuit shall be controlled and monitored with the help of suitable MCBs/HRC Fuses.
- i) CB Trip coil –1, Circuitry for Main –I Distance protection, Differential protection, Gr. A protection shall be fed from DC supply – 1.
 - ii) CB Trip coil –2, Circuitry for Main –II Distance protection (if applicable), REF protection, Back up protection, Over fluxing protection, Neutral displacement protection, Gr. B protection shall be fed from DC supply – 2.
- e) D.C. annunciation bus shall be teed off from the Bus Transfer (2 bus system)/ Bus Coupler (3 bus system) panel of each system for annunciation system through 6A HRC fuse both at +ve and -ve side with necessary D.C. supervision relay and the same shall run continuously through the entire C&R board for annunciation system in respective panels. In addition, Annunciation DC shall be supervised by the Annunciator through auxiliary AC supply of the Annunciator in each panel.

14.04 D.C. CIRCUIT FOR 33 KV C&R PANEL:

- a) There shall be only one DC incomer (220V) for the entire control and relay panel of 33KV system voltage fed from D.C. distribution board through a 32Amp. switch fuse unit provided there. One 16Amp. rating HRC fuse unit both at +ve and -ve side shall be provided for the D.C. incomer in Bus Transfer/ Bus Section (2 bus system)/ Bus Coupler (3 bus system) panel of 33KV system. The above D.C. incoming bus of 33KV CR Panel only shall run continuously in the control and relay board of each system voltage. Individual panel D.C. supply shall be teed off in each panel from the above D.C. bus through a set of links.

D.C. annunciation bus shall be teed off from the incomer D.C. bus of 33KV Bus Transfer / Bus Section (2 bus system)/ Bus Coupler (3 bus system) panel for 33 KV annunciation system through 6A HRC fuse both at +ve and -ve side with necessary D.C. supervision relay and the same shall run

continuously through the entire C&R board for facia annunciation system in respective panels. In addition, Annunciation DC shall be supervised by the Annunciator through auxiliary AC supply of the Annunciator in each panel.

- b) DC supply to individual panel shall be distributed within the panel as below:
- i) C.B. remote closing, local operation circuit including auxiliary relay function, C.B. remote and protection trip to trip coil 1 with trip circuit supervision relay shall be through 10A HRC fuse and link.
 - ii) C.B. remote and protection trip to trip coil 2 with trip circuit supervision relay through 10A HRC fuse and link.
 - iii) Protective relay and P.T. selection circuit with D.C. supervision relay through 10A HRC fuse both at +ve and -ve side.
 - iv) Indication circuit through 6A HRC fuse and link.
 - v) Isolator control circuit through 10A HRC fuse and link.
 - vi) D.C. emergency lamp circuit with 2A HRC fuse and link.
 - vii) D.C. supply to synchronising socket through links both at +VE & -VE side.

14.05 AC CIRCUIT:

- a) 230V, single phase 50Hz AC auxiliary supply to the control, relay and protection panel board of each system voltage 400KV, 220KV, 132KV and 33KV will be fed from AC distribution board through separate 32Amp. switch fuse units provided there. The supply shall be provided in Bus coupler/Bus Transfer panel. A continuous AC bus shall be provided at the control, relay and protection panel board of each group wherefrom AC supply to each panel shall be teed off through a set of links. One 16Amp rated HRC fuse units shall be provided for a complete control, relay and protection panel board of each system voltage for the incoming AC supply. 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.
- b) Door operated corridor illumination lamp ckt. of duplex type panel shall be arranged from the above incoming AC bus through suitably rated fuse and link.
- c) AC circuit for incoming DC Annunciation DC fail alarm scheme shall be provided in the Bus coupler panel of 400KV & 220 KV system and in the Bus Transfer/ **Bus Section** (2 bus system)/ Bus Coupler (3 bus system) panel of 132KV and 33KV system. The above circuit shall be teed off from the above respective panel AC bus through fuse and link suitably rated.
- d) 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 of Bus Coupler panel of 400KV & 220KV system and of the Bus Transfer/ **Bus Section** (2 bus system)/ Bus Coupler (3 bus system) panel of 132KV and 33KV system.

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) For 400KV/220KV system three sets VT selection relays operated from DC supply-1/ change over DC system If VT selection relay is latched type, change over DC system of the respective panel can be used to energize all the three VT selection relays.
- 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) In 132KV C&R panel, where more than one set of 132KV PT is available or not, necessary 132KV PT selection scheme shall be adopted and made ready for future use and where more than one set of 33KV bus PT is available, necessary 33KV PT selection scheme shall be adopted through switch at 33KV C&R panel.

15.00 ANNUNCIATION SYSTEM:

15.01 INCOMING DC FAIL AND ANNUNCIATION BUS D.C.FAIL ALARM SCHEME:

- a) 400KV system shall have alarm scheme, as follows: -
 - i) Incoming DC-1/DC-2 supervision shall be provided in each panel.
 - ii) In each Protection panel, DC-1/DC-2 fail supervision shall be provided.
 - iii) In Bus bar protection panel, DC fail supervision shall also be provided.
 - iv) Audible AC alarm shall be provided for Incoming DC/Annunciation DC Fail.
 - v) 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 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 lamps, AC operated hooter and push button for cancellation of audible alarm, as necessary.
 - vi) In each panel, Annunciation DC Fail indication at Annunciator, which is fed by AC supply.
- b) 220KV and 132KV system shall have alarm scheme, as follows: -
 - i) In each relay panel, Protection DC-1/DC-2 fail supervision shall be provided.
 - ii) In Bus bar protection panel, DC fail supervision shall also be provided.
 - iii) The "Incoming DC fail (DC – 1 and DC – 2) and 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 panel. The scheme shall comprise of D.C. supervision relays with test push buttons for Incoming DC supply (DC – 1 and DC – 2) and Annunciation bus DC system, AC operated alarm accept relays, indication lamps, AC operated hooter and push button for cancellation of audible alarm, as necessary.
 - iv) In each panel, Annunciation DC Fail indication at Annunciator, which is fed by AC supply.
- c) 33KV system shall have alarm scheme, as follows: -
 - i) In each relay panel, Protection DC fail supervision shall be provided.
 - ii) The "Incoming DC fail and 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 incoming DC supply and Annunciation bus DC system, one AC operated alarm accept relays, one indication lamp, one AC operated hooter and one push button for cancellation of audible alarm.
 - iii) In each panel, Annunciation DC Fail indication at Annunciator, which is fed by AC supply.

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.*

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:

<u>Alarm Condition</u>	<u>Fault contact</u>	<u>Visual Annunciation</u>	<u>Audible Annunciation</u>
Normal	Open	OFF	OFF
Abnormal	Close	Flashing	ON
Accept push button is pressed.	Close Open	Steady ON Steady ON	OFF OFF
Reset push button is pressed.	Close Open	ON OFF	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 scheme wiring should be such that the warning annunciation facia window can be converted to trip annunciation facia window or vice versa with the change in audible alarm connection accordingly, 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. Audible common annunciation for the entire board formation of each system voltage shall be provided by a hooter. The visual annunciation shall be provided by flickering of a window facia of a group of facia window to be provided in each panel.

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. Audible annunciation shall be provided by means of a separate common bell with different tone and visual annunciation 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.

Live demonstration of any offered relay has to be arranged by the Party at the laboratory of Central Testing Department of WBSETCL, if felt necessary by WBSETCL before finalisation of bid.

- 16.01** All shall conform to the requirement of IS: 3231 / IEC 255 and shall be suitable for operation within a temperature range 0°C to 55°C 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.
- 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 0°C to 55°C 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 his list of special requirement, if any, for D.C. input arrangement or cabling considered necessary for satisfactory operation of solid state relays quoted by him.
- 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 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.

For existing and new substations, provision is to be made for connectivity with the existing and or future numerical relays through PC by providing external comport multiplier (e.g. Rocket port/Serial sharer etc.).

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 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 compatible with the following features:

- i) Peer-to-peer communication using GOOSE messages (latest IEC61850) for interlocking.
- ii) Interoperability with third party IEC 61850 (latest version) compliant devices
- iii) Generate XML file for integration/engineering with vendor independent SCADA systems.
- iv) Should be directly connected to the inter bay bus on IEC 61850 (latest version) without the use of any gateways. Connections of bay protection IEDs to the IEC 61850 bus (latest version) through the bay control units are not acceptable.

v) All Numerical relays must be PRP compliant for SAS.

All the numerical relays shall have one front port for direct access with proprietary protocol, rear ports with latest IEC 61850 protocol (One no. mandatory FO port and another FO/RJ 45 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.

- c) 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 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 7/ WINDOWS 10 operating system compatible.

- d) Interconnection architecture among the relays showing details identification of all intermediate hardware including interfacing port of the monitoring PC and other hardware
- e) Connectivity architecture of Disturbance recorder evaluation station of all numerical relays like numerical distance relay, numerical differential relay etc. with time synchronisation unit.
- f) Interface architecture involving multiple nos. of numerical relays of respective make, with the monitoring PC.
- g) Interface architecture of the above network with existing/future network of other make numerical relays with monitoring PC, wherever applicable.
- h) The bidder has to furnish the **certificate for latest IEC 61850 Compliance from KEMA/CPRI**, type test certificate from any Govt. recognized Test House and performance certificate from Power Utilities in India.
- i) Local area networking system: -
 - i) 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
 - ii) External comport (RS232C) multiplier to be interfaced with the comport of PC, having minimum 8 nos interfacing port.

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

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

- a) One no. BCU shall be provided for supervision and control of each bay (a bay comprises of one circuit breaker and associated disconnect, earth switches and instrument transformer).
- b) Communication Port : BCU shall be PRP compliant for SAS with latest 61850 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 via fibre-optic communication and process bus.
- 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.
- k) Self-monitoring of components, modules and communication shall be incorporated to increase the availability and the reliability of the equipment and minimize maintenance.
- l) "The bay control unit shall be fed from redundant DC power supplies, this may be implemented with redundant power supply modules in the BCU or with automatic DC source selection with a suitable auxiliary relay."
- m) The BCU must also have redundant processor unit.
- 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
 - 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

17.02 EVENT LOGGER:

[The IED should be latest IEC61850 compliant having rear port compatible to latest IEC 61850 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, equipment, 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 compliant having rear port compatible to latest IEC 61850 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/ intertripping 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 5 millisecond 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 $\pm 3\%$ 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 maloperation, 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 20nos Binary Outputs (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.

17.03. AUTO-RECLOSE RELAY:

01

- 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. Either 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:

02

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

- a) Microprocessor based type.
- b) be "on-line" type
- c) be suitable for breaker operating time.
- d) have built in display unit.
- e) the display shall be directly in kilometers without requiring any further calculations.
- f) 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.
- g) 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.
- h) have facility for remote data transmission.
- i) **shall be in-built in distance relay with facility for triggering from external protection.**
- j) 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 compliant having rear port compatible to latest IEC 61850 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 ± 0.5 sec 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 pre-fault 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 compliant having rear port compatible to latest IEC 61850 protocol.]

- a) Line Differential protection relay shall have phase segregated line differential protection.
- b) It shall measure Differential as well as restrain current continuously and shall display the same as measurement.
- c) It shall communicate analogue as well as digital signals to remote end.
- d) It shall have Line charging current compensation feature for better sensitivity.
- e) Have backup built-in Distance protection functionality as specified for distance protection relay. Distance protection function can be utilized as independent or as back up of Differential protection in case of failure of remote communication.
- f) It shall communicate time coordinated current signals for remote communication to execute Line differential protection algorithm accurately. Time synchronization through GPS shall also be possible.
- g) Have high immunity to electrical & electromagnetic interference.
- h) Have DR with 8nos analog channel & 32nos binary channel.
- i) Generate GOOSE message as per latest IEC 61850 standards for interlocking and also to ensure interoperability with third party relays.
- j) be provided with necessary user friendly configuration tools to configure the relays and shall be compatible with SCL/SCD files generated by a third party system. GOOSE signals shall be freely configurable for any kind of signals using graphic tool/user friendly software. There shall be a facility to have latest IEC 61850 protocol inbuilt without use of any external converter.
- k) Have the facility of setting parameter access restriction.
- l) Have self supervision with fault diagnostics.
- m) Be provided with necessary WINDOWS 7/ WINDOWS 10 based support software for setting parameterisation, up & downloading data etc.
- n) have channel communication with continuous supervision facility and the facility for switching to backup protection mode in the event of communication channel failure.
- o) Have cold start switching facility at every end.
- p) Have phase segregated measurement and tripping facility.
- q) Have a high set differential trip setting with tripping time of maximum 15ms.
- r) Have a normal line differential trip time of maximum 35ms at 5 times of set value.
- s) Provide high stability during external faults.

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 equipment 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 equipment& the same shall be housed in a separate simplex type panel.
- b) For all new substations, GPS shall be redundant, i.e. Two nos of Clock & Antenna must 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 \pm 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 compliant having rear port compatible to latest IEC 61850 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 30millisec 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 inrush 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 three instantaneous site selectable high set over current units (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 have built in feature for derivation of zero sequence voltage internally. The MTA of the relay shall be 45°lag for earth fault and 45°lead for over current.
- k) 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.
- l) 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.
- m) 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.
- n) 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
- o) 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.
- p) 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.

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 above protection shall be provided for 220/132/33KV auto-transformers, 220/33KV transformer & 132/33KV transformers both at HV and LV side and also 33/11KV transformers at HV and LV side.

The Relay shall be:

- a) stand-alone type. Numerical type may also be accepted.

- b) single pole type.
- c) current/ voltage operated high impedance type with a suitable setting to cover the maximum portion of transformer winding. Necessary calculation to prove the above winding coverage shall be furnished along with the tender.
- a) tuned to the system frequency.
- e) have suitable nonlinear resistor to limit the peak voltage without detriment to the scheme.
- f) operating time shall be less than 20 ms.
- g) have suitable stabilizing resistor to prevent mal-operation during external faults if necessary.

17.08 CIRCULATING CURRENT PROTECTION FOR 400/220/33KV AUTO TRANSFORMER:

The above protection shall be provided for 400/220/33KV auto-transformers at the HV side protection panel and for the 400 KV bus reactor to act as differential protection .The protection shall be responsive for both phase and earth fault of the transformer and reactor winding. The relay shall be –

- a) stand-alone type. Numerical type may also be accepted.
- b) triple pole type .
- c) voltage operated high impedance type with a suitable setting to cover the maximum portion of the transformer winding. Necessary calculation to prove the above winding coverage shall be furnished along with the tender.
- d) tuned to the system frequency.
- e) have suitable nonlinear resistor to limit the pick voltage without detriment to the scheme .
- f) operating time shall be less than 20msec .

17.09 OVER FLUXING PROTECTION:

- a) The HV & MV sides of 400/220/33KV & 220/132/33KV Auto-Transformer and the HV side of 220/33KV Transformer shall be provided with stand alone numerical type over fluxing relay.
- 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 \pm 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 98%.
- h) The relay shall have the disturbance recording function with at least 4nos analog channels and 8nos digital channels

17.10 OVER LOAD PROTECTION:

The 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 be -

- 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:

The relay shall be stand-alone type & connected to Line CVT. It will be used for 400KV feeder protection and shall –

- a) monitor all three phases.
- b) be connected between Phase to Phase in Delta configuration.
- c) have two stages .
- d) 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 .
- e) have an adjustable setting range of 100 – 170% of rated voltage with a delay of 100 – 200msec for the second stage .
- f) have power frequency filters.
- g) have a drop off to pickup ratio greater than 99%.
- h) 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:

This relay will be used as back up protection of 400/220/33KV & 220/132/33KV Transformer, HV side of 220/33KV & 132/33kV Transformer and back up to distance relays for 220KV and 132KV system and shall have follow properties-

- a) Minimum two characteristics, one IDMT of 3sec and the other one of definite time 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) Any of the out puts including trip shall be latched and reset of the outputs 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) No of output contact required – 8 nos
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 45°lag for earth fault and 45°lead for over current. Any extra feature like time synchronization, LAN compatibility with other numerical relays shall be mentioned specifically.

17.13 AUXILIARY RELAY FOR TRANSFORMER & REACTOR INTERNAL TROUBLE PROTECTIONS:

DC voltage operated auxiliary relays provided with mechanically operated hand reset indicator and sufficient number of hand-reset contacts shall be provided for protection and supervision against transformer internal troubles/faults. Number of element and number of relays shall be as per requirement of individual transformers and reactor.

17.14 MASTER TRIP RELAY:

Master trip relay shall be provided to cause tripping of all the associated breakers. The operating time of master trip relay should be less than 15ms. 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 be provided with electrical reset as well as hand reset arrangement.

17.15 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 –

- a) be triple pole type.
- b) have a 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.

For Over-voltage protection of 400kV bays, Voltage-controlled LBB protection relay is to be considered.

17.16 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.
- b) These relays shall monitor the whole of the trip circuit whether the breaker is in open or closed 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. The relay shall have a delay in drop off at least 200ms to avoid a false alarm during a normal tripping operation.

17.17 NUMERICAL BUS BAR PROTECTION

[The relay should be latest IEC61850 compliant having rear port compatible to latest IEC 61850 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) 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.
- e) 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 feeder
- h) 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.
- i) 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

- j) include continuous D.C. supplies supervision.
- k) include protection 'IN/OUT' switch for each zone
- l) The scheme should be equipped completely for supporting **four** numbers spare circuits 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.

- m) 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.

17.17. 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

17.17. For 220KV 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

17.18 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.

17.19 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 a overcurrent sensing element & trip bus breaker under fault condition.

17.20 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 400KV LINE PROTECTION:

The general concept is to have two parallel primary protections having equal reliability of performance called Main –1 and Main – 2 protection. Main –1 and Main – 2 distance protection relay shall be of different make.

The following protection scheme has been envisaged: -

- 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.
- c) Auto reclosing, fault locator and disturbance recorder scheme.
- d) Local breaker back up protection scheme.
- e) Direct tripping command from remote end through carrier channel.
- f) Line CVT operated two stage over voltage protection.
- g) Main-1 & Main-2 PT juice either BVT/CVT is to be mentioned.

18.02 PROTECTION OF 315MVA, 400 / 220 / 33 KV AUTO TRANSFORMER PROTECTION:

- a) Percentage biased differential protection (three winding).
- b) Circulating current protection responsive to both phase faults and earth faults.
- c) Directional IDMT polarised, three element over current with directional high set and single element earth fault protection scheme with directional high set both at HV and MV side with necessary PT fuse failure monitoring feature.
- d) Over load protection alarm on HV side.
- e) Transformer over flux protection on HV side & MV side.

- f) Flag relays for transformer mounted protection like buchholtz, winding temperature, oil temperature, pressure relay device etc.
- g) Local breaker back up protection at HV side & MV side.
- h) Numerical stand-alone type neutral displacement relay with stage operation for tertiary winding protection.

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 220KV LINE PROTECTION:

- a) It should have two parallel primary protections having equal reliability of performance called Main –1 and Main – 2 protection. Main –1 and Main – 2 distance protection relay shall be of different make and type.
- b) Main – 1 distance protection by microprocessor based numerical distance relaying scheme with carrier aided distance protection scheme.
- c) Main – 2 distance protection by microprocessor based numerical distance relaying scheme but of a different make & type with carrier aided distance protection scheme.
- d) For 220kV Line, where the line length is less than 3km, and for 220kV cable line, Line Differential protection scheme numerical relay is to be considered.
- e) The auto-recloser, disturbance recorder, fault locator, event logger etc. shall be built in with distance relay as specified in Clause no.16.9.
- f) Local breaker back up protection.
- g) Direct tripping command from remote end through carrier channel.

18.05 132 KV LINE PROTECTION:

- a) It should have one Numerical Distance Relay as main protection along with one Numerical Directional Over Current & Earth Fault Relay as back up.
- b) Carrier aided distance protection scheme numerical relay shall be offered.
- c) For 132kV Line, where the line length is less than 3km, and for 132kV cable line, Line Differential protection scheme numerical relay is to be considered.
- d) Back up protection with voltage polarised, IDMT, directional Three Over current and one earth fault relaying scheme with necessary PT fuse failure monitoring scheme for both the above cases.
- e) Local breaker back up protection.
- f) The auto-recloser, disturbance recorder, fault locator, event logger etc. shall be built in with Main Numerical protection relay as specified in Clause no.16.9.

18.06 220/132/33KV AUTO-TRANSFORMER PROTECTION:

- a) Percentage biased differential protection (three winding).
- b) Restricted earth fault protection.
- c) Back-up directional voltage polarised, three element IDMT overcurrent with directional high set instantaneous element and one earth fault protection with directional high set instantaneous element both at HV side and MV side with necessary P.T. fuse failure monitoring scheme.

- d) Flag relays for transformer mounted protections like Buchholz, winding temperature, oil temperature, pressure relief device etc.
- e) Local breaker back up protection at HV side only.
- f) Over flux protection and over load alarm at HV side.
- g) Numerical stand-alone type neutral displacement relay with stage operation for tertiary winding protection.

18.07 132/33 KV STAR-DELTA TRANSFORMER PROTECTION:

- a) The control and protection shall cover both HV&LV side breakers.
- b) Percentage biased differential protection (Two winding).
- c) Restricted earth fault protection both at HV and LV side.
- d) Back up non directional, IDMT three over current protection both at HV and LV side.
- e) 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. The earthing transformers shall be connected at 33KV bus outside the transformer differential zone.
- f) Back up Earth Fault protection scheme shall be achieved either by selector switch or by developing logic using isolator contact of Earthing Transformer and stage contact of the numerical relay.
- 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) Flag relays for transformer mounted protections like Buchholz, Winding temperature, Oil temperature, Pressure relief device etc. shall be provided. Internal trouble protection auxiliary relays for alarm and trip signal to LV breakers for earthing transformer to trip 33KV breaker shall have sufficient number of contacts for extending the trip pulse to other 33KV feeders connected with generating stations and only alarm signal for station service transformers shall also be provided.
- i) Trip transfer scheme for both HV & LV side shall be provided with two separate trip transfer switch.

18.08 400KV & 220KV BUS COUPLER PROTECTION:

- a) Over Current & Earth Fault Protection with Check-Sync facility.
- b) Bus bar protection.
- c) Local breaker back up protection.

18.09 400KV & 220KV TRANSFER BUS BAY PROTECTION:

The breaker shall be used for transfer of any circuit 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 excepting the LBB protection shall be kept inoperative with the help of protection IN/ OUT selector switch. However, its own protection shall be used when there is trouble in the protection system of transferred circuit.

The protection scheme of transfer bus bay shall be as follows: -

- a) Single distance protection scheme for transferred feeder protection with protection IN/ OUT switch. Numerical type shall be quoted as per feeder protection.
- b) Local breaker back up protection.

18.10 132KV TRANSFER BUS BAY PROTECTION:

The breaker shall be used for transfer of any circuit through transfer bus in case of necessity. During the period of transfer, the protective relays of individual circuits operated from line side CTs will trip

the Transfer bus breaker in place of respective bay circuit breaker through trip transfer circuit. The protection scheme provided in the transfer bus bay shall be kept inoperative with the help of a 3-position protection selector switch having selection for Feeder 132/33KV transformer and off position. The contacts of the switch shall be make before break type. However, its own protection shall be used when there is trouble in the protection system of transferred circuit.

The protection for transfer bus bay shall be as follows: -

- a) Distance protection scheme for feeder bay protection shall be with protection selector switch. Numerical relay shall be quoted as per feeder protection. The transfer bus numerical distance relay should be identical type of those relays used in the feeder protection for easy replacement of the same in future if required.
- b) Back up protection of feeder with voltage polarised, directional, IDMT, three over current and one earth fault protection scheme with protection selector switch and VT supply supervision scheme.
- c) 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)

18.11 33KV FEEDER PROTECTION:

- a) Directional, IDMT, three over current protection with high set instantaneous unit.
- b) Directional, definite time sensitive earth fault protection.

18.12 33/11KV TRANSFORMER PROTECTION (DELTA-STAR):

- a) Non-directional, IDMT, three over current protection with high set instantaneous unit at HV side.
- b) Restricted Earth fault protection for HV & LV.
- c) Transformer internal trouble protection e.g. Buchholz, winding temperature etc.
- d) Under frequency relay operated CB tripping scheme as stated under 17.12 (c).
- e) Percentage bias differential protection (Two winding) for 10MVA and above, 33/11KV transformers.

18.13 33KV TRANSFER BUS BAY PROTECTION:

The breaker shall be used for transfer of any circuit excepting the 33KV Shunt Capacitor bay through transfer bus in case of necessity. During the period of transfer, the line side C.T. operated protection of individual circuit will trip the transfer bus bay circuit breaker in place of respective bay circuit breaker through trip transfer circuit. Therefore, the protection scheme provided in the bus transfer bay shall be kept inoperative with the help of a 3-position protection Selector switch having selection for feeder, transformer and OFF position. The switch shall have make before break contacts. However, its own protection shall be used when there is trouble in the protection system of transferred circuit.

The protection scheme for the transfer bus bay shall be -

- a) Non-directional, IDMT, three over current protection with high set instantaneous unit with protection selector switch.
- b) Non-directional, definite time earth fault protection with protection selector switch.
- c) One common under frequency relay 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.

18.14 33KV SIDE OF 220/132/33KV TRANSFORMER FOR TERTIARY LOADING:

- a) Non-directional, IDMT, three over current protection with high set instantaneous unit at HV side.
- b) Neutral displacement relaying scheme through open delta connection.

18.15 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 inverse time characteristics.
- 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.

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

Bus configuration for various voltage class shall be as follows, unless otherwise mentioned:

- a) 400KV switchyard of all the sub-stations shall be of One & a Half Breaker system or two Main bus and one Transfer Bus system.
- b) 220KV switchyard of all the sub-stations shall be with two main Bus and one transfer Bus.
- c) 132KV switchyard of all the sub-station shall be either with one Main Bus with/without bus section breaker and one transfer Bus or two Main bus and one Transfer Bus.
- d) 33KV switchyard of all the sub-station shall be with one main Bus and one Transfer. But 33KV shunt capacitor shall be connected at Main Bus only where applicable.

18.17 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".

19.00 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.

19.00 MANDATORY SPARES:

Shall be supplied as per schedule.

20.00 SCHEDULE OF EQUIPMENT OF DIFFERENT PANELS:

Though the Bidder has to design the Control Panel and Protection Schemes for Lines, Transformers, Bus Coupler & Bus Transfer Bays of 400KV, 220KV, 132KV, 33KV System, 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 EQUIPMENT FOR DIFFERENT VOLTAGE CLASS:

Name of Equipment	Quantity	Name of Panel	Remarks
Digital Ammeter	3nos	Each Line bay, Trafo bay, Tie bay (in case One & Half Breaker system), Bus Coupler bay, Bus Transfer bay, Bus Reactor bay, Capacitor bank bay	
Digital Wattmeter with Transducer	1set	Each Line bay, Trafo bay, Tie bay (in case of One & Half Breaker system)	
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	

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	
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)	
CB Control Switch (Discrepancy type)	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 (Supply 1-Independent-Supply 2)	1no	Each bay (132kV & above)	

Bus VT selector switch (Bus VT 1 / Bus VT 2)		Bus Coupler bay (in case of 2M1T system or 2M system)	If Two nos PTs are used in 1M system with Bus Section CB, the switch is to be considered in Bus Transfer bay.
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 with 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	1set	Each Bus Coupler bay (in case	

and associated relays for Annunciation scheme		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
Cut out, mounting and wiring for RWTI and Selector switch	1no each	Each Bus Reactor bay	
Cut out, mounting and wiring for 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), Bus Reactor bay, Capacitor Bank bay	Not required for 132kV side of 220/132kV Trafo, 33kV side 220/33kV Trafo and 33kV side of 132/33kV Trafo
Common items e.g. Mimic; Circuit Label; Label indicating Manufacturer's Name, P.O. details, Drg. Ref. nos etc.; internally mounted equipment like Heater with Switch &Thermostat, AC Cubicle lamp with On/Off switch, DC Emergency Cubicle lamp with On/Off switch,	As Reqd	For each panel	

Corridor Illumination lamps with door switches at both ends of the corridor, 5/15A Power Socket with On/Off switch, Switches, Fuses, Links etc. in line with Tech Spec.			
---	--	--	--

20.01 COMMON RELAY/ PROTECTION PANEL EQUIPMENT 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 equipment 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 of the 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 with bi-stable relays for Double Bus arrangement	1set	For each panel (2M1T system & 2M system)	Except Bus Coupler 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)	
Auxiliary relays for C.B. Closing/Tripping, if necessary	1set	For each Circuit Breaker	
CB Monitoring scheme with Flag Relays/Aux. Relays	1set	For each Circuit Breaker	
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	1 No. each	Each Bus Coupler bay (in case of 2M1T system or 2M system) and	

Supervision Relays		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 Bus Transfer bay	
O/C & E/F Relay Setting Group Selector Switch, 3 – position, TRAF0 – 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	

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 equipment mentioned for control panel is generally applicable unless it is defined elsewhere and in case of bay extension in existing substations, necessary equipment for matching the existing control panel shall be supplied.

20.02 RELAY/ PROTECTION PANEL EQUIPMENT FOR DIFFERENT VOLTAGE CLASS:

FEEDER BAY					
	400kV	220kV	132kV	33kV	11kV
Main – I Numerical Distance Protection scheme/ Line Differential Protection scheme, in case of cable line and where the line length is less than 3km	✓	✓	✓	---	---
Main – II Numerical Distance Protection scheme	✓	✓	---	---	---
Single and Three Phase Auto-reclosing scheme including aux. relays & tripping relays	✓	✓	✓	---	---
Auto Reclose Selector switch	✓	✓	✓	---	---
Numerical Directional O/C & E/F Protection scheme	---	---	✓	✓	✓ (Non Dir)
Over Voltage Protection scheme	✓	---	---	---	---
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	As Reqd.	As Reqd.	As Reqd.	As Reqd.	As Reqd.
Master Trip relays (86A and 86B)	✓	✓	✓		
Master Trip relay (only 86)				✓	✓
Under Voltage Protection relay for Earth Switch	✓	✓	✓		
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 Switch (Line VT- Inter1-Inter2-Selected Bus VT)	✓	✓	✓		
Carrier Received LED Indicating Lamp	✓	✓	✓		
DT Received LED Indicating Lamp	✓	✓	✓		

HV SIDE OF TRAF0 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	✓	✓		
Transformer Auxiliary Protection scheme with Flag Relays/Aux. Relays	✓	✓	✓	✓
Master Trip relays 86A and 86B	✓	✓	✓	
Master Trip relay (only 86)				✓
P.T. selection scheme with bi-stable relays for Double Bus arrangement	✓	✓	✓	

LV SIDE OF TRAF0 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)			✓	✓	✓	
Master Trip relays 86A and 86B	✓	✓				
Master Trip relay (only 86)			✓	✓	✓	✓
P.T. selection scheme with bi-stable relays for Double Bus arrangement	✓	✓				

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)				✓	✓

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 ancillary 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.

20.03 Bus Zone Protection for 400 & 220kV 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 Clause No. 16.21.01 & 16.21.02 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 RECOMMENDED 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 TEST AND 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 equipment and 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) Outlined drawings of internal wiring diagram of the instrument, relays, meters, annunciator and other equipment showing external terminal connections with the equipment terminal number.
- d) 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 the protective and auxiliary relays, recording instruments, metering instruments, control and other switches, annunciators, fault locator, disturbance recorder and other equipment which are used in the C&R panel.
- b) List of spare parts, identification number of renewable parts of relays, instruments, switches and other equipment 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 equipment 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.

GUARANTEED TECHNICAL PARTICULARS OF CONTROL & RELAY PANEL

(To be filled in and signed by the Bidder)

SUBMISION OF GTP AGAINST LOA REF:		<TO BE FILLED BY THE BIDDER>
NAME OF THE BIDDER		<TO BE FILLED BY THE BIDDER>
SL	DESCRIPTION	SUBMISSION
	NAME OF THE EQUIPMENT	CONTROL & RELAY PANEL
A	CONTROL & RELAY PANELS	
1	Name Of Manufacturer	
2	Type and Designation	
3	Conforming Standard	
4	Type of sheet steel	
5	Thickness of sheet steel	
5.1	Front	
5.2	Back	
5.3	Sides	
6	Details of Painting	
7	Weight of each panel section	
8	Overall dimensions of each panel section in mm. (width x depth x height)	
9	Total weight of all panels	
10	Space required for installation of all panels	
11	Details of Tropicalisation	
12	Largest package for Transport	
12.1	Gross weight	
12.2	Overall dimensions	
B	LED POSITION INDICATORS	
1	Name Of Manufacturer	
2	Type and Designation	
3	Conforming Standard	
4	Operating Voltage	
C	TERMINAL BLOCK	
1	Name Of Manufacturer	
2	Type and Designation	
3	Conforming Standard	
4	No.of terminal studs per way	
5	Rated current	
6	Rated voltage	
7	Materials used	

SUBMISION OF GTP AGAINST LOA REF:		<TO BE FILLED BY THE BIDDER>
NAME OF THE BIDDER		<TO BE FILLED BY THE BIDDER>
SL	DESCRIPTION	SUBMISSION
7.1	Body	
7.2	Terminal studs	
7.3	Connecting links	
7.4	Support springs	
8	Minimum no.of conductors of area 2.5 sq.mm suitable for connection	
8.1	All circuits except CT	
8.2	CT Circuits	
D	CONTROL SWITCHES	
1	Name Of Manufacturer	
2	Type and Designation	
3	Conforming Standard	
4	Type of Handle	
5	No.of possible positions of handle with diagrams	
5.1	No.of contacts available	
5.2	Maximum No.of contacts which can be accommodated for each position	
6	Rating of Contacts :	
6.1	Voltage	
6.2	Make and carry current continuously	
6.3	Make and carry Current for 0.5 sec.	
6.4	Break resistive load	
6.5	Break inductive load	
7	Whether locking arrangement provided	
8	Mounting details	
9	Dimensions	
10	Other information, if any	
E	INDICATING LAMPS	
1	Name Of Manufacturer	
2	Type and Designation	
3	Conforming Standard	
4	Ratings :	
4.1	Current	
4.2	Voltage	
4.3	Wattage	
5	Colour of lamp	
6	Permissible voltage variation	

SUBMISION OF GTP AGAINST LOA REF:		<TO BE FILLED BY THE BIDDER>
NAME OF THE BIDDER		<TO BE FILLED BY THE BIDDER>
SL	DESCRIPTION	SUBMISSION
7	Whether series resistance is provided, if so :	
7.1	Ohmic value	
7.2	Power loss	
8	Life of lamp in burning hours	
9	Other information, if any	
F	PUSH BUTTONS	
1	Name Of Manufacturer	
2	Type and Designation	
3	Conforming Standard	
4	Contact type momentary / maintained	
5	Whether integral engraved inspection plates provided	
6	No.of NO/NC contacts	
G	ANNUNCIATORS	
1	Name OF Manufacturer	
2	Type and Designation	
3	Conforming Standard	
4	No.of windows	
5	Dimensions of each Window (Length x height x depth)	
6	No.of lamps per window	
7	Auxiliary supply voltage	
8	Power Consumption	
9	Details of auxiliary equipments such as relays etc.	
10	Required instantaneous making capacity of initiating contacts	
11	Type of reset-manual / self	
12	Overall dimensions of annunciators	
13	Particulars of wiring	
14	Technical literature	
15	Brief write-up of the scheme furnished	
16	Built-in facility of DC Fail Annunciation (Yes/No)	
H	INDICATING METERS (Digital) (To be furnished separately for each type of meter)	

SUBMISION OF GTP AGAINST LOA REF:		<TO BE FILLED BY THE BIDDER>
NAME OF THE BIDDER		<TO BE FILLED BY THE BIDDER>
SL	DESCRIPTION	SUBMISSION
1	Name Of Manufacturer	
2	Type and Designation	
3	Conforming Standard	
4	Range :	
4.1	Effective Range	
4.2	Fiducial value	
5	Whether CTR & PTR are Programmable	
6	CT Ratio	
7	PT Ratio	
8	Accuracy class	
9	Overall dimensions	
10	Auxiliary Voltage (If required)	
11	Display dimension	
12	Display illumination	
13	EMC	
14	Measurement principal	
15	Whether communicable	
16	Response time	
I	NUMERICAL TYPE DISTANCE RELAY	
1	Name OF Manufacturer	
2	Type and Designation	
3	Conforming Standard (Whether latest IEC 61850 compliant)	
4	Input Quantities	
4.1	Rated AC Current &Maxm. Continuous AC Current	
4.2	Rated AC Voltage &Maxm. Continuous AC Voltage	
4.3	Rated DC Voltage	
4.4	Tolerance Allowance in DC Voltage	
4.5	Allowable Maxm.Ripple	
5	Burden	
5.1	C.T.Circuit	
5.2	P.T.Circuit	
5.3	D.C.Circuit :	
5.3.1	Operating (Maxm.)	
5.3.2	Quiescent (Maxm.)	
6	Thermal withstand rating (Current/Voltage)	

SUBMISION OF GTP AGAINST LOA REF:		<TO BE FILLED BY THE BIDDER>
NAME OF THE BIDDER		<TO BE FILLED BY THE BIDDER>
SL	DESCRIPTION	SUBMISSION
6.1	For one sec.	
6.2	For 0.5 sec	
7	Frequency range for satisfactory operation	
8	Characteristic on R - X plane	
9	Number of zones provided	
10	Setting ranges for distance measurement :	
10.1	Zone 1	
10.2	Zone 2	
10.3	Zone 3	
10.4	Any other zone	
11	Timer setting ranges	
11.1	Zone 2	
11.2	Zone 3	
11.3	Any other zone	
12	Power swing blocking characteristics	
13	Power swing blocking	
13.1	Setting ranges	
13.2	Whether independent zone selection provided	
13.3	Timer setting whether selectable or fixed and its value	
14	V.T.Supply supervision	
14.1	Method of detection	
15	Switch on to fault feature	
15.1	Method of detection	
16	Whether scheme is suitable for autoreclose	
16.1	Single phase	
16.2	Three phase	
16.3	Whether check synchronising relay and deadline charging relay is in-built with the distance relay	
17	Whether scheme is suitable for carrier aided tripping scheme	
18	Directional O/C & earth fault element	
18.1	Whether provided as in-built of numerical distance relay:	
18.2	Its setting range	

SUBMISION OF GTP AGAINST LOA REF:		<TO BE FILLED BY THE BIDDER>
NAME OF THE BIDDER		<TO BE FILLED BY THE BIDDER>
SL	DESCRIPTION	SUBMISSION
18.3	Whether contact for carrier inter tripping from the DEF relay is provided	
19	Accuracy :	
19.1	Zone 1 reach	
19.2	Zone 2 reach	
19.3	Zone 3 reach	
19.4	Zone timer unit	
19.5	Angular reach	
20	Operating time for fault at 50% of zone 1 set with CVT on line side and with :	
20.1	SIR = 4	
20.2	SIR = 15	
21	Accuracy due to variation of frequency (+/- 5%)	
22	Setting range of residual compensation	
23	Trip contact ratings	
23.1	Make and carry continuously	
23.2	Make and carry for 0.5 sec.	
23.3	Break :	
23.3.1	Resistive load	
23.3.2	Inductive load (with L/R = 40)	
24	No.of B/Is & B/Os	
25	Details of Man Machine interface both for local and remote control and monitoring provided such as serial communication protocol, communication speed, LAN compatible, type of connectors etc.	
26	Additional functions provided in the relay which are not specified in the specification	
	AUTO RECLOSE RELAY (Built-in feature of Numerical Distance Relay)	
1	Suitable for single and three phase auto re-closing.	
2	Single phase dead time setting range	
3	Three phase dead time setting range	
4	Reclaim time setting range	
5	Whether check synchronising and dead line charging relays included as a part of the auto reclose scheme	

SUBMISION OF GTP AGAINST LOA REF:		<TO BE FILLED BY THE BIDDER>
NAME OF THE BIDDER		<TO BE FILLED BY THE BIDDER>
SL	DESCRIPTION	SUBMISSION
6	Whether four position selector switch is included ?	
7	Whether single shot?	
	FAULT LOCATORS (Built-in feature of Numerical Distance Relay)	
1	Triggering Method	
2	Rate of sampling per cycle	
3	A/D converter bit resolution	
4	Whether following fault information provided in displaying unit	
4.1	Distance to fault location reach in Km	
4.1.1	Resistive detection	
4.1.2	Reactive detection	
4.2	Faulted Phase	
4.3	Time of Fault	
4.4	Date of Fault	
5	Whether mutual compensation of D/C line provided	
6	Maximum registering time	
7	Whether direct display unit provided ?If so, details to be given	
8	Accuracy	
J	NUMERICAL TRANSFORMER DIFFERENTIAL RELAYS	
1	Name of Manufacturer	
2	Type and Designation	
3	Conforming Standard (Whether latest IEC 61850 compliant)	
4	Current Rating	
5	Operating setting range	
6	Bias setting range	
7	No.of B/Is & B/Os	
8	Whether ICT required	
9	Display	
10	Detail of Man-machine Interface both for Local & Remote control and monitoring provided	
11	Speed of Operation of Relay	

SUBMISION OF GTP AGAINST LOA REF:		<TO BE FILLED BY THE BIDDER>
NAME OF THE BIDDER		<TO BE FILLED BY THE BIDDER>
SL	DESCRIPTION	SUBMISSION
12	Setting of instantaneous element	
13	Type and scheme for second and fifth harmonic restrain	
14	Contact rating :	
14.1	Make and carry continuously	
14.2	Make and carry for 0.5 sec.	
14.3	Break :	
14.3.1	Resistive load	
14.3.2	Inductive load with 40 millisec time constant	
15	Additional function & feature provided in the Relay which are not specified in the specification	
K	TRANSFORMER OVERFLUXING RELAY	
1	Name of Manufacturer	
2	Type and Designation	
3	Conforming Standard	
4	Rated voltage and frequency	
5	Rated DC voltage	
6	Solid state or Electro mechanical	
7	Thermal Withstand Rating	
8	Number of Contacts	
8.1	Normally open	
8.2	Normally closed	
9	Contacts - Self reset	
10	Rated Burden at highest and lowest tap	
11	Operating indicator provided ?	
12	Contact Ratings :	
12.1	Make and carry continuously	
12.2	Make and carry for 0.5 sec.	
12.3	Break	
12.3.1	Resistive Load	
12.3.2	Inductive Load (with L/R = 40)	
13	Setting ranges :	
13.1	V/F	
13.2	Time for alarm	
13.3	Time for tripping	

SUBMISSION OF GTP AGAINST LOA REF:		<TO BE FILLED BY THE BIDDER>
NAME OF THE BIDDER		<TO BE FILLED BY THE BIDDER>
SL	DESCRIPTION	SUBMISSION
L	NUMERICAL OVERCURRENT & EARTH FAULT RELAYS - NON-DIRECTIONAL / DIRECTIONAL :	
1	Name of Manufacturer	
2	Type and Designation	
3	Conforming Standard (Whether latest IEC 61850 compliant)	
4	Rated current	
5	Rated AC voltage (Directional Relay only)	
6	Rated DC voltage	
7	Operating Principle	
8	Thermal Withstand Rating	
9	Number of B/Is & B/Os	
10	Contacts - Latched/Unlatched/Programmable	
11	Burden	
12	Operation indicator provided ?	
13	Contact Ratings	
13.1	Make and carry continuously	
13.2	Make and carry for 0.5 sec.	
13.3	Break :	
13.3.1	Resistive Load	
13.3.2	Inductive Load (with L/R = 40)	
14	Operating characteristics	
15	Current unit setting range	
15.1	Inverse time	
15.2	High set inst.unit	
16	Characteristic angle for Directional Relay	
M	<u>Additional features applicable for numerical relays only</u>	
1	Whether self supervision and diagnostic feature available	
2	Whether potential free change over contact for annunciation in the event of internal failure	
3	Whether password protection available for setting change etc.	

SUBMISION OF GTP AGAINST LOA REF:		<TO BE FILLED BY THE BIDDER>
NAME OF THE BIDDER		<TO BE FILLED BY THE BIDDER>
SL	DESCRIPTION	SUBMISSION
4	Number of binary inputs & outputs available	
5	Whether LED indication available for visual annunciation of different types of faults	
6	Current and time setting range & steps	
7	Whether separate IVT is required for derivation of zero sequence voltage in Directional relays	
DISTURBANCE RECORDERS (Built-in feature of Numerical Distance Relay)		
1	Number of channels provided for analog recording	
2	Number of channels provided for event recording	
3	Time of recording prior to event	
4	Duration of recording after the event	
5	By how many nos. can the channels be expanded :	
5.1	Analog Channel	
5.2	Event Channel	
6	Whether all starting sensor Provided?	
7	Linearity Error	
8	Memory :	
8.1	Pre fault in ms	
8.2	Post fault in sec.	
9	Frequency Response	
10	Resolution of the event channel (ms)	
11	Resolution :	
11.1	Time	
11.2	Amplitude	
12.1	Whether facility provided for downloading of station identification code along with date & time	
12.2	If yes mention the programmable character length (nos.) available	
13	Details of arrangements for date & time marking	

SUBMISION OF GTP AGAINST LOA REF:		<TO BE FILLED BY THE BIDDER>
NAME OF THE BIDDER		<TO BE FILLED BY THE BIDDER>
SL	DESCRIPTION	SUBMISSION
N	RESTRICTED EARTH FAULT RELAY / CIRCULATING EARTH FAULT PROTECTION	
1	Name of Manufacturer	
2	Type and Designation	
3	Conforming Standard	
4	Rated current	
5	Rated DC voltage	
6	Operating principle	
7	Solid state or Electro mechanical	
8	Thermal Withstand Rating	
9	Number of Contacts and ratings	
10	Contacts - Self reset/hand reset	
11	Burden	
12	Operation indicator provided ?	
13	Contact Ratings	
13.1	Make and carry continuously	
13.2	Make and carry for 0.5 sec.	
13.3	Break	
13.3.1	Resistive Load	
13.3.2	Inductive Load (with L/R = 40)	
14	Setting range	
15	Operating Time	
16	Whether tuned to system frequency	
17	Value of stabilising resistor	
18	Particulars of non-linear resistor	
O	NUMERICAL BUS BAR PROTECTION SCHEME	
1	Name of Manufacturer	
2	Type and Designation	
3	Conforming Standard (Whether latest IEC 61850 compliant)	
4	Rated current	
5	Rated DC voltage	
6	Operating principle (Distributed architecture or Central architecture)	
7	Maximum no of bays can be incorporated in the scheme	

SUBMISION OF GTP AGAINST LOA REF:		<TO BE FILLED BY THE BIDDER>
NAME OF THE BIDDER		<TO BE FILLED BY THE BIDDER>
SL	DESCRIPTION	SUBMISSION
8	Suitable for 2 Main & 1 Transfer bus or not	
9	Operation – Low impedance/High Impedance:	
10	% Biasing	
11	Thermal Withstand Rating	
12	Number of Contacts :	
12.1	Normally open	
12.2	Normally closed	
13	Contacts - Self reset	
14	Burden	
15	Operation indicator provided ?	
16	Contact Ratings :	
16.1	Make and carry continuously	
16.2	Make and carry for 0.5 sec.	
16.3	Break :	
16.3.1	Resistive Load	
16.3.2	Inductive Load (with L/R = 40)	
17	Operating time	
18	Setting ranges	
19	Transient free in operation ?	
20	Particulars of end zone protection	
21	Particulars of CT secondary open circuit protection	
22	Does the scheme give 100% security and reliability during all system operating conditions	
23	Through fault stability	
P	CIRCUIT BREAKER FAILURE RELAY	
1	Name of Manufacturer	
2	Type and Designation	
3	Conforming Standard	
4	Rated current	
5	Rated DC voltage	
6	Operating principle	
7	Solid state or Electro mechanical	
8	Thermal Withstand Rating	
9	Number of Contacts :	
9.1	Normally open	

SUBMISION OF GTP AGAINST LOA REF:		<TO BE FILLED BY THE BIDDER>
NAME OF THE BIDDER		<TO BE FILLED BY THE BIDDER>
SL	DESCRIPTION	SUBMISSION
9.2	Normally closed	
10	Burden	
11	Operation indicator provided ?	
12	Contact Ratings :	
12.1	Make and carry continuously	
12.2	Make and carry for 0.5 sec.	
12.3	Break :	
12.3.1	Resistive Load	
12.3.2	Inductive Load (with L/R = 40)	
13	Operating time	
14	Resetting time	
15	Setting range :	
15.1	Current	
15.2	Time	
Q	TRIP CIRCUIT SUPERVISION RELAY	
1	Name of Manufacturer	
2	Type and Designation	
3	Conforming Standard	
4	Rated DC voltage	
5	Operating principle	
6	Electro mechanical	
7	Thermal Withstand Rating	
8	Number of Contacts :	
8.1	Normally open	
8.2	Normally closed	
9	Contacts - self reset	
10	Burden	
11	Operation indicator provided ?	
12	Contact Ratings :	
12.1	Make and carry continuously	
12.2	Make and carry for 0.5 sec.	
12.3	Break :	
12.3.1	Resistive Load	
12.3.2	Inductive Load (with L/R = 40)	
13	Whether pre-closing and post closing supervision provided ?	
14	Time delay	

SUBMISION OF GTP AGAINST LOA REF:		<TO BE FILLED BY THE BIDDER>
NAME OF THE BIDDER		<TO BE FILLED BY THE BIDDER>
SL	DESCRIPTION	SUBMISSION
R	UNIVERSAL TYPE AUXILIARY CTs AND VTs :	
1	Name of Manufacturer	
2	Type and Designation	
3	Conforming Standard	
4	Ratio	
5	Rated output VA	
6	Class of accuracy	
7	Short time rating :	
7.1	Current	
7.2	Voltage	
8	Knee point voltage for Class `PS'	
9	Excitation current for Class `PS'	
9.1	KPV	
9.2	50 Percent KPV	
10	Internal resistance of	
10.1	Primary	
10.2	Secondary	
11	Temperature rise	
12	Mounting details	
13	Overall dimensions	
14	Any other details	
S	MASTER TRIP RELAY	
1	Name of Manufacturer	
2	Type and Designation	
3	Conforming Standard	
4	Rated DC voltage	
5	Electro mechanical	
6	Whether Electrical Reset (Yes/No)	
7	Thermal Withstand Rating	
8	Number of Contacts :	
8.1	Self Reset	
8.2	Hand Reset	
9	Burden	
10	Operation indicator provided ?	
11	Contact Ratings :	
11.1	Make and carry continuously	
11.2	Make and carry for 0.5 sec.	

SUBMISION OF GTP AGAINST LOA REF:		<TO BE FILLED BY THE BIDDER>
NAME OF THE BIDDER		<TO BE FILLED BY THE BIDDER>
SL	DESCRIPTION	SUBMISSION
11.3	Break :	
11.3.1	Resistive Load	
11.3.2	Inductive Load (with L/R = 40)	
12	Operating Time	
T	OVER VOLTAGE RELAY	
1	Name of Manufacturer	
2	Type and Designation	
3	Conforming Standard	
4	Rated Auxuliary DC voltage	
5	Solid state or Electro mechanical	
6	Rated AC Voltage & Frequency	
7	Setting Range (Voltage & Time)	
7.1	for First Stage	
7.2	for Second Stage	
8	Drop-Off to Pick-Up ratio	
9	Burden	
10	Operation indicator provided ?	
11	No. of Output Contacts for each Phase	
12	Contact Ratings :	
12.1	Make and carry continuously	
12.2	Make and carry for 0.5 sec.	
12.3	Break :	
12.3.1	Resistive Load	
12.3.2	Inductive Load (with L/R = 40)	