GUJARAT ENERGY TRANSMISSION CORPORATION LTD.

SARADAR PATEL VIDYUT BHAVAN,
RACE COURSE, BARODA – 390 007.

TECHNICAL SPECIFICATIONS

FOR

400 / 220 /132/ 66/ *33* & 11 kV CONTROL & PROTECTION PANELS for Sub Station with SCADA

GETCO / E / TS- SCP 3703 / *R5, June 2022*

Blank

Blank

SECTION –I I

SPECIFICATION FOR CONTROL & PROTECTION PANELS

1 SCOPE

The scope covers supply of 400/220/132/66/33 & 11 kV control and protection panels, duly incorporating required Relays/IEDs as per Annexure-I* for following types of applications, as mentioned in respective tender,

a) 400/220/132/66/33 kV feeders
b) 400/220 kV, 220/33 kV, 220/11kV, 220/66 kV, 220/132 kV, 132/66 kV, 132/11 kV,66/11 kV, 33/11kV Auto/Two winding transformers
c) 400/220/132/66/33 kV Bus coupler/ Bus section
d) 400/220/132 kV Transfer bus coupler
e) 400/220 kV Reactor
f) 400/220/132 kV Bus bar

including design, Engineering, manufacturing of Control & Protection panels, configuration, erection, testing, commissioning, integration with Substation Automation System and training.

*For BCU and BCPU i. e. Bay Control & Protection Relays separately attached specifications shall be referred.

*For Energy meter, separately attached specifications shall be referred.

The detailed scope for two kinds of modalities viz. i) through EPC contract and ii) through direct tender is as follows.

1.1 SCOPE for *(Control & Protection Panel supply – Through EPC Contract)*

When the above panels are required to be supplied through EPC contract with GETCO, the scope of EPC contractor shall be as follow.

1.1.1 Following activities shall be got executed in coordination with Relay/IED OEM.

a. To ensure and understand complete design and engineering of schematics and drawing preparation as per respective bay type and its configuration from OEMs of Relays/IEDs.
b. To understand and validate drawings and documents prepared by OEM as per project requirement before submission to GETCO. List fo drawings are mentioned in clause No. 5.1.1.

c. To understand and ensure design, fabrication and manufacturing of complete Control & Protection panels as per clause 5.1.2.
d. To understand and ensure design and manufacture of IEDs/Relays and IED/Relay assemblies to meet the requirements of various Control & Protection schemes as per approved drawings.
e. To ensure and coordinate for delivery of all required Relays/IEDs from OEM for providing of Relays/IEDs along with all other necessary panel auxiliaries components/equipments as per clause 5.1.3 & 5.1.5.
f. To ensure configuration of Relays/IEDs for protection as well as substation automation aspects and database creation for integration in SAS at manufacturer's works.
g. To coordinate and ensure integration of Control & Protection panels in Substation Automation System as per approved drawings/documents.
h. To coordinate and ensure integrated testing of Control & Protection panels as per clause no. 5.1.8 at manufacturer's works before offering the inspection.
i. To coordinate and witness inspection for integrated testing of Control & Protection panels as per approved FAT procedures at manufacturer's works.
j. To ensure dispatch of completely assembled, tested and configured Control & Protection panels at site.

Following activities shall be carried out at site in coordination with OEMs of Relays/IEDs.

1.1.2 Installation of control & protection panels in Yard Kiosk/Control room as per approved drawings.

1.1.3 Preparation of wiring schedule and thereby wiring & termination of external cabling in Control & Protection panels to establish all necessary interfaces as per approved drawings.

1.1.4 Connection of all Relays/IEDs to SAS network, through Ethernet switch, as per approved SCADA system architecture, in coordination with OEMs of Relays/IEDs.

1.1.5 Testing of complete Control & Protection panels at site in due coordination with OEMs of Relays/IEDs as well as purchaser as per clause No. 5.1.10.

1.1.6 Imparting training from appropriate trainer of OEMs of Relays/IEDs as per clause No.12 (if specified in schedule-A).

1.1.7 Supply and service support as per clause no 16.

1.2 SCOPE *(Control & Protection Panel supply – Through direct tender)*

When the above Control & Protection panels are required to be supplied through direct tender to GETCO, the scope of the bidder shall be as follow.

1.2.1 Complete design and engineering for schematics and drawing preparation for respective bay type and its configuration.

1.2.2 Submission of drawings of the offered Control & Protection panels as per clause no. 5.1.1.

1.2.3 Design, fabrication and manufacturing of complete Control & Protection panels as per clause no. 5.1.2.

1.2.4 To ensure and coordinate delivery of all required Relays/IEDs from OEM for providing of IEDs/Relays along with all other necessary panel auxiliaries components/equipments as per approved drawings

1.2.5 Design and manufacture of IEDs/Relays and IED/Relay assemblies including wiring of complete Control & Protection panel as per clause no. 5.1.3 & 5.1.5.

1.2.6 Configuration of Relays/IEDs for protection as well as substation automation aspects and database creation for integration in SAS at works.

1.2.7 Integration of Control & Protection panels into Substation Automation System existing / to be supplied in all respect as per approved drawings/documents.

1.2.8 Integrated testing of Control & Protection panels as per clause no. 5.1.8 at works before offering the inspection.

1.2.9 Inspection for integrated testing of Control & Protection panels, as per approved FAT procedures, at manufacturer's works.

1.2.10 Dispatch of completely assembled, tested and configured Control & Protection panels at site.

1.2.11 Testing of complete Control & Protection panels at site, in due coordination with purchaser / EPC contractor, as per clause No. 5.1.10.

1.2.12 Imparting training for offered items, as per clause No.12 (if specified in schedule-A).

1.2.13 Supply and service support as per clause no 16.

It is not the intent to specify completely all the details of the design and construction of equipment. However, the Control & Protection panel shall conform in all respects to high standards of engineering, design and

workmanship and shall be capable of performing continuous commercial operation up to the specified guarantee period as mentioned in clause no. 9 of the specification. In a manner, acceptable to the purchaser, who will interpret the meaning of drawings and specifications, and shall have the power to reject any work of material which, in his judgment is not in accordance therewith. The offered Control & Protection panel shall be complete with all components necessary for their effective successful and trouble free operation. All such components shall be supplied without any limitation whether it is a part of specification /purchase order or not.

2 SCHEDULE OF REQUIREMENT:

2.1 The type of Control & Protection Panels to be supplied and their required deliveries shall be as mentioned in schedule-A of respective tender.

2.2 The delivery instructions shall be issued to the successful bidder/s after successful inspection and testing of panels at manufacturer's works.

3. STANDARDS:

3.1. Unless otherwise specified elsewhere, in this specification, the rating, performance and testing of Control & Protection Panels, Relays/IEDs and accessories shall confirm to the latest revisions, available of all relevant standards listed in Annexure – II.

3.2. The equipment shall also comply the latest revision of Indian Electricity Act and Indian Electricity Rules and any other applicable statutory provisions, rules and regulations applicable in the locations where these are to be installed.

4. PRINCIPAL TECHNICAL PARAMETERS:

The Control & Protection Panels covered in this specification shall have the technical requirements as listed in Clause 5 and its sub clauses.

The Relays/IEDs covered in this specification shall have to fulfill all the technical requirements as listed in **Annexure – III.**

5. GENERAL TECHNICAL REQUIREMENTS:

5.1. SCOPE OF WORK

5.1.1. The successful bidder shall have to prepare and furnish following drawings (as per clause No.10) based on design and engineering as per specification requirement for approval.

I. Panel Construction
II. Panel General Arrangement (Front, Internal, Rear)
III. Bill of Quantity
IV. Schematic drawings

V. Wiring schedules

5.1.2. Design and fabrication of complete Control & Protection panels as per approved drawings with provision for mounting all the associated equipments/components.

5.1.3. Supply and mounting of all Relays/IEDs, Relays/IEDs assemblies, equipment, accessories etc. together with all auxiliary equipment and materials in Control & Protection panel as per approved drawings.

5.1.4. The bidder shall indicate make, type, rating & technical description of all equipments, accessories provided.

5.1.5. Complete internal wiring of above panels as per approved drawings shall be carried out. Provision and carrying out of wiring between adjacent panels shall also be considered.

The manufacturing of the Control & Protection panels shall be strictly in accordance with the approved drawings and Quality assurance plan.

5.1.6. Type of Relays/IEDs required for different types of Control & Protection panels shall be as per Annexure – I.

5.1.7. Integrated testing of Control & Protection panels along with all IEDs/ Relays, equipment/components as per approved FAT procedures and furnishing of routine test reports as per clause no. 6.2 before offering the material for inspection.

5.1.8. Testing and commissioning of Control & Protection panels at site along with integration in existing / to be supplied Substation Automation System as per approved SAT procedures as per clause No. 13 & 18.

5.1.A DETAILS OF INSTRUMENT TRANSFORMRS

a) 400 KV CURRENT TRANSFORMERS

Sr. No.	Parameter	**Core - I**	**Core - II**	**Core - III**	**Core - IV**	**Core - V**
1	Ratio 2000-1000-500/	1 A	1 A	1 A	1 A	1 A
2	Rated Burden	---	---	40	---	---
3	Class of Accuracy	PS	PS	0.5	PS	PS
4	Accuracy Limit	---	---	ISF < 5	---	---

	Factor					
5	Min KPV (Vk)	4000 at 2000/1	4000 at 2000/1	---	2000 at 2000/1	2000 at 2000/1
6	Max I_{ex} at VK/2	30 on 2000/1,60 on 1000/1, 120 on 500/1	30 on 2000/1,60 on 1000/1, 120 on 500/1	---	30 on 2000/1,60 on 1000/1, 120 on 500/1	30 on 2000/1,60 on 1000/1, 120 on 500/1
7	Rsec (Ω)	10/5/2.5	10/5/2.5	10/5/2.5	10/5/2.5	10/5/2.5
8	Purpose	Trf / Line Main - 1	Trf / Line Main - 2	Metering	Bus Bar Protection	Bus Bar Protection

b) 220/132 KV CURRENT TRANSFORMERS HAVING

Sr. No.	Parameter	**Core - I**	**Core - II**	**Core - III**	**Core - IV**	**Core - V**
1	Ratio 1200-600-300/	1 A	1 A	1 A	1 A	1 A
2	Rated Burden	30	---	---	---	---
3	Class of Accuracy	0.5	5P	PS	PS	PS
4	Accuracy Limit Factor	ISF < 5	20	---	---	---
5	Min KPV (Vk)	---	---	1400 at 1200/1	1400 at 1200/1	1400 at 1200/1
6	Max I_{ex} at VK/2	---	---	25	25	25
7	Rsec (Ω)	---	---	< 12	< 12	< 12
8	Purpose	Instrumentation	O/C-E/F Protection	Main – I Protection	Main – II Protection	Bus Bar Protection

c) 66 KV CURRENT TRANSFORMERS HAVING

Sr. No.	Parameter	**Core - I**	**Core - II**	**Core - III**
1	Ratio 1200 - 600 / 600 - 300 / 150 -100	1 A	1 A	1 A
2	Rated Burden	15	15	---
3	Class of Accuracy	0.2	5P	PS
4	Accuracy Limit Factor	ISF < 5	10	---
5	Min KPV (Vk)	---	---	600 /

				650 / 650V
6	Max I_{ex} at Vk	---	---	25
7	Rsec (Ω)	---	---	< 10
8	Purpose	Instrumentation	O/C-E/F Protection	Differential Protection

d) 400 KV CVT

Sr. No.	Parameter	**Core - I**	**Core - II**	**Core - III**
1	Ratio	400/√3 KV / 110/√3 V	400/√3 KV / 110/√3 V	400/√3 KV / 110/√3 V
2	Thermal Burden	200 VA	200 VA	100 VA
3	Class of Accuracy	3P	3P	0.2
4	Purpose	Protection	Protection	Instrumentation

e) 220 CVT HAVING

Sr. No.	Parameter	**Core - I**	**Core - II**
1	Ratio	220/√3 KV / 110/√3 V	220/√3 KV / 110/√3 V
2	Thermal Burden	50 VA	50 VA
3	Class of Accuracy	0.2	3P
4	Purpose	Instrumentation	Protection

f) 220/132KV PT

Sr. No.	Parameter	**Core - I**	**Core - II**	**Core - II**
1	Ratio	(220or132)/√3KV / 110/√3 V	(220or132)/√3KV / 110/√3 V	(220or132)/√3 KV / 110/√3 V
2	Thermal Burden	250 VA	250 VA	250 VA
3	Class of Accuracy	0.5	3P	3P
4	Purpose	Instrumentation	Protection	Protection

g) 66KV PT

Sr. No.	Parameter	**Core - I**	**Core - II**
1	Ratio	66/√3 KV / 110/√3 V	66/√3 KV / 110/√3 V
2	Thermal Burden	100 VA	200 VA
3	Class of Accuracy	0.5	3P
4	Purpose	Instrumentation	Protection

5.1.B PARITCULARS OF POWER TRANSFORMERS

The details of power transformers to be protected and/or ICTs viz. Rating, Winding type, Vector Group etc for respective s/s shall be provided by GETCO to the successful bidder during ~~for~~ detailed engineering.

5.1.C D C DISTRIBUTION AND DC SUPERVISION

1. Main Incoming DC supply required for Control & Protection panel shall be provided through 32A DC MCB from two independent sources. 220/110V DC distribution for the Control & Protection Panels shall be such that separate sub – circuits with suitable rating HRC Fuse shall be provided. Typical distribution shall be as per following

DC Source -1	DC Soure-2
Distance M-I /Differential protection & 86A	Distance M-II /REF protection & 86B
BCU/BCPU & VT Selection	O/C-E/F protection
REF LV	Bus bar protection
Direct trip-1 (If mentioned)	Direct Trip-2 (If mentioned)
Trf/Reactor trouble GR-A	Trf/Reactor trouble GR-B
CB Closing & TC-1	CB TC-2
LBB trip relay	Isolator & E/S Control/Interlocking
Energy meter data converter supply	Ethernet switch

2. DC supervision shall be provided to supervise continuously the DC supply. The scheme shall be suitable to work on 220/110 VDC supply from the station battery, and shall have position for alarm.

3. Auxiliary relays used for the DC supervision scheme shall have adequate number of elements (minimum ***4*** nos.) with suitable self-reset type operation indicators wherever applicable.

4. Two independent DC sources are used to have independent working of M1 and M2 protection, independently. The scheme shall be designed to operate two group of relays on separate battery and if required all relays i.e. two groups can be connected on either of DC source by auto change over scheme through relays/contactors having operating time less than relay DC interruption sence time.

5.2. SIZE AND GENERAL DIMENSIONS REQUIREMENTS

5.2.1. Control & Protection Panels: The panels shall be `Simplex' type front operated with swing frame front door. Control & Protection panels shall be front openable only. The overall panel dimensions shall be 2312mm H (Height) (including base channel) x 750mm D (Depth) x 900mm W (Width) [with ± 10 mm tolerance].

5.2.2. The Control & Protection Panels shall be modular rack mounting type consisting of standard width racks, in accordance with the IEC – 60297.The Control & Protection Panel shall have full transparent (Perspex) front door with lockable handle, in addition to main front swing frame door. Ancillary components like switches, pushbuttons etc whenever needed, for protection schemes shall be installed on plates suitable for mounting in racks.

5.2.3. GENERAL REQUIREMNT FOR CONTROL & PROTECTION PANEL

5.2.3.1. The slots for inter panel wiring shall be spaced at 300mm from top of the side panel and their size shall be 80mm (H) x 300mm (W).

5.2.3.2. Panels shall be completely metal enclosed and shall be dust, moisture and vermin proof without louvers to meet the requirement to IP-54 as per IS 60947-1 (latest version)/ IEC 60529.

5.2.3.3. The panels shall be free standing, floor mounting type and shall comprise rigid, welded structural frame enclosed completely with specially selected, smooth finished cold rolled sheet steel of thickness not be less than 3.0 mm for load bearing members (front panel, base frame, door frame, gland plates) and 2.0 mm for non-load bearing members (side panel, cubicle roof, door). The panel structure shall be mounted on 100 mm base channel [with ± 5 mm tolerance] as well as 15 mm antivibration pad. The minimum thickness of base channel shall not be less than 3.0 mm. There shall be sufficient reinforcement to provide level surfaces, resistance to vibration, and rigidity during transportation and installation. There shall be proper lifting arrangement of panel by providing lifting eye bolts at top (at all corners).

5.2.3.4. All doors and removable covers shall be gasketed all-round as per IP-54 type test report.

5.2.3.5. Control & Protection panels shall be installed either in air-conditioned prefabricated Kiosks (suitably located in switchyard) or in air-conditioned control room as per respective tender.

5.2.3.6. Design, material selection and workmanship shall be such as to result in neat appearance inside and outside with no weld, rivets or bolt heads apparent from outside and with all exterior surface true and smooth.

5.2.3.7. Purchaser's external cable connection will be terminated on the terminal blocks to be provided by the bidder in Control &

Protection Panels. Cable entries to the panels shall be from the **two numbers** of screwed type removable bottom gland plates of the panel covering panel cut outs of **size** 350mm x 200mm with punched hole for suitable size cable glands.

5.2.3.8. Bay wise Bay Control Unit* i.e. BCU, Breaker control switch, Energy meter, Numerical protective relays as per Annexure-I along with required Auxiliary / Multiplication /Tripping / Supervision Relays & Push Buttons shall be accommodated in Control & Protection Panels for 400, 220 & 132KV Bays.

5.2.3.9. In case of AIS Bay Control & Protection Relays (IEDs)* i. e. BCPU, Breaker control switch, Energy meter, Numerical protective relays as per Annexure-I along with required Auxiliary / Multiplication / Tripping / Supervision Relays & Push Buttons for 2 nos. of bays shall be accommodated in one Control & Protection Panel for 66KV Bays.

5.2.3.10. In case of GIS or Hybrid switchgear modules; BCU, Breaker control switch, Energy meter, Numerical protective relays as per Annexure-I along with required Auxiliary / Multiplication / Tripping / Supervision Relays & Push Buttons for individual bays shall be accommodated in one Control & Protection Panel for 66KV Bays.

5.3. LABEL

5.3.1. Labels shall be made of Aluminum anodized plate P.V. Castings. Labels shall have white letters on black background. All Relays/IEDs shall be given standard abbreviation with name of device, corresponding to the ones shown in the panel internal wiring.

5.3.2. All front mounted equipment as well as equipment mounted inside the panels shall be provided with individual labels with equipment designation engraved. The labels shall be mounted directly below the respective equipment. Label with large and bold letters engraved with panel designation shall be provided at the top of each panel on front and rear side. Label shall contain following details.

i. Bay name e.g. ***220 kV GONDAL –JETPUR Line No.1***

5.3.3. All the front mounted equipment shall also be provided with legends corresponding to the ones shown in the panel internal wiring to facilitate each tracing of wiring. These labels shall be mounted directly below the respective equipments and shall not be got hidden by the equipment wiring.

5.3.4. Each switch shall bear clear inscription identifying its function e.g. `BREAKER', 52A, etc. Similar inscription shall also be provided on each device whose function is not other-wise identified. If any switch

device does not bear this inscription separate name plate giving its function shall be provided for it. Switch shall also have clear inscription for each position indication e.g. `Trip – Neutral – Close', `ON-OFF', `R-Y-B-OFF' etc.

5.3.5. Control & Protection panel shall be provided with name plate marked with following details.

a) Name of item
b) Name of manufacturer
c) Order details
d) Serial No and/or type of designation making it possible to get all relevant information from manufacturer
e) Year of manufacturing
f) DC Auxiliary voltage
g) Bus bar configuration
h) Type of application
i) Property of GETCO

5.4. CONTROL SWITCHES

5.4.1. Control switch shall be rotary type provided with escutcheon plates clearly marked to show operating position and suitable for flush mounting with only the switch front plate and operating handle projecting out. The connections shall be from the rear. The contact assembly at the back of the switch shall be enclosed in dust tight removable covers. The access to the contacts shall be from the back by the removal of the cover. Contact assembly shall be smooth enough for operations.

5.4.2. Breaker control switch of "3 position spring return to neutral" type shall be provided. The control springs shall be strong and robust enough to prevent inadvertent operation due to light touch. The spring return type switch shall have spring return from close and trip position to `After Close' and `After Trip' positions respectively. The handle or base for breaker control switch shall have "RED COLOUR".

5.4.3. Contacts of the switch shall be spring assisted and contact faces shall be silver plated. Spring shall not be used as current carrying parts. The contacts of all switches shall preferably open and close with snap action to minimize arcing. The contact rating of the switches shall be as follows:

Sr. No.	Description	Contact rating in Amps.		
		240V	110VDC	220VDC
a)	Make and carry continuously	25A	25A	25A
b)	Make and carry for 0.5 sec.	30A	30A	30A
c)	1) Resistive load	7A	7A	3A

	2) Inductive load with L/R = 40msec.	7A	5A	2A

5.5. Panel Internal Wiring

5.5.1. All internal wiring shall be carried out with use of 1100V grade single core, multi strand flexible copper conductor wires covered with PVC insulation and shall be flame retardant FRLS type, vermin and rodent proof. The current carrying capacity of wire shall be adequate for the duty assigned to it considering short circuit condition and shall have sufficient flexibility to facilitate proper termination at any location. Colour coded wires (red, yellow, blue, black, green) shall be used for R-Y-B Phase, neutral and earthing respectively for CT, VT and CVT secondary connections. The size of flexible copper PVC wire conductor used for internal wiring shall be as follows:

a) All circuits except instrument transformer circuit shall be of 1.5 Sq mm
b) CT circuit - one 2.5 Sq mm
c) VT circuits one 1.5 Sq mm
d) Energy metering - 2.5 Sq mm for both PT & CT circuits.

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

5.5.3. The wire numbers shown in the wiring diagram shall be in accordance with IS375/BS152/BS156. All wires directly connected to trip circuit breaker trip coils shall be distinguished by addition of a red colored “T” lettered ferrule.

5.5.4. Panel wiring shall be securely supported, neatly installed by proper lacing and tying, readily accessible and connected to equipment terminals and terminal blocks. Flame retardant, plastic wiring channels/troughs with strap on plastic covers shall be used for this purpose. Sufficient space in channel for modification of wiring shall be kept.

5.5.5. Accidental short circuiting of certain wires is likely to result in malfunction of equipment, such as closing or tripping of a breaker or positive and negative wires, such wires shall not be terminated on adjacent terminal blocks.

5.5.6. The unused space on the front or rear of the panels shall be kept clear of wiring to facilitate addition of devices without rewiring associated portion of the panels.

5.5.7. Wire termination shall be made with solder less crimping type of tinned copper lugs which firmly grip the conductor. Insulation sleeves shall be provided at all the wire terminations. Engraved core identification machine printed tubular 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 from terminal blocks.

5.5.8. The bidder shall be responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipment. To ensure this, intermediate internal checks shall be carried out.

5.5.9. Terminations on Terminal Blocks shall be grouped as per function as per clause no. 5.8 on one region of T.B. (may not be full T.B) so as to ease to take outlet connections, in one cable for the function.

5.6. Interior Lighting

5.6.1. The Control & Protection panel shall be provided with 11 W, LED tube with fixture including reflector, front cover, etc. The voltage rating shall be 240 Volts, 50 Hz, AC supply. The LED shall be operated by door operated switch.

5.6.2. The panel shall be provided with 240V, 50Hz. 15 A, multi pin universal socket with switch duly fitted in industrial casing mounted inside the panel at easily approachable convenient.

5.7. Earthing

5.7.1. Each panel shall be provided with earth bus of copper strip, having minimum cross section of 25 x 6 sq mm, securely fixed along with inside base of panels throughout the panel width. It shall be provided with M4 holes and Nuts & Bolts at a distance of 100mm. Since several panels are to be mounted adjoining to each other, the earth bus shall be made continuous by providing earth bus coupling links of 25x6 sq.mm copper at both the ends of earth bus along with necessary nuts and bolts. The earth bus coupling links shall be utilized to extend earth bus to future adjoining panels or purchaser's earth grid.

5.7.2. All metallic cases of relays, instruments and other mounted equipment shall be connected to earth bus directly without any looping to any other equipments/components by using insulated copper wires of size not less than 2.5 sq. mm. The colour of the earthing wire shall be green.

5.7.3. VT, CVT and CT secondary neutral or common lead shall not be earthed at panel. Such earthing shall be made through links, at bay marshalling kiosks only so that earthing may be removed from one

group without disturbing continuity of earthing systems for other group.

5.8. Terminal blocks

5.8.1. Terminal blocks shall be 800V grade, 45 amps rated as per IEC 60947-7-1, single piece molded, complete with insulated barriers, stud type, melamine housed brass terminals, washers, brass nuts and brass lock nuts and identification strips. Markings on the terminals strips shall correspond to wire number on the wiring diagrams. Not more than 2 wires shall be connected on any single side of terminals.

5.8.2. Terminal blocks for CT, CVT and VT secondary leads shall be provided with test links and isolating facilities. CT secondary wiring shall be such that it can connect additional circuit in series.

5.8.3. Minimum 20% spare terminals shall be provided in each panel duly distributed uniformly on all terminal blocks, near each group of connections for function wise circuits.

5.8.4. All spare contacts and terminals of the panel mounted equipment and devices shall be wired up to terminal blocks with ferrule numbers starting with U.

5.8.5. Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors of purchaser's cables on each side.

5.8.5.1. All DC and auxiliary AC circuits -- minimum one of 2.5mm^2 copper.
5.8.5.2. All CT & PT circuits -- minimum two of 4 mm^2 copper.

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

5.8.7. Terminal blocks to be used shall be self extinguishing or resistant to flame propagation, substantially non hydroscopic and shall not carbonize when tested for tracking. The insulation between any terminal and frame work between adjacent terminals shall with stand test of 2 kV rms for one minute. The molding shall be mechanically robust to withstand handling while making terminations.

5.8.8. Easily removable Protective transparent plastic covers of appropriate size shall be provided for placing over the live parts of the terminal blocks.

5.9. Painting

5.9.1. All CR sheet steel work shall be phosphated in accordance with the following procedures and in accordance with IS; 6005 `Code of Practice for phosphating iron and steel'.

5.9.2. Oil, grease, dirt and swart shall be thoroughly removed by emulsion cleaning.

5.9.3. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

5.9.4. After phosphating, through rinsing shall be carried out with clean water followed by final rinsing with dilute bi-chromate solution and oven drying.

5.9.5. After pretreatment of phosphating, powder coating shall be applied to sheet steel material through electrostatic spray process for uniform and consistent coating quality.

5.9.6. After application of the spray, the sheet steel shall be passed through oven for final tough, uniform and consistent powder coating. The paint shade shall be 631 of IS-5 for external surfaces while egg shell white for internal surfaces of the panel. outside. Inside of the panel will be egg shell white.

5.9.7. Finishing paint shall be of aesthetically pleasing appearance free from dirt and uneven surface.

5.9.8. Finished painted appearance of panel shall present ~~an~~ aesthetically pleasing high value appearance free from dirt and uneven surface.

5.9.9. The total paint thickness shall be between 60 to 100 microns for powder coating.

5.10. Mounting

5.10.1. At front of panel, all Relays/IEDs, components/ equipment shall be mounted on rack duly flush to the panel swing frame surface.

5.10.2. Equipment shall be mounted such that, individual removal and replacement can be accomplished individually without interruption of service to adjacent equipment. Equipment mounted inside the panel shall be so located that terminals of adjacent devices are readily accessible without the use of special tools. Terminal markings shall be clearly visible.

5.10.3. The center line of switches, pushbuttons etc. shall be at a height not less than 750mm from the bottom of the panel. The horizontal

center line of relays and meters shall be at a height not less than 450mm from the bottom of the panel.

5.10.4. The centre lines of switches, push buttons etc. shall be matched to give a neat and uniform appearance. Likewise, the top edges of all meters, relays etc. shall be matched.

5.10.5. No equipment shall be mounted on the doors.

5.11. RELAYS

5.11.1. The general requirements for the protective relays are described here under however all relays shall, in general, comply with the technical specifications mentioned in Annexure-III**.**

5.11.2. The Relays/IEDs shall be suitable, to form composite Relay/IED assemblies in racks, to form complete protection schemes with minimum external wiring involved.

5.11.3. All Relays/IEDs shall conform to the type test requirements as specified in clause no. 6.1. and Annexure-II of this specifications. Relays shall be suitable for flush mounting on the racks from front side and connections from the rear side.

5.11.4. All protective relays shall be with proper on line testing facilities without isolation from TB where inputs viz. CT/ PT and DC are wired. All main relays shall be provided with test plug to test the relay on line. Necessary test plugs/ test handles shall be supplied loose and shall be included in contractor's scope of supply.

5.11.5. All AC operated relays shall be suitable for operation at 50 Hz. AC voltage operated relays shall be suitable for 110V VT secondary and current operated relays for 1or 5 amp CT secondary. All DC operated relays and timers shall be designed for the DC voltage specified, and shall operate satisfactorily within specified range of rated voltage. Voltage and Current operated relays shall have adequate thermal capacity for continuous operation as specified in Annexure-III.

5.11.6. REQUIREMENT OF AUXILIARY RELAYS FOR MULTIPLICATION OF CONTACTS

5.11.6.1. Latched type electrically reset auxiliary relay having sufficient nos. of contacts required for completeness of the scheme including spare for future use shall be provided for multiplication of contacts with Flag / LED Indication.

5.11.6.2. These contacts will be used for status indications, switchgear interlocks, DR etc.

5.11.6.3. These contacts multiplication relays shall be completely wired up to the terminal blocks of the control panel.

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

5.11.8. All protective relays, auxiliary relays and timers except the lockout relays and interlocking relays specified shall be provided with self-reset type contacts. All protective relay and timers shall be provided with externally hand reset positive action operation indicators with inscription. All protective relays, which do not have built-in hand-reset operation indicators, shall have additional auxiliary relays with operating indicators (flag relays) for this purpose. Similarly, separate operating indicator (auxiliary relays) shall also be provided in the trip circuits of protections located outside the board such as buchholz relays, oil and winding temperature protection, sudden pressure devices, fire protection etc.

5.11.9. Timers shall be of the solid state & shall be of continuous rating. Time delay in terms of milli seconds obtained by the external capacitor resistor combination is not acceptable. The variable pot type timer is not acceptable.

5.11.10. No control / protection Relay/IED shall be provided in the circuits which can trip the power circuit breaker when the relay is de-energized.

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

5.11.12. All protective relays and alarm relays shall be provided with one extra isolated pair of contacts wired to terminals exclusively for future use.

5.11.13. The setting ranges of the relays offered, if different from the ones specified shall also be acceptable if they meet the functional requirements.

5.11.14. Any alternative/ additional protections or relays considered necessary for providing complete effective and reliable protection shall also be offered separately. The acceptance of this alternative/ additional equipment shall lie with the GETCO.

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

5.11.16. Wherever numerical relays are used, the scope shall also include the following:

a) Necessary licensed copy of software and hardware to up/ down load the data to/from the relay from/to the personal computer installed in the substation shall be provided. Relay shall be looped by Fiber Optic/ twisted wire Cables up to PC. However, the supply of PC is not covered under this clause.

b) The software shall be suitable for operations like switching, retrieval of information or changing of setting groups, retrieve oscillographic fault data from the relay memory and to store fault record data as oscilloraphic records in standard COMTRADE format. The software shall be suitable to provide oscilloraphic data into several different graphical representations that can be used to analyze the fault or event captured by the relay. It shall also be possible to calculate additional values from the captured signals and displaying analog curve with time base phasor diagram locus diagrams, harmonic graphs etc. Automatic upload of DR files should be possible.

c) The relay shall have suitable communication facility on fiber optic port / electrical Ethernet port for connectivity to SCADA. The relay shall be capable of supporting IEC-61850 protocols or as specified with respective relay specification. Neither the interface hardware nor the software for connectivity to SCADA will form part of the scope of this specification.

d) The relay shall be supplied with all the original customized licensed software, IO Cards, required cable for local or remote communication mentioned in the catalogue.

5.11.17. All unused terminal shall also be provided with screws washers, lugs etc. as that of used terminals.

5.11.18. REQUIREMENT OF DIRECT CARRIER INTERTRIP FOR LINES:

Instantaneous tripping of the remote end breaker shall be achieved (either hard wired or through GOOSE interface as mentioned in respective tender) through the direct carrier inter-trip tele-link in case any of the following operations/occurrences.

5.11.18.1. Hand tripping of the line breakers.

5.11.18.2. Hand tripping of the TBC (Transfer bus coupler) breaker if the line is controlled by the TBC breaker.

5.11.18.3. Operation of the local breaker back up protection.

5.11.18.4. Operation of the transfer bus, bus-bar protection relay, Local breaker back –up protection relay if the line is on the transfer bus.

5.11.18.5. Over voltage protection operation.

5.11.18.6. Bus bar protection operation.

Sufficient number of contacts shall be provided on the concerned switches relays, etc. to enable transmission of the carrier impulse by two independent carrier channels simultaneously.

5.12 Energy Meter:

The Energy Meter shall be 3-Phase, 4 Wire type with accuracy class 0.5S. It shall be as per separately attached technical specifications and it shall be compatible to the existing DAS (Data Acquisition System) working in GETCO network.

6. TESTS

6.1. Type test:

The following tests from NABL accredited laboratory shall be carried out in accordance with IEC 60255, IEC 60068, IEC 61000, IEC 60529, IEC 61010-1, IEC 60255-27 & IEC 61850 or the latest / amended / up to date IS/IEC. The bidder has to submit the all type test reports as stated hereunder for the offered item along with the technical bid. The type test reports from NABL approved laboratory shall not be older than seven years. Type test reports shall be valid as on the last date of submission of bid.

The reports for the type tests mentioned in Annexure-II shall be submitted by the bidder for the Relays/IEDs. However, the type test report not mentioned in Annexure-II, but relevant to the offered protective relay, as on date, shall also be submitted.

A. Relays / IEDs

The list of type test reports to be submitted for Relays/IEDs shall be as follows.

a. Performance tests:
   i. Accuracy requirements
   ii. Limits of operating range of auxiliary energizing inputs and auxiliary Voltage dependence.
   iii. Limits of frequency range and frequency dependence
   iv. Rated burden
   v. Mechanical Endurance test
   vi. Characteristic and Functional test

b. Thermal requirements:
   i. Maximum allowable temperature
   ii. Limits of short time thermal withstand value of input energizing quantities.
   iii. Limiting dynamic value

c. Insulation Tests:
   i. Dielectric Tests
   ii. Impulse Voltage withstand Test
   iii. Insulation resistance measurement

d. Influencing Quantities
   i Permissible ripples
   ii. Interruption of input voltage

e. Electromagnetic Compatibility Test:
   i. 1 MHZ burst disturbance test
   ii. Electrostatic Discharge Test
   iii. Radiated Electromagnetic Field Disturbance Test
   iv. Electrical Fast Transient Disturbance Test
   v. Conducted Disturbances Tests induced by Radio Frequency Field
   vi. Magnetic Field Test
   vii. Emission (Conducted and Radiated) Test.
   viii. Surge Immunity Test

f. Contact performance Test
   i. Contact making/Breaking capacity test
   ii. Continuous capacity test

g. Environmental tests:
   i. Dry Cold Test
   ii. Dry Heat test
   iii. Storage temperature test
   iv. Damp heat Cyclic test

h. Mechanical Tests:
   i. Vibration response & Vibration endurance test
   ii. Bump test
   iii. Shock response test
   iv. Seismic test

i. Enclosure Test:
   i. Degree of Protection test – IP51

j. Safety Test:
   i. Single fault condition assessment
   ii. Earth bonding impedance test
   iii. Mechanical resistance to shock and impact
   iv. Protection against electrical shock
   v. Protection against the spread of fire

k. IEC 61850 Compatibility tests

B) Control & Protection Panel

Degree of Protection Type test report IP-54 as per IS 60947-1(Latest revision) / IEC 60529 stipulating all the details like Gasket material type, profile & size, Door proflle, Panel GA etc.

Note:
In case of non-submission /partial submission or type test reports of which validity is over, bidder shall submit pending type test report/s from NABL accredited laboratory, in the event of an order, before commencement of supply without affecting delivery schedule, free of cost to GETCO. Confirmation for above shall be invariably submitted along with technical bid.

6.2. Routine and Acceptance tests:

Following Routine and Acceptance tests shall be carried out on offered Control & Protection panels.

6.2.1. Routine testing:

a. Routine testing of Relays/IEDs/accessories and equipments as well as complete control & protection panel shall be performed at manufacturer's works on 100% material to be offered for inspection as per standards mentioned in specifications, approved manufacturing Quality Assurance Plan and approved FAT procedures.

b. On successful completion of routine test, routine test report along with RTCs of Relays/IEDs, components, accessories etc shall be submitted.

c. Purchaser reserves right for witnessing of routine test as and when required, in presence of Purchaser's representative.

6.2.2. Acceptance testing:

After successful completion of routine tests, the Control & Protection panels shall be offered for acceptance testing as mentioned below.

a. Immediately after finalization of the program of acceptance, testing the supplier/contractor shall give advance intimation to the purchaser to enable him to depute his representative for witnessing the acceptance tests.
b. Acceptance testing shall be performed on each type of Control & Protection panels (voltage class wise) from the offered Control & Protection panels for acceptance testing.
c. Acceptance test shall be performed in presence of GETCO representative in case of direct supply to GETCO.
d. In case of supply through EPC contract, representative of EPC contractor shall also witness acceptance test with GETCO representative.
e. Acceptance testing shall cover following tests
    i. Verification of panel construction
    ii. Verification of Bill of quantity including ordering information of Relays/IEDs
    iii. Verification of High voltage at 2 kV rms for 1 minute between all panel wiring and earth (by shorting all wires at Terminal blocks except communication wires if any)
    iv. Insulation resistance test between all panel wiring and earth (by shorting all wires at Terminal blocks except communication wires if any
    v. Verification of network formation and configuration thereof
    vi. Verification of Binary inputs-outputs including simulated interface in Substation Automation System
    vii. Verification of Binary inputs-outputs including simulated interface in Substation Automation System
    viii. Verification of Analogue inputs-outputs including simulated interface in Substation Automation System
    ix. Verification of control-interlocking logics including simulated interfaces in Substation Automation System
    x. Verification of protection functions including simulated interfaces in Substation Automation System
    xi. Verification of Time synchronization configuration
    xii. Verification of DR and automatic transfer of DR to work station
    xiii. Verification of GOOSE configuration for control-interlocking-protection functions including simulated interfaces in Substation Automation System
    xiv. Verification of performance for GOOSE based protection functions

7. INSPECTION

7.1. The Control & Protection panel shall be offered for inspection.

7.2. No material shall be dispatched without inspection.

7.3. The purchaser shall have access at all the times to the works of manufacturer where Control & Protection panels are being manufactured.

The supplier shall provide purchaser's representative all facilities for unrestricted inspection of the works, raw material, bought out items, accessories and for conducting necessary tests.

7.4. The successful bidder shall have to give advance intimation of inspection programme.

7.5. On successful completion of acceptance testing, inspection report shall be submitted.

7.6. On acceptance of inspection report, dispatch instruction will be issued from Chief Engineer (Project), Vadodara.

7.7. Control & Protection panel shall be dispatched only after receipt of dispatch instruction

7.8. The acceptance of any quantity of the equipment shall in no way relieve the successful bidder from his responsibility for meeting all the requirements of this specification & shall not prevent subsequent rejection, if such equipments are found defective later.

7.9. Inspection during manufacturing

7.9.1. The inspection may be carried out by the purchaser at any stage of manufacture. The successful bidder shall grant free access to the purchaser's representative at a reasonable time when the work is in progress. Inspection and acceptance of any equipment under this specification by the purchaser shall not relieve the supplier of his obligation of furnishing equipment in accordance with the specifications and shall not prevent subsequent rejection if the equipment is found to be defective.

7.9.2 The supplier shall keep the purchaser informed well in advance, about the manufacturing program so that the arrangement can be made for inspection.

8. QUALITY ASSURANCE PLAN

8.1. The bidder shall invariably furnish along with his offer the quality `assurance plan adopted is him/his sub-supplies in the process of manufacturing all major equipments/components and control & protection panels.

8.2. Precaution taken in testing for ensuring usage of quality raw materials and sub- components shall be stated in the quality assurance plan.

8.3. The bidder should specifically express their consent to accept additions, revisions to their quality assurance plan to meet the purchaser's requirements if needed.

8.4. In the event of supply order, bidder shall have to submit Quality assurance plan comprising above details for approval.

9. GUARANTEE PERIOD

All equipment supplied against this specification shall be guaranteed for a period 36 months from the date of commissioning. However, any engineering error, omission, wrong provision, equipment failure etc., if found during actual commissioning of the equipment shall be attended by the bidder free of cost.

10. DOCUMENTATION

10.1. The bidder shall furnish, as a part of their offer, complete set of following documents, of the offered products as mentioned in respective clauses.

a. Technical literature/catalog & manuals
b. GA & Schematics drawings
c. Bill of quantity
d. Type test reports
e. Quality assurance plan
f. Authorization letter from OEM
g. Service support back-up guarantee letter from OEM

10.2. After issue of detailed purchase order, the successful bidder shall have to submit three sets of complete drawings as per clause No. 5.1.1 for approval along with following documents detailed bill off material to the CE (Projects), GETCO, Sardar Patel Vidyut Bhavan, Race Course, VADODARA -390 007.

a. Type test reports
b. Quality assurance plan
c. Authorization letter from OEM
d. Service support back-up guarantee letter from OEM
e. Soft copies of all approved drawings of Control & Protection panel as well as Quality assurance plan (after approval)

All the drawings submitted in soft form shall be in pdf format. However, requirement in AutoCAD form shall be at the discretion of GETCO.

10.3. The supplier/contractor shall dispatch sets of approved drawings and sets of technical literature/ commissioning manuals along with the panels at site.

11. PACKING AND TRANSPORT

11.1. All equipment/material shall be suitably packed for transport, carriage at site and outdoor storage during transit. The ***bidder*** shall be responsible for any damage to the equipment during transit due to improper and inadequate packing. The cases containing easily damageable material shall be very carefully packed and marked with appropriate caution

symbols i.e. `FRAGILE' `HANDLE WITH CARE', `USE NO HOOK' etc. The contents of each package shall bear marking that can be readily identified from the package list and packing shall provide complete protection from moisture, termites and mechanical shocks etc.

11.2. Wherever necessary proper arrangement for attaching slings for lifting shall be provided and all packages clearly marked with gross weight, signs showing `UP' and `DOWN' sides of boxes, contents of each package, order no. and date, name of the plant/SS/ of which the material in the package forms part of and any handling and unpacking instructions considered necessary. Any material found short inside the intact packing cases shall be supplied by the manufacturer/supplier without any extra cost.

11.3. Bidder shall ascertain, prior to shipment, from concerned authorities, the transport limitations like weight and maximum allowable package size for transportation. Fragile material such as relay cases, Instruments and other glass material shall be carefully covered with shock absorbing protective materials, such as thermocol, silica gel or equivalent moisture absorbent material in small cotton bags shall be placed inside the packing wherever necessary.

11.4. Each consignment shall be accompanied by a detailed packing list containing the following information.

a) Purchase order reference.

b) Name of consignee

c) Details of consignment

d) Destination

e) Total weight of consignment

f) Handling and unpacking instructions.

g) Bill of materials indicating contents of each package

h) Sign showing upper/lower side of the crate.

12. TRAINING

12.1. The successful bidder has to Impart training to the person/s identified by GETCO, free of cost, at site.

12.2. Training shall be imparted through qualified trainer of the Relay/IED OEM.

12.3. Training shall be in view of manufacture, assembly, erection, configuration, testing, operation and maintenance for items to be supplied.

12.4. Training shall cover following

a. Explanation of Protection principles and configurations of various Relays/IEDs

b. Explanation of configuration tools
c. Configuration of Bay interlocks & Automation logics
d. Configuration of DR and Relay parameterization for various make & type of relays
e. Trouble shooting of various problems of Relay, /IEDs,

12.5. The program of the training shall be as mutually agreed between purchaser and supplier/contractor.

13. ERECTION, TESTING & COMMISSIONING

13.1. The successful bidder shall have to carry out the testing and commissioning of Control & Protection panels as well as integration in Substation Automation System by deputing his Engineer/s at site without any extra cost to GETCO.

13.2. Testing and commissioning shall be carried out with their all required tools, tackles, test kits etc. for successful commissioning & integration of Control & Protection panels.

13.3. The service charges for above purpose shall not be paid during first testing & commissioning and any services to be provided within guarantee period of 36 months after commissioning.

14. SCHEDULES

14.1. The bidder shall fill in the following schedules which form part of the tender specification and offer. In case of non-submission of the same, the offer is liable to be rejected.

Schedule – B	Guaranteed Technical particulars

14.2. Any deviation from the specification shall be mentioned in Annexure-12 (schedule of deviations) only. Any deviations mentioned other than above shall not be considered.

15. INFORMATION TO BE FILLED IN INVARIABLY BY THE BIDDER:

For ready reference of the purchaser, the items of information required to be invariably furnished by him in his offer, are listed below:

1. Schedule - `B'
2. Documents and drawing listed in Clause no.10.1
3. Documents specified in clause no. 8.0
4. Schedule of deviations (Annexure-12)

16. GUARANTEE FOR MAINTENANCE SPARES AND SERVICES

The bidder shall guarantee for supplying maintenance spares and services as well as repairing of relays for a period of the life expectancy of 25 years.

Authorization letter and service support guarantee from Relay/IED OEM shall be submitted for offered products along with the bid.

17. GENERAL IMPORTANTS POINTS

1. The successful bidder shall ensure looping to Ethernet switch of Numerical relays of all the bays for inter communication and time synchronization.
2. GPS Unit suitable for SNTP and IRIG-B and other output ports as per specification shall be supplied and commissioned. All the relays shall be time synchronized on SNTP protocol and GPS based TSE shall be configured as primary time source. IRIG-B output shall be provided to adjacent IED/RTU and that IED shall be configured as secondary time source for all other IEDs in case of any trouble of SNTP.
3. Any modifications in wiring required by the purchaser at site shall be carried out by the successful bidder at the time of commissioning, free of cost.
4. Configuration of Relays/IEDs for GOOSE based various logics, interlocking as well as protection aspects shall be ensured along with establishing network performance in all respect as per FAT/SAT procedure documents.
5. Configuration of Relays/IEDs for reporting of all the protection alarms to HMI with latched functionality shall be ensured as per the FAT/SAT procedure as well as HMI bay view configuration.
6. Configuration of Relays/IEDs function keys as Control keys for Carrier In-Out, DT In-Out, A/R In-Out, Bus bar Zone In-Out etc. shall be ensured as per the FAT/SAT procedure as well as HMI configuration.

Annexure-I

Control & Protection Requirements for various Panels

	400KV System, 1½ Bkr Configuration								
Panel Type	**Main I Protn.**	**Main II Protn.**	**B/U Protn.**	**O/V Protn.**	**Over flux**	**DC Sup**	**U/V Protn.**	**BCU**	**Energy Meter**
Feeder C&P panel 220 V. DC	Dist Protn, With DR (Protocol – 61850)	Dist Protn, With DR (Protocol – 61850)	X	Static/ Numerical Relay	X	√	√	√ (Protocol – 61850)	√
Tie Bkr C&P panel 220 V. DC	Teed Protn*, Low Imp Diff relay With DR (Protocol – 61850)	Teed Protn* High Imp Diff Relay With DR (Protocol – 61850)	X	X	X	√	X	√ (Protocol – 61850)	X
400/220 KV Trf. HV side, C&P panel 220 V. DC	Diff Protn, With DR (Protocol – 61850)	REF Protn, High Imp, With DR (Protocol – 61850)	Dir O/C & E/F, With DR (Protocol – 61850)	X	X	√	X	√ (Protocol – 61850)	√
400/220 KV Trf. LV side, C&P panel 220 V. DC	X	X	Dir O/C & E/F, With DR (Protocol – 61850)	X	Static/ Numerical Relay	√	X	√ (Protocol – 61850)	√
Reactor C&P panel 220 V. DC	Diff Protn, With DR (Protocol – 61850)	REF Protn High Imp, With DR (Protocol – 61850)	B/U Imp. With DR (Protocol – 61850)	X	X	√	X	√ (Protocol – 61850)	√
Bus Bar Protection 220 V DC	Distributed Bus Zone Protn for minimum 12 Bays With DR in Bay as well as Central Unit (Protocol – 61850)			X		√	X	X	X

*** Teed Protn. Shall be provided in Feeder, Transformer & Reactor C & R Panels.**

	400KV System, 3 Bus Configuration								
Panel Type	**Main I Protn.**	**Main II Protn.**	**B/U Protn.**	**O/V Protn.**	**Over Flux**	**DC Sup**	**U/V Protn.**	**BCU**	**Energy Meter**
Feeder C&P panel 220 V. DC	Dist Protn, With DR (Protocol – 61850)	Dist Protn, With DR (Protocol – 61850)	X	Static / Numerical Relay	X	√	√	√ (Protocol – 61850)	√
400/220 KV Trf. HV side, C&P panel 220 V. DC	Diff Protn, With DR (Protocol – 61850)	REF Protn, High Imp, With DR (Protocol – 61850)	Dir O/C & E/F, With DR (Protocol – 61850)	X	X	√	X	√ (Protocol – 61850)	√
400/220 KV Trf. LV side, C&P panel 220 V. DC	X	X	Dir O/C & E/F, With DR (Protocol – 61850)	X	Static / Numerical Relay	√	X	√ (Protocol – 61850)	√
Reactor C&P panel 220 V. DC	Diff Protn, With DR (Protocol – 61850)	REF Protn High Imp, With DR (Protocol – 61850)	B/U Imp. With DR (Protocol – 61850)	X	X	√	X	√ (Protocol – 61850)	√
B/C or Bus Section C&P panel 220 V. DC	X	X	Non-Dir O/C, With DR (Protocol – 61850)	X	X	√	X	√ (Protocol – 61850)	√ (Bus section)
TBC C&P panel 220 V. DC	X	X	X	X	X	√	X	√ (Protocol – 61850)	√
Bus Bar Protection 220 V DC	Distributed Bus Zone Protn for minimum 12 Bays With DR in Bay as well as Central Unit (Protocol – 61850)			X		√	X	X	X

	220KV System (Single Bus / 2 Main Bus / Main & Transfer Bus / 3 Bus Configuration)							
Panel Type	**Main I Protn.**	**Main II Protn.**	**B/U Protn.**	**O/V Protn.**	**DC Sup**	**U/V Protn.**	**BCU**	**Energy Meter**
Feeder C&P panel 220/110 V. DC	Dist / # Line Diff. Protn, With DR (Protocol – 61850)	Dist / # Line Diff. Protn, With DR (Protocol – 61850)	X	X	√	√	√ (Protocol – 61850)	√
220/132 KV Auto Trf. HV side C&P panel 220/110 V. DC	Diff Protn, With DR (Protocol – 61850)	REF Protn High Imp, With DR (Protocol – 61850)	Dir O/C & E/F, With DR (Protocol – 61850)	X	√	X	√ (Protocol – 61850)	√
220/132 KV Auto Trf. LV side C&P panel 220/110 V. DC	X	X	Dir O/C & E/F, With DR (Protocol – 61850)	X	√	X	√ (Protocol – 61850)	√
220/66 or 33 or 11 KV Trf. HV side C&P panel 220/110 V. DC	Diff Protn, With DR (Protocol – 61850)	REF Protn High Imp, With DR (Protocol – 61850)	Dir O/C & E/F, With DR (Protocol – 61850)	X	√	X	√ (Protocol – 61850)	√
220/66 or or 33 or 11 KV Trf. LV side C&P panel 220/110 V. DC	X	REF Protn High Imp, With DR (Protocol – 61850)	Dir O/C & E/F, With DR Built in feature of BCPU / Separate Dir. O/C-E/F Protn relay with DR * (Protocol – 61850)	X	√	X	BCPU /BCU * (Protocol – 61850)	√
B/C or Bus Section C&P panel 220/110 V. DC	X	X	Non-Dir O/C, With DR (Protocol – 61850)	X	√	X	√ (Protocol – 61850)	√ (Bus section)
TBC C&P panel 220/110 V. DC	X	X	X	X	√	X	√ (Protocol – 61850)	X
Bus Bar Protection 220 V DC	Distributed Bus Zone Protn for minimum 12 Bays With DR in Bay as well as Central Unit (Protocol – 61850)			X	√	X	X	X

	132KV System (Single Bus / 2 Main Bus / Main & Transfer Bus Configuration)							
Panel Type	**Main I Protn.**	**Main II Protn.**	**B/U Protn.**	**O/V Protn.**	**DC Sup**	**U/V Protn.**	**BCU**	**Energy Meter**
Feeder C&P panel 220/110 V. DC	Dist / # Line Diff. Protn, With DR (Protocol – 61850)	X	Dir O/C & E/F, With DR (Protocol – 61850)	X	√	√	√ (Protocol – 61850)	√
132/66 KV Auto Trf. HV side C&P panel 220/110 V DC	Diff Protn, With DR (Protocol – 61850)	REF Protn High Imp, With DR (Protocol – 61850)	Dir O/C & E/F, With DR (Protocol – 61850)	X	√	X	√ (Protocol – 61850)	√
132/66 KV Trf. LV side C&P panel 220/110 V DC	Dir O/C & E/F, With DR Built in feature of BCPU / Separate Dir. O/C-E/F Protn relay with DR * (Protocol – 61850)	X	X	X	√	X	BCPU /BCU * (Protocol – 61850)	√
132/11 KV Trf. LV side C&P panel 220/110 V. DC		REF Protn High Imp, With DR (Protocol – 61850)	Dir O/C & E/F, With DR Built in feature of BCPU / Separate Dir. O/C-E/F Protn relay with DR * (Protocol – 61850)	X	√	X	BCPU /BCU * (Protocol – 61850)	√
B/C or Bus Section C&P panel 220/110 V. DC	Non-Dir O/C, With DR (Protocol – 61850)	X	X	X	√	X	√ (Protocol – 61850)	√ (Bus section)
TBC C&P panel 220/110 V. DC	Dir O/C & E/F, With DR (Protocol – 61850)	X	X	X	√	X	√ (Protocol – 61850)	X
Bus Bar Protection 220/110 V DC	Distributed Bus Zone Protn for minimum 12 Bays With DR in Bay as well as Central Unit (Protocol – 61850)			X	√	X	X	X

66KV System (Single Bus / 2 Main Bus / Main & Configuration)								
Panel Type	**Main Protn.**	**B/U Protn.**	**O/V Protn.**	**U/V Protn.**	**Controller**	**DC Sup**	**BCPU / BCU ***	**Energy Meter**
Feeder C&P panel 220/110 V. DC	Dir O/C & E/F, With DR Built in feature of BCPU / Separate Dir. O/C-E/F Protn relay with DR * (Protocol – 61850)	X	X	√ (No Volt relay If Line PT provided)	X	√	√ (Protocol – 61850)	√
66/11KV Transformer HV Side C&P Panel 220/110 V DC	Diff Protn, With DR (Protocol – 61850) Built in REF protection for LV winding	Non-Dir O/C & E/F, With DR Built in feature of BCPU / Separate Non-Dir. O/C-E/F Protn relay with DR * (Protocol – 61850)	X	X	X	√	√ (Protocol – 61850)	√
66/11KV Transformer LV Side C&P Panel 220/110 V.DC	Non-Dir O/C & E/F, With DR Built in feature of BCPU / Separate Non-Dir. O/C-E/F Protn relay with DR * (Protocol – 61850)	X	X	X	X	√	√ (Protocol – 61850)	√
B/C or Bus Section C&P panel 220/110 V DC	Non-Dir O/C & E/F, With DR Built in feature of BCPU / Separate Non-Dir. O/C-E/F Protn relay with DR * (Protocol – 61850)	X	X	X	X	√	√ (Protocol – 61850)	√ (Bus section)
Capacitor Bank Panel 220/110 V. DC	Unbalance Current protection Non-Dir O/C & E/F, With DR (Protocol – 61850) (Qty - as per configuration on capacitor bank)	Non-Dir O/C & E/F, With DR Built in feature of BCPU / Separate Non-Dir. O/C-E/F Protn relay with DR * (Protocol – 61850)	√	√	Leading PF controller with IEC 61850 Protocol	√	√ (Protocol – 61850)	√

	33KV System (Single Bus / 2 Main Bus)						
Panel Type	**Main Protn.**	**B/U Protn.**	**O/V Protn.**	**U/V Protn.**	**DC Sup**	**BCPU / BCU ***	**Energy Meter**
Feeder C&P panel 220/110 V DC	Dir O/C & E/F, With DR Built in feature of BCPU / Separate Dir. O/C-E/F Protn relay with DR * (Protocol – 61850)	X	X	√ (No Volt relay If Line PT provided)	√	√	√
220/33kV Transformer LV C&P panel 220/110 V DC	Dir O/C & E/F, With DR Built in feature of BCPU / Separate Dir. O/C-E/F Protn relay with DR * (Protocol – 61850)	X	X	X	√	√	√
33/11KV Transformer HV Side C&P Panel 220/110 V DC	Diff Protn, With DR (Protocol – 61850) Built in REF protection for LV winding	Non-Dir O/C & E/F, With DR Built in feature of BCPU / Separate Non-Dir. O/C-E/F Protn relay with DR * (Protocol – 61850)	X	X	√	√	√
33/11KV Transformer LV Side C&P Panel 220/110 V DC	Non-Dir O/C & E/F, With DR Built in feature of BCPU / Separate Non-Dir. O/C-E/F Protn relay with DR * (Protocol – 61850)	X	X	X	√	√	√
B/C or Bus Section C&P panel 220/110 V DC	Non-Dir O/C & E/F, With DR Built in feature of BCPU / Separate Non-Dir. O/C-E/F Protn relay with DR * (Protocol – 61850)	X	X	X	√	√	√ (Bus section)

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.

The following shall be included in case of new sub stations:

1. GPS based time synchronizing unit. (If asked in schedule-A).
2. Automatic U/F Load Shedding Panel (If asked in schedule-A).

For GPS based TSE, AUFLS, Bay Control Unit i.e. BCU and Bay Control & Protection Relays (IEDs) i. e. BCPU, separately attached specifications shall be referred.

* BCU and Separate O/C-E/F protection relay shall be provided in 66KV Control & Protection panel for Bays with GIS / Hybrid switchgear modules, while BCPU with built-in O/C-E/F protection feature for AIS.

Line Differential relays / relay shall be provided in 220kV / 132kV Feeder panels instead of Distance protection relay if specified in schedule-A or BOQ.

Details of Relay/IED wise typical Input-Output, Soft protection Alarm signals List, LED list etc. is provided at Annexure-A.

Details of Relay/IED wise typical GOOSE signal List is provided at Annexure-B. Accordingly, IEDs shall have capability for GOOSE functionality.

ANNEXURE: II
CONTROL & PROTECTION PANELS – LIST OF STANDARDS

Sr. No.	Standard no.	Title
1.	IS-3231 IEC-255, Part 1 to 3 BS – 142	Electrical relays for power system protection.
2.	IS – 722 BS – 37 IEC-337 & 337-1	Control switches (LV Switching devices for control and auxiliary circuits.)
3.	IS – 2705	Current transformers
4.	IS – 3156	Voltage transformers
5.	IS – 4237	General requirements for switches and control gear for voltages not exceeding 1 kV.
6.	IS – 375	Marking and arrangements for switch gear, bus bars, main connections and auxiliary wiring.
7.	BS – 152	Relay coding, auxiliary wiring and panel and wiring.
8.	IS – 8686	Static protective relays
9.	IS – 2147	Degree of protection for cubicles
10.	IEC-297 Part 1-3	Dimensions of mechanical structures of the 482.6mm (19)" series.
11.	IS – 6875	Control switches (LV Switching devices for control and auxiliary circuits)
12.	IS – 5	Colour for ready mixed paints and channels.
13.	IS – 1554 Part-I, 1988	PVC insulated cables up to and including 1000 volts.
14.	IS – 3842 Part- II to IV	Application guide for protection
15.	IS – 9224 Part- II	HRC Cartridge fuse links.
16.	IS – 6005	Code of practice for phosphating iron and steel
17.	IS-5578	Guide for making of insulated conductors.
18.	IS – 11353	Guide for uniform system of marking and identification of conductors and apparatus terminals.
19.	IS – 9482-1980	Characteristics values of input and outputs of single side band PLCC terminals.
20.	IS- 9528 Part-1 and 2	Planning of (single side band) power line carrier systems.
21.	IS – 10706 – 1983	Methods of tests for single side band PLC terminals.
22.	IS-8997-1978	Coupling device for PLC systems (note This is to be referred for the PLCC terminal connections.
23.	IEC-686-1	Transducers
24.	IS – 2206	Fuses
25.	IS – 9000	Dry heat test
26.	IEC – 801-4	Electrical heat transient bursts.
27.	IS 694	PVC Insulated cable for working voltage up to & including 1100 volt.
28	IEC 60947-7-1,	Low-voltage switchgear and control gear - Part 7-1: Ancillary equipment - Terminal blocks for copper conductors

List Of IEC Standards – Protection Relays/*IEDs*

Sr.No.	Standard no.	Title
Characteristic, Performance, Accuracy, Burden, Mechanical endurance test		
1.	IEC-60255-6/IEC 60255-1	Thermal requirements Mechanical requirements Limiting dynamic value Accuracy requirements Rated Burden
2.	IEC-60255-11/ IEC 60255-1	Interruption to and alternating component in DC aux. Energizing quantity
3.	IEC-60255-3, IEC-60255-12, IEC-60255-13/ IEC 60255-1	Relay characteristic & Performance test
4.	IEC-60255-23/ IEC 60255-1	Contact Performance test
Electromagnetic Compatibility type test:		
1.	IEC-60255-22-1, Class-III,	1MHz burst immunity test
2.	IEC-60255-22-2, Class-III IEC-61000-4-2, Class-III	Electrostatic discharge test Direct application Indirect application
3.	IEC-60255-22-4, Class-A	Fast transient **/** burst immunity test
4.	IEC-, 60255-22-5	Surge immunity test
5.	IEC-60255-22-7, Class-A	Power frequency immunity test
6.	IEC-61000-4-8, Class-V	Power frequency magnetic field test
7.	IEC- 60255-22-3	Radiated electromagnetic field immunity
9.	IEEE/ANSI/C37.90.2	Radiated electromagnetic field disturbance
10.	IEC- 60255-22-3	Immunity to conducted disturbances induced by radio frequency fields test
11.	IEC- 60255-25	Electromagnetic emission tests - Conducted emission test - Radiated emission test
Insulation tests:		
1.	IEC- 60255-5	Dielectric test Impulse voltage test Insulation resistance
Environmental tests:		
1.	IEC-60068-2-1	Cold test Storage test
2.	IEC-60068-2-2	Dry heat test
3.	IEC-60068-2-3	Damp heat test, steady state
4.	IEC-60068-2-30	Damp heat test, cyclic
5.	IEC-60068-2-48	Storage temperature test
CE compliance		
1.	IEC- 60255-26	Electromagnetic compatibility requirements

Mechanical tests		
1.	IEC- 60255-21-1	Vibration
2.	IEC- 60255-21-2	Shock and bump
3.	IEC- 60255-21-3	Seismic
Degree of protection test		
1.	IEC 60529	Degree of Protection Provided by enclosure test
Safety test		
1.	IEC 61010-1/IEC 60255-27	Single fault condition assessment Earth bonding impedance test Mechanical resistance to shock and impact - Rigidity test - Impact hammer test Protection against electrical shock Protection against the spread of fire

ANNEXURE: III

PRINCIPAL TECHNICAL PARAMETRS OF CONTROL & PROTECTION PANELS

SR. No.	Item	Specification
The protective relay used in panel viz. Feeder/ Transformer/ Bus-coupler/ TBC/ Bus Bar shall confirm to the specification for the respective relay mentioned below.		
1.	**DISTANCE PROTECTION**	Main I and Main II Distance Protection shall be of two different make (i.e. from different manufacturers) or of same make with two different platforms with same specifications. The Distance Protection Scheme shall: 1 Be based on principle of impedance measurement. 2 Be **numerical** type and shall be **multi digital signals processor scheme.** 3 Be modular in construction. 4 Provide protection for the transmission line from all types of faults, multi phase as well as phase to earth. 5 The protection algorithm shall utilize fault voltages and currents, as well as the superimposed voltages and currents to arrive at a secure trip decision in the shortest possible time with reliability, selectivity and full sensitivity to all types of faults on line. 6 Have **non-switched measurement/ Independent measuring loop for all type of faults in each zone**, which implies processing of all possible fault loops for each phase. 7 Have **shaped quadrilateral/polygonal characteristics** to prevent relay operation during max. Load conditions and shall be suitable for short as well as long lines. Selectable **mho characteristic** for phase fault is preferable depending upon the requirement at the time of technical scrutiny. 8 Have independently adjustable reactive or impedance and resistive reaches for all zone characteristic for maximum selectivity and maximum fault resistance coverage.

		9 Have adjustable characteristic line angle. 10 The relay shall use the memory voltage for proper directional discrimination at close in 3 phase fault which shall be based on positive sequence voltages. **The directional discrimination and phase selection based on negative sequence measurement techniques is not acceptable.** 11 All the zones shall have setting such that they can detect the fault on line from minimum 0.3 km to 500 km. 12 Have a maximum operating time up to trip impulse to circuit breaker (complete protection time including applicable carrier and trip relay time) with CVT being used on the line for all types of faults anywhere in the protected line section during both max and min generation conditions. a) For SIR 0.01-4, as 40 ms at the nearest end and 60ms at the other end of the line with carrier transmission time taken as 20 ms. b) For SIR 4-15 as 45 ms at the nearest end and 65ms at the other end of line with carrier transportation time taken as 20 ms. c) Isochronic curves shall be provided in support of operating times. 13 Have independent continuously variable time setting ranges for each zone. 14 The maximum fault current could be as high as 50kA but the minimum fault current could be as low as 20% of rated current. 15 The starting and measuring relays characteristics should be satisfactory under these extreme varying conditions. 16 The protective relays shall be suitable for **1A CT secondary current.** 17 The protective relay shall not be affected by CT saturation. 18 Also the relay shall be suitable for use with CVT having non-electronic damping and transient response as per IEC. 19 Have a continuous current rating of two times rated current. The voltage circuit shall be capable of operation at 1.2 times rated voltage. The relay shall also be capable of carrying a high short time current of 70 times rated current without damage

		during a period of 1 sec. 20 It shall be ensured that there is no additional delay in relay operating time created intentionally to have stable operation. 21 Numerical full scheme distance protection terminal shall be **suitable for use with any communication scheme** (permissive under reach, over reach, blocking) and have facility for connection to sub – station control system. 22 The scheme shall have input transformation modules, analogue and digital filters, processing units, A/D and D/A converters, DC supply modules etc. 23 The sampling rate of analogue inputs, the processing speed and processing cycle of digital values shall be selected so as to achieve the operating time specified. 24 Be capable of **performing basic instrumentation functions and display on demand** of various measured parameters like voltage, current, active power, reactive power, etc. in primary values. Additionally all sequence current and voltage values, direction of power flow, alarms and clock, relay identification, settings etc. during normal as well as fault conditions on individual phase basis shall be displayed on line. **Pre fault and fault values of current and voltage must be available for fault analysis purpose.** 25 Have a MMI (Man Machine Interface) in the front of relay comprising of a 2-3 line alphanumeric LCD display. 26 Facilities shall be available through a **soft touch keypad on the MMI** for setting alteration, display of all settings, scheme logics and any other requirements as per the software and hardware configuration of the system other than the menu driven alarms. 27 Have a front RS 232 / RJ 45 Communication port for use with a PC locating for local access to settings, events and records. 28 Have one rear communication port on fiber optic medium to support (1) all the facilities available via the integral user interface and (2) facilities supported under IEC-61850-8-1 interface. 29 Shall be provided with standard protocols and

		changing of protocols must be possible at a later date depending on future communication requirement. 30 Have **mutual zero sequence compensation factor setting**. The relay shall have facility to select different group settings to cater for mutual coupling on account of multi circuit line conditions. The minimum no. of group should be four. 31 Be suitable for 110 or 220 volt DC supply. The relay shall have suitable DC to DC converter. DC voltage range of ±20% & harmonic level is max 2% at rated value. 32 Have **resetting ratio more than 105%** and resetting time of typical 30 ms. 33 Operate instantaneously for a close-in three-phase fault and switch on to fault. 34 Be suitable for single and three phase tripping. 35 Be selective for internal and external faults. 36 Include **power swing blocking** feature which shall: a) Have separate measuring element for power swing detection. b) Have fast detection of power swing. c) Shall be on the principle of measurement of the rate of impedance vector change and monitoring of the vector path. d) Have selective blocking of zones. e) Have settable unblocking criteria for earth faults, phase faults and three phase faults. f) Have the Earth fault detection feature, which shall over ride power swing blocking and allow the relay to operate for trip as per zone detection. **g) The relay shall be blocked for the set time for the first PS sensed and remain unblocked for the set time for the successive PS.** 37 Include **fuse failure protection/ Loss of voltage feature** which shall: a) Monitor all three phase fuses of capacitance / electro-magnetic voltage transformer and associated cables against open circuit. b) Inhibit tripping on sudden total loss of voltage or one/two fuse fail condition and initiate annunciation.

		c) Have an operating time less than 7 ms. d) Remain operative for system earth fault. 38 Have minimum **06 no. of heavy duty contacts on trip relays** to provide for energizing two trip coils of each of the main and TBC breaker through the two separate DC source. 39 Have at least **24 no. of programmable binary input and 32 no. of programmable binary output contact** to cater for DR/SER carrier aided tripping auto re-closing etc. 40 Have built in supervision and testing facility including continuous DC supply supervision. 41 Be provided with a continuous **self-monitoring and diagnostic unit** to give alarm in case of abnormalities and locate defective units immediately. Self-monitoring should cover microprocessor, EPROM contacts, measuring elements, battery status and all associated program. 42 Include **built-in distance to fault locator** with features as below. a) An accurate fault locator is an essential complement to the line protection. It shall have an accuracy of 3% or better for all types of faults and fault levels. b) It shall provide digital indication of distance to fault in percentage of the supervised line length of kilometers or in kilometers directly without requiring further calculations. c) It shall provide distance to the fault together with information about the measuring loop that has been used in the calculations. d) Information of the last 08 disturbances should be available. e) The fault locator algorithm compensates the effect of the load currents, the apparent fault resistance and zero sequence mutual impedance. f) It shall meet IEC-255 or other equivalent recognized standards. g) It shall be suitable for breaker operation time of 2 cycles. h) The above accuracy shall not be impaired under the following conditions. i Presence of remote end in feed. ii Predominant DC components in fault

		current. iii High fault Arc resistance. iv Severe CVT transients. 43 Conditional accessories shall not be acceptable. 44 Be supplied along with all suitable **Original Customized licensed software & communication cable** for local and remote communications, analysis of fault etc. 45 Have **reset push button on front panel board**. 46 Have provision of **Broken Conductor Detection / protection** with alarm/trip facility to detect open conductor condition by way of level detector or negative sequence measurement. 47 Have built in an independent directional/non-directional (selectable) Earth fault protection element to detect highly resistive faults. This elements shall have IDMT characteristic with a definite minimum time of 3.0 sec. at 10 times setting and shall have variable setting range of 20-80% of rated current and characteristics angle 45 degree lag. 48 Have directional/non-directional (selectable) back up over current function in built. This elements shall have IDMT characteristic with a definite minimum time of 3-0 seconds at 10 times setting having a variable setting range of 50-200 % rated current and a characteristic angle of 45 degree lead. 49 Provide protection against short circuit and interruption in the secondary wiring of the V.T supply circuit supplying the relay. 50 Have **Disturbance recording** facility, which records a minimum of 08 analogue channels (phase and residual values) and a minimum of 32 digital programmable digital channels, which shall include various digital inputs, output relays and internal digital signals. The facility must be capable of recording at least 10 disturbances. The duration of record shall be settable and be adequate to capture maximum possible information and be bifurcated in pre-fault & post-fault time. Necessary software shall be provided for retrieving and analyzing the records. 51 Have sampling rate of minimum 12 samples/ cycle to capture disturbance parameters faithfully.

		52 Have programmable threshold values for each analog channel for over/under value triggering. 53 Be compatible with GPS **time synchronizing facility via IRIG-B / SNTP**. 54 Have additional protection functionality over and above mentioned earlier such as: a) Current reversal and weak end infeed protection logic. b) SOTF feature. c) Over / under voltage protection. d) Breaker failure protection. e) Dead line Detection. f) Auto re-closure with synchro-check facility. 55 **Have non-volatile storage of DR & SER and also have real time clock buffered by Battery or any other suitable means. In case of Battery; it** shall be reliable and long lasting. There shall be an alarm and indication for declining battery status. 56 **Auto re-closing feature shall be included** in the Numerical Distance Protection Scheme as a built-in feature. It shall a) Have single phase and three phase re-closing facilities b) Have a continuously variable single phase dead time of 0.5 to 5 seconds c) Have continuously variable three phase dead time range of 0.5 to 5 seconds. d) Have a continuously variable reclaim time range of 5-25 seconds e) Incorporate a four-position selector switch from which single phase/three phase/single and three phase/auto re-closure and non-auto re-closure mode can be selected f) Have facilities for selecting check synchronizing or dead line charging features. It shall be possible at any time to change the required feature by reconnection of links. g) Be of multishot type h) Include check synchronizing relay which shall i Have a time setting variable between 0.5 to 5 seconds. ii Have a response time within 200 ms with the timer disconnected. i) Include dead line charging relay. j) Incorporate necessary auxiliary relays and timers to give comprehensive scheme.

		k) Incorporate a separate pole discrepancy relay with timing range of 0.1 to 1 sec l) Auto re-closure of the line shall take place only when fault is cleared in first zone by the main protection. m) Incorporate auto re-closure lockout features to prohibit auto re-closure under the following conditions. i Tripping due to operation of bus bar protection. ii Tripping immediately after the manual closer of line breaker. iii Tripping for faults in 2nd and 3rd zone as backup. iv When tripping takes place after a power swing condition. v In the event of trip on pole discrepancy. vi When carrier is out of service. n) It should have positive phase selections under all operating conditions. The scheme should be such that shut down and testing on one Main protection should not affect the other Main protection. The auto re-closure should then be connected to the other Main protection. o) Come in to operation with distance protection when these protections operate for Zone-I fault and trip the breaker. 57 **Built in Local breaker backup protection scheme shall:** a) Comprise of a breaker failure initiating relay, breaker failure relay which supervises the fault current flowing through the breaker being protected against failure and breaker failure time delay relay and breaker failure lockout relay. b) The operation of both breaker failure initiating relay and breaker failure relay will initiate timer relay which in turn operates lockout relay. The lockout relay will have N/O contacts for annunciation and for energisation of bus bar protection trip relays (available on bus bar protection panels procured separately) for tripping all the other breakers connected to the bus c) Breaker failure relay scheme above shall: i Be triple pole type. ii Be suitable for 110 or 220 V DC supply.

iii have an operating time of less than 15 ms.
iv have a resetting time of less than 15 ms.

d) Have necessary auxiliary relays to make a comprehensive scheme. The scheme shall be so engineered that in the event of persisting breaker lockout condition and simultaneous incidence of fault shall result in instantaneous tripping of the concurred bus bar to which the faulty breaker is connected.

Technical Parameters

Power supply module

a) Aux. DC Voltage - 110/220 V DC
b) Permissible tolerance - ± 20%
c) Power consumption - 15 to 40 W

Analog inputs

a) Current - 1A CT < 0.5VA
b) AC voltage - 110V PT, < 0.5VA
c) Permissible overload - CT 4A cont.
PT 230V Cont.
d) Frequency - 50 Hz, ± 5%

Distance protection Zones

a) No. of zones - Five, selectable direction
b) Characteristic - Quadrilateral and/ or mho (selectable)
c) Minimum operate current - (10-30)% of In
d) Xp Setting Range - 0.5 to 250 Ω/Ph
e) Rp Setting Range - 0.1 to 250 Ω/Ph
f) Xo Setting Range - 0.5 to 250 Ω/Ph
g) Ro Setting Range - 0.5 to 250 Ω/Ph
h) Angle - 10^0 to 85^0
i) Zone timers - 0 – 30 s, ± 10 ms
j) Operate time - @ 25 ms
k) Reset ratio - 105% for DPR
95% for SOTF
l) Reset time - 40 ms

Binary inputs Module

a) Binary inputs - 24 (freely assignable to any function)
b) DC Voltage - 110/125 V DC, ± 20%
220/250V, ± 20%
c) Power consumption - Max 0.2 W/Input-110V

Max 0.4 W/Input-220V

Binary output module

a) Binary outputs - 32 (Programmable)
b) Max system voltage - 250V, AC/DC
c) Test voltage across open circuit 1 min - 1000V rms
d) Current carrying capacity- Continuous – 5A
For 1 sec – 10 A
e) Making capacity at inductive load - 0.2s – 30 A,
1.0s – 10 A
f) Breaking capacity for AC - 250V/8.0A
g) Breaking capacity for DC with L/R < 50 ms - 25 VA

Synchro-check and energizing check

a) Shall initiate on: Auto re-closure
Manual CLOSE control
Control Commands
b) Operating Modes: Synchro-check
Line Dead/ Bus Live
Line Live/ Bus Dead
Line and Bus Dead
Bypassing
c) Phase angle difference 5 to 80^0
Between bus and line
d) Voltage difference 2 to 10% of nominal voltage.
e) Reset ratio Synchro-check > 95%
f) Frequency diff. Limit 0.03 to 1.000 Hz
Between bus and line.
g) Time delay 0 to 30 s

Auto re-closure

a) Operating Mode Only 1-Pole,
Only 3-Pole,
1 or 3-Pole
b) No. Of auto re-closing shots Minimum 3
c) Dead Time 0.5 to 5 sec
d) Reclaim Time 5 to 25 sec

Measurements

Function	**Range**	**Accuracy**
Frequency	0.95 to 1.05 x fn	± 2.0 m Hz
Voltage	0.1 to 1.5 x V	± 1.0 %
Current	0.2 to 3.0 x In	± 1.0 %

		Phase angle 0 to 360 deg ± 2.0 deg. Power(P,Q and S) within specified current and Voltage range, Accuracy ± 2.0% of Apparent power. Power factor Within specified current and Voltage range, Accuracy ± 2.0 deg. **Disturbance report** a) Pre fault time (0.05 – 30.0)s b) Post fault time (0.1 – 5.0)s c) Limit time (0.5 – 6.0)s d) Min. no. of recordings 10 e) Time tagging resolution 1 ms **Communication**: • Front Port - RS232 / RJ45, • Rear Port - Fiber optic / Electrical Ethernet • IEC-61850-8-1 **Remote communications** a) Type of fiber – Graded-index multi core 62.5/125μm b) Wave length – 820 nm c) Transmission distance – 0-3 Km d) Optical connector – Type ST e) Data transmission – Synchronous f) Transmission rate – 64 K bit/ s **Time synchronization** a) IRIG-B / SNTP - as per the requirement (finalized during detail engineering) **Temperature and humidity** a) Ambient temp -10 to 55 °C b) Relative humidity 10% to 90% Non Condensing c) Operate range 0-95% d) Storage temp. -40 to 70 °C **Water and dust protection level according to IEC-60529** Front – IP40 (IP54 with sealing strip) Rear – IP20 Sides – IP40 Top and bottom – IP30

		CT&VT CONNECTIONS Type - Terminal block Range – 250V AC,20A Max. conductor area – 4 sq. mm **Binary I/O connections** Rated voltage – 250V AC Max. conductor area – 2.5 sq. mm , 2x1 sq. mm
1A	Line Differential Protection	Main I and Main II Line Differential Protection shall be of two different make (i.e. from different manufacturers) or of same make with two different platforms with same specifications. The relay shall have all the features as per Distance protection relay over and above following feature. 1. It shall be working on phase segregated current Differential protection principle. 2. It shall have multiple slope characteristic (preferably) to have stability against CT saturation and heavy through faults as well as sensitivity for internal faults. 3. It shall measure Differential as well as restrain current continuously and shall display the same as measurement. 4. It shall use fiber optic cable or multiplexed digital network to exchange telegrams. 5. It shall communicate to remote end through IEEE C37.94 format. 6. It shall have redundant communication channels for protection communication. 7. It shall communicate analogue as well as digital signals to remote end. 8. It shall have various communication options for remote communication i.e. mono-mode / multi-mode for direct communication / communication through multiplexer. 9. It shall have Line charging current compensation feature for better sensitivity. 10. Distance protection function can be utilized as independent or as back up of Differential protection in case of failure of remote communication. 11. It shall communicate time coordinated current

		signals for remote communication to execute Line differential protection algorithm accurately. Time synchronization through GPS shall also be possible. 12. It shall monitor individual communication links continuously and switchover to standby link after preset time in case of failure of one link. 13. It shall supervise individual telegrams. 14. It shall detect reflected telegrams. 15. It shall detect change in communication delay time. 16. It shall measure delay time for remote end along with dynamic compensation of the same in differential protection algorithm. 17. It shall also supervise maximum permissible delay time. 18. It shall generate alarm for heavily disturbed communication link. Technical Parameters A. Line Differential Protection setting: 1. Minimum operating current - 20 to 200% of In 2. Slope (Single/dual) - 10 to 100% 3. End section (Single/dual) - 20 to1000% of In 4. Highset operating current - 100 to 5000% of In 5. 2 nd Harmonic blocking - 5 to100 % 6. Typical operating time - 25 ms 7. Operating time for high set - 15 to 20 ms 8. Charging current comp. - Selectable B. Remote communication: 9. Analogue signal transfer – Minimum 3 Nos. 10. Binary signal transfer - Minimum 8 Nos 11. Remote Communication module Dual modules suitable for a. 1300 nm - multi-mode OR b. 1300 / 1550 nm – mono-mode (finalized during detailed engineering 12. Synchronization mode - GPS / Echo (finalized during detailed engineering) 13. Time delay alarm - 5 to 500 ms, step 5 ms

		(for communication fail) 14. Time delay - 5 to 500 ms, step 5 ms (for switching to redundant channel) 15. Asymmetric delay - - 20 to +20 ms, step 1 ms (When echo mode is used) 16. Max. Transmission delay – 0 to 40 ms, step 1 ms
2	**Backup Impedance PROTECTION**	(A) Features: a) Shall be Numerical type. b) Shall have 2 over current and 1 Earth Fault element. c) TRUE RMS Measurement. d) Have selectable and front panel programmable normal inverse, very inverse, extremely inverse & long inverse IEC/ANSI Characteristic. e) Selectable CT Secondary. I.e. 1A / 5A f) High set over current with selectable time delay. g) High set Earth fault with selectable time delay h) Have adjustable characteristic angle, lead/ lag, for Directional over current/ Earth Fault respectively. ~~i)~~ Shall decide directionality by internally derived zero sequence quantity through software. j) Shall have in built Breaker Failure Protection. k) Include hand reset Flag/LED indicators for fault. l) Readable Human Machine Interface with LCD display. m) Should be able to store at least last 3 fault records viz. Fault current, Faulty Phase etc with time stamp. n) Shall have Disturbance Recording facility for minimum 3 sec for each fault. o) Self monitoring. p) Relay offered shall be communicable type. q) Be supplied along with all suitable Original Customized licensed software & communication cable for local and remote communications, analysis of fault etc (B) Technical Parameters: 1. Analogue input: Rated Current : 1A / 5A (site selectable), 50 Hz ±2.5 Hz Power consumption: <0.05VA/0.3 VA for 1/5 Amp Over load capability: 4xIn continuous 100xIn 1 Sec. 25xIn 3 Sec. 250xIn Dynamic

		Rated Voltage: 110/63.5V, 50 Hz ±2.5 Hz Power consumption: <0.3 VA per phase Over load capability: 2xVn continuous 2. Auxiliary Supply: 110/220 V DC ±15 % Power consumption: < 15W Ripple (peak to peak): < 12% (C) Other Features: 1. Binary inputs: Min 16 Nos. and suitable for Station Aux DC (freely 16 assignable). 2. Outputs: • Output contacts: Minimum 16 (Programmable at site) suitable to station Aux DC • Trip contacts: Minimum 2 N/O contacts with - Continuous carry 5 A - Make & Carry for 0.5 s 30 A - Make & Carry for 3.0 s 15 A 3. Communication: • Front Port - RS232 / RJ45, • Rear Port - Fiber optic / Electrical Ethernet • IEC 61850 protocol • Time Synchronization: - IRIG-B / SNTP - as per the requirement (finalized during detail engineering) 4. Housing • Flush Mounting • Screw Terminals ('O' Lug for CT Connection) • Degree of Protection IP54 5. Temperature and humidity (a) Ambient temp -10 to 55 °C (b) Relative humidity 10% to 90% Non Condensing (c) Operate range 0-95% (d) Storage temp. -40 to 70 °C
3	**Directional O/C & E/F PROTECTION**	**(A) Features:** r) Shall be Numerical type. s) Shall have 2 over current and 1 Earth Fault element. t) TRUE RMS Measurement. u) Have selectable and front panel programmable normal inverse, very inverse, extremely inverse & long inverse IEC/ANSI Characteristic.

		v) Selectable CT Secondary. I.e. 1A / 5A w) High set over current with selectable time delay. x) High set Earth fault with selectable time delay y) Have adjustable characteristic angle, lead/ lag, for Directional over current/ Earth Fault respectively. ~~z)~~ Shall decide directionality by internally derived zero sequence quantity through software. aa) Shall have in built Breaker Failure Protection. bb) Include hand reset Flag/LED indicators for fault. cc) Readable Human Machine Interface with LCD display. dd) Should be able to store at least last 3 fault records viz. Fault current, Faulty Phase etc with time stamp. ee) Shall have Disturbance Recording facility for minimum 3 sec for each fault. ff) Self monitoring. gg) Relay offered shall be communicable type. hh) Be supplied along with all suitable **Original Customized licensed software & communication cable** for local and remote communications, analysis of fault etc **(B) Technical Parameters:** 3. Analogue input: Rated Current : 1A / 5A (site selectable), 50 Hz ±2.5 Hz Power consumption: <0.05VA/0.3 VA for 1/5 Amp Over load capability: 4xIn continuous 100xIn 1 Sec. 25xIn 3 Sec. 250xIn Dynamic Rated Voltage: 110/63.5V, 50 Hz ±2.5 Hz Power consumption: <0.3 VA per phase Over load capability: 2xVn continuous 4. Auxiliary Supply: 110/220 V DC ±15 % Power consumption: < 15W Ripple (peak to peak): ≤ 12% **(C) Relay settings:** 1. Over Current: 50% - 200% (In steps of 5%) 2. Earth Fault: 5% - 80% (In steps of 5%) 3. High set O/C: 0.5 – 15 times In or more. 4. High set E/F: 0.5 – 12 times In or more. 5. Time multiplier for IDMT: 0.05 – 1.0 (In steps of 0.025) (Independent for O/C & E/F)

		6. Time delay for high set element : 0.02 to 2 sec (in steps of 0.01 sec) 7. Pick up: Within 1.1 times of set current value. 8. Reset current: 95% to 90% of pick-up current. 9. Operating Time: As per selectable characteristic. For Inst. Element < 40 ms for 2xIn. **(D) Other Features:** 6. **Binary inputs**: Min ***8*** nos. and suitable for Station Aux DC. 7. **Outputs**: • Output contacts: Minimum 2 N/O contacts with - Continuous carry 5 A - Make & Carry for 0.5 s 30 A - Make & Carry for 3.0 s 15 A • Binary Output: Minimum 6 Nos. and suitable for Station Aux. DC (Programmable at site) 8. **Communication**: • Front Port - RS232 / RJ45, • Rear Port - Fiber optic / Electrical Ethernet • IEC 61850 protocol • Time Synchronization: - IRIG-B / SNTP - as per the requirement (finalized during detail engineering) 9. **Housing** • Flush Mounting • Screw Terminals ('O' Lug for CT Connection) • Degree of Protection IP54 10. **Temperature and humidity** (a) Ambient temp -10 to 55 ^{o}C (b) Relative humidity 10% to 90% Non Condensing (c) Operate range 0-95% (d) Storage temp. -40 to 70 ^{o}C
4	**Non-Dir. O/C & E/F PROTECTION**	**(A) Features:** a) Shall be Numerical type. b) Shall have 2 over current and 1 Earth Fault element. c) TRUE RMS Measurement. d) Have selectable and front panel programmable normal inverse, very inverse, extremely inverse & long inverse IEC/ANSI Characteristic. e) Selectable CT Secondary. I.e. 1A / 5A f) High set over current with selectable time delay.

g) High set Earth fault with selectable time delay
h) Shall have in built Breaker Failure Protection.
i) Include hand reset Flag/LED indicators for fault.
j) Readable Human Machine Interface with LCD display.
k) Shall be able to store at least last 3 fault records viz. Fault current, Faulty Phase etc with time stamp.
l) Shall have Disturbance Recording facility for minimum 3 sec for each fault.
m) Self monitoring.
n) Relay offered shall be communicable type.
o) Be supplied along with all suitable **Original Customized licensed software & communication cable** for local and remote communications, analysis of fault etc

(B) Technical Parameters:

1. Analogue input:
   Rated Current : 1A / 5A (site selectable), 50 Hz ±2.5 Hz
   Power consumption: <0.05VA/0.3 VA for 1/5 Amp
   Over load capability: 4xIn continuous
   100xIn 1 Sec.
   25xIn 3 Sec.
   250xIn Dynamic
2. Auxiliary Supply: 110/220 V DC ±15 %
   Power consumption: < 15W
   Ripple (peak to peak): ≤ 12%

(C) Relay settings:

1. Over Current: 50% - 200% (In steps of 5%)
2. Earth Fault: 5% - 80% (In steps of 5%)
3. High set O/C: 0.5 – 15 times In or more.
4. High set E/F: 0.5 – 12 times In or more.
5. Time multiplier for IDMT: 0.05 – 1.0 (In steps of 0.025) (Independent for O/C & E/F)
6. Time delay for high set element : 0.02 to 2 sec (in steps of 0.01 sec)
7. Pick up: Within 1.1 times of set current value.
8. Reset current: 95% to 90% of pick-up current.
9. Operating Time: As per selectable characteristic. For Inst. Element < 40 ms for 2xIn.

(D) Other Features:

1. **Binary inputs**: Min ***8*** nos. and suitable for

		Station Aux DC. 2. **Outputs**: • Output contacts: Minimum 2 N/O contacts with - Continuous carry 5 A - Make & Carry for 0.5 s 30 A - Make & Carry for 3.0 s 15 A • Binary Output: Minimum 4 Nos. and suitable for Station Aux. DC (Programmable at site) 11. **Communication**: • Front Port - RS232 / RJ45, • Rear Port - Fiber optic / Electrical Ethernet • IEC 61850 protocol • Time Synchronization: - IRIG-B / SNTP - as per the requirement (finalized during detail engineering) 3. **Housing** • Flush Mounting • Screw Terminals ('O' Lug for CT Connection) • Degree of Protection IP54 4. **Temperature and humidity** (a) Ambient temp -10 to 55 ^{o}C (b) Relative humidity 10% to 90% Non Condensing (c) Operate range 0-95% (d) Storage temp. -40 to 70 ^{o}C
5	**% BIASED DIFFERENTIAL PROTECTION**	**A) Differential % BIASED protection** i). Be high speed with an **operating time of less than 30 ms** at 5 times the rated current. ii). Shall be **numerical type.** iii). True RMS Measurement. iv). Shall have **continuous self-monitoring and diagnostic** features. v). Be suitable for three phase **auto star/ non-auto** two/ three winding transformer. vi). Be stable on heavy through faults. vii). Be immune to magnetizing inrush current. viii). Have features to provide stability under over excited conditions and have 2nd and 5th harmonic restraint features.**5th harmonic bypass is not acceptable**. ix). Be triple pole type with faulty phase identification/ indication. x). **Have internal features in the relay to take care of the angle and ratio correction.** xi). Shall have the following functions. i. Differential Protection

		ii. Restricted Earth Fault Protection iii. Thermal Over Load Detection iv. Over Fluxing Protection v. LBB xii). Provide sufficient number of potential free contacts to cater the needs of connection to alarm annunciation. Data acquisition and optional trip facility to be connected by purchaser where needed. xiii). Be supplied along with all suitable **Original Customized licensed software & communication cable** for local and remote communications, analysis of fault etc. xiv). Have a local user interface (MMI) comprising of a 2-3 line alphanumeric LCD display and a soft touch key pad to access the settings, events and records in the relay. xv). Have a front RS 232 communication ports for use with a PC locally for local access to settings, events and recorders. xvi). Have one rear communication port on fiber optic to support (1) all the facilities available via the integral user interface and (2) facilities supplied under **IEC – 61850** interface. vii). Have a **disturbance recording** feature to record graphic form of instantaneous values of current in all three windings in nine analog channels during faults and disturbances for the pre fault and post fault period. The disturbance recorder shall have the facility to record the following external digital channel signals apart from the digital signals pertaining to differential relays. a. REF protection operated b. HV Each Breaker pole status i.e. 3 no. inputs c. LV Each Breaker pole status i.e. 3 no. inputs. d. Buchholz / OLTC Buchholz alarm / trip i.e. 4 no. inputs. e. WTI/OTI/PRV alarm /trip of transformer. Necessary hardware and software for down loading the data captured by disturbance recorder to the personal computer available in the sub station shall be included in the scope. **B) <u>OVER FLUX FEATURE</u>** i). Operate on the principle of voltage to frequency ratio and shall be phase to phase connected. ii). Have inverse time characteristics, matching with transformer over fluxing withstand capability curve.

		iii). Provide an independent `alarm' with the time delay continuously adjustable between 0.1 to 6 seconds. iv). Tripping time shall be governed by v/f vs. time characteristic of the relay. v). V/F setting shall be adjustable from 1.0 to 1.5 times rated flux. vi). Have a set of characteristics for various time multiplier settings. The maximum operating time of the relay shall not exceed 3 seconds and 1.5 seconds at `V/F' values of 1.4 and 1.5 times of rated values respectively. vii). have an accuracy of operating time, better than ± 10% Have a resetting ratio of 95% or better, rated voltage 110V AC. 50Hz.. viii). Provide sufficient number of potential free contacts to cater the needs of connection to alarm annunciation. Data acquisition and optional trip facility to be connected by purchaser where needed. Includes hand reset LED for Alarm & Trip operated indication. **C) REF feature** i). Be single pole type ii). Be high impedance differential protection iii). Be high speed circulating current type iv). Be tuned to the system frequency v). Be high speed with typical operating time of less than 30 ms vi). Be stable for through fault **D) Breaker failure feature** i). Shall provide back up protection when primary breaker fails to operate by isolating all breakers connected to faulty breaker bus. ii). Shall initiate tripping on persisting breaker lock out condition and simultaneous incidence of fault. iii). Be high speed with typical operating time of less than 30 ms **<u>Technical Parameters</u>:** 1. Analogue input: Rated Current : 1A / 5A (site selectable), 50 Hz ±2.5 Hz Power consumption: <0.05VA/0.3 VA for 1/5 Amp Over load capability: 4xIn continuous 100xIn 1 Sec. 25xIn 3 Sec. 250xIn Dynamic Rated Voltage: 110/63.5V, 50 Hz ±2.5 Hz

		Power consumption: <0.3 VA per phase Over load capability: 2xVn continuous 2. Auxiliary Supply: 110/220 V DC ±15 % Power consumption: < 15W Ripple (peak to peak): ≤ 12% **Differential protection settings:** 1. Diff. Current: 10% - 50% (In steps of 5%) 2. Diff. High Current 2 – 10 times In (In steps of 1) 3. Bias Diff Current 10% - 50% (In steps of 5%) 4. Bias slope limit 10 times 5. 2nd Harmonic Restraint ratio 10 to 80% 6. 5th Harmonic Restraint ratio 10 to 80% **Over Excitation Function settings:** 7. V/f Alarm. 1.05 to 1.20 (step 0.01) 8. Time delay for alarm 0 to 60 s (step 0.01) 9. Characteristic Values V/f 1.05 to 1.50 (step 0.05) IDMT characteristic 10. Time delay for each V/f 0 to 20000 sec (step 1 s) **REF protection settings** 11. Differential current 0.1 to 1 A **Breaker failure protection settings** 12. current range 0.05 to 1 A in steps of 0.05 In 13. Time Delay 0 to 800 ms In steps of 10 ms 14. Breaker status monitoring Binary I/P for each pole **Thermal over load protection** 15. Rated thermal current 0.5 to 2.5 In 16. Thermal alarm 50 to 200% In 17. Current alarm 50 to 200% In **Other Features:** 18. **Binary inputs**: Min ***20*** nos. and suitable for Station Aux DC. 19. **Outputs**: • Trip contacts: Minimum 2 N/O contacts with - Continuous carry 5 A - Make & Carry for 0.5 s 30 A - Make & Carry for 3.0 s 15 A • Binary Output: Minimum 10 Nos. and suitable for Station Aux. DC (Programmable at site) 12. **Communication**: • Front Port - RS232 / RJ45, • Rear Port - Fiber optic / Electrical Ethernet

		• IEC 61850 protocol • Time Synchronization: - IRIG-B / SNTP - as per the requirement (finalized during detail engineering) 20. **Housing** • Flush Mounting • Screw Terminals ('O' Lug for CT Connection) • Degree of Protection IP51 21. **Temperature and humidity** (a) Ambient temp -10 to 55 ^{o}C (b) Relative humidity 10% to 90% Non Condensing (c) Operate range 0-95% (d) Storage temp. -40 to 70 ^{o}C
6	**RESTRICTED EARTH FAULT PROECTION (R.E.F. PROECTION)**	(A) Features: 1) Shall be Numerical type. 2) Shall have 2 over current and 1 Earth Fault element. 3) TRUE RMS Measurement. 4) Have selectable and front panel programmable normal inverse, very inverse, extremely inverse & long inverse IEC/ANSI Characteristic. 5) Selectable CT Secondary. I.e. 1A / 5A 6) High set over current with selectable time delay. 7) High set Earth fault with selectable time delay 8) Have adjustable characteristic angle, lead/ lag, for Directional over current/ Earth Fault respectively. ~~9)~~ Shall decide directionality by internally derived zero sequence quantity through software. 10) Shall have in built Breaker Failure Protection. 11) Include hand reset Flag/LED indicators for fault. 12) Readable Human Machine Interface with LCD display. 13) Should be able to store at least last 3 fault records viz. Fault current, Faulty Phase etc with time stamp. 14) Shall have Disturbance Recording facility for minimum 3 sec for each fault. 15) Self-monitoring. 16) Relay offered shall be communicable type. 17) Be supplied along with all suitable Original Customized licensed software & communication cable for local and remote communications, analysis of fault etc. (B) Technical Parameters: Analogue input:

		Rated Current : 1A / 5A (site selectable), 50 Hz ±2.5 Hz Power consumption: <0.05VA/0.3 VA for 1/5 Amp Over load capability: 4xIn continuous 100xIn 1 Sec. 25xIn 3 Sec. 250xIn Dynamic Rated Voltage: 110/63.5V, 50 Hz ±2.5 Hz Power consumption: <0.3 VA per phase Over load capability: 2xVn continuous Auxiliary Supply: 110/220 V DC ±15 % Power consumption: < 15W Ripple (peak to peak): < 12% (C) Other Features: Binary inputs: Min 8 Nos. and suitable for Station Aux DC (freely assignable). Outputs: • Trip contacts: Minimum 2 N/O contacts with - Continuous carry 5 A - Make & Carry for 0.5 s 30 A - Make & Carry for 3.0 s 15 A • Alarm contacts: Minimum 4 Nos. and suitable for Station Aux. DC (Programmable at site) Communication: • Front Port - RS232 / RJ45, • Rear Port - Fiber optic / Electrical Ethernet • IEC 61850 protocol • Time Synchronization: - IRIG-B / SNTP - as per the requirement (finalized during detail engineering) Housing • Flush Mounting • Screw Terminals ('O' Lug for CT Connection) • Degree of Protection IP54 Temperature and humidity (a) Ambient temp -10 to 55 ^{o}C (b) Relative humidity 10% to 90% Non Condensing (c) Operate range 0-95% (d) Storage temp. -40 to 70 ^{o}C
6A	***UNBALANE CURRENT***	The relay shall i) be suitable for rated current of 1 amp

	PROTECTION RELAY	ii) be of numerical type. iii) have two stages to set alarm & tripping at different values of current iv) have current setting of 10- 50 % of rated current. v) have alarm and trip output contacts. vi) have a local user interface (MMI) comprising of a 2-3 line alphanumeric LCD display and a soft touch key pad to access the settings, events and records in the relay. vii) have hand reset flag/LED indicator. viii)be high speed with typical operating time of less than 25 ms. ix) be provided with sufficient number of potential free contacts to cater the needs of connection to alarm annunciation, Data acquisition and optional trip facility to be connected by purchaser whenever needed. x) be able to store at least last 3 fault records viz. Fault current, Faulty Phase etc. with time stamp. xi) have Disturbance Recording facility for minimum 3 sec for each fault. xii) have continuous self-hardware & software monitoring and diagnostic feature. xiii) be communicable type and support IEC 61850 protocol. xiv) have on line testing facility as per clause no. 5.11.4. xv) Be supplied along with all suitable Original Customized licensed software & communication cable for local and remote communications, analysis of fault etc B) Technical Parameters: 1. Analogue input: Rated Current :1A , 50 Hz, ±2.5 Hz Power consumption: < 0.3 VA Over load capability: 4xIn continuous 100xIn 1 Sec. 25xIn 3 Sec. 250xIn Dynamic 2. Auxiliary Supply: 110/220 V DC ±15 % Power consumption: < 15W Ripple (peak to peak): < 12% (C) Relay settings: 4. Unbalance Current: 10% - 50% (In steps of 5%) 5. Pick up: Within 1.1 times of set current value. 6. Reset current: 95% to 90% of pick-up current. (D) Other Features:

		7. Binary inputs: Min 8 nos. and suitable for Station Aux DC. 8. Outputs: • Trip contacts: Minimum 2 N/O contacts with - Continuous carry 5 A - Make & Carry for 0.5 s 30 A - Make & Carry for 3.0 s 15 A • Alarm contacts: Minimum 4 Nos. and suitable for Station Aux. DC (Programmable at site) (E) Communication: • Front Port - RS232 / RJ45/USB, • Rear Port - Fiber optic / Electrical Ethernet • IEC 61850 protocol • Time Synchronization: - IRIG-B / SNTP - as per the requirement (finalized during detail engineering) (F) Housing • Flush Mounting • Screw Terminals ('O' Lug for CT connection) • Degree of Protection IP51 (G) Temperature and humidity (a) Ambient temp -10 to 55 ^{o} C (b) Relative humidity 10% to 90% Non Condensing (c) Operate range 0-95% (d) Storage temp. -40 to 70 ^{o} C
7	**AUXILIARY RELAYS FOR TRANSF TROUBLES.**	(1).Buchholz trip. – 1 no. (2).Buchholz alarm --- 1 no. (3).OLTC Surge Relay trip. --- 3 no. (4).Oil temperature trip. --- 1 no. (5).Oil temperature alarm. – 1 no. (6).Winding temperature trip. --- 1 no (7).Winding temperature alarm. --- 1 no (8).P.R.V. trip. --- 3 no. (9).Deluge valve operated – 2 no. (10). Low oil level alarm – 1 no. (11). Cooling system trouble alarm. --1 no. (12). Air cell rupture – 1 no (13). Sudden pressure relief – 1 no (14). On line breather alarm – 1 no (15). NIFPS Opts – 1 no (16). NIFPS Alarm – 1 no (17). Spare – 2 nos. (each group) (18). Provide sufficient number of potential free contacts to cater the needs of connection to trip relay 1 & 2, alarm/annunciation, DR/SER/Data acquisition and

		a spare contact to be connected by purchaser where needed.
8	**HIGH SPEED TRIP RELAY**	As per the system design sufficient relays having potential free contacts for (lock out) trip circuit 1 & 2 of main breaker and TBC. The contacts for trip circuit shall be Heavy Duty. 1) Provide sufficient number of potential free contacts to cater the needs of connection to trip circuits, alarm/ annunciation, LBB relay, DR/SER/Data acquisition and spare contacts to be connected by Purchaser where needed. 2) It shall be instantaneous with operating time less than 10 ms. It shall have 18NO & 2NC Electrical resetting type contacts. It shall be 220/110V DC operating and preferably provided with single coil. 3) Be provided with operation indicators.
9	**SUPERVISION RELAY FOR HIGH SPEED TRIP RELAY**	Coil supervision relay shall be provided for all high speed trip relays. The relay shall 1) Monitor the complete coil circuit for both the trip relays i.e. Gr. A & Gr. B. 2) Monitor loss of battery supply 3) Have a delay on drop off 4) Provide alarm output 5) Include hand reset flag indicator 6) Provide sufficient number of potential free contacts to cater the needs of connection to alarm annunciation. Data acquisition and optional trip facility to be connected by purchaser where needed.
10	**TRIP CIRCUIT SUPERVISION RELAY**	Trip circuit supervision relay shall be provided for each pole of the breaker for both trip coils with separate DC source. The relay shall a) Monitor the complete trip circuit with circuit breaker in pre-close & post-close condition. b) Monitor loss of battery supply. c) Have a delay on drop off d) Provide alarm output. e) Include hand reset flag indicator. f) Provide sufficient number of potential free contacts to cater for DR / SER.
11	**DC SUPPLY SUPERVISION RELAY**	The relay shall be capable of monitoring the failure of D.C supply to which it is connected. It shall have adequate potential free contacts to meet the scheme requirement. The relay shall have a time `delay on drop-off' of not less than 100ms. And be provided with operation indicator/flag.
12	**PT SELECTION RELAY**	The necessary PT selection relay shall be provided for line/bus voltage selection. It shall be provided with sufficient contacts for selected P.T. to protection and metering circuits and D.C permissive to protection. The relay should be latched type and operating and resetting coils. The relay shall have clear visible indication flag/LED.

13.	**NUMERICAL BUS BAR PROTECTION RELAYS.**	Numerical Bus Bar Protection scheme shall cover all the main and auxiliary buses and circuits. Numerical Bus Bar Protection scheme shall have the following features. a) It shall be a **Numerical** Bus Bar Protection scheme. b) Operate selectively for the bus bar faults. c) Include protection in / out switch. d) Provide **100% stability up to 50KA fault level.** e) Be **low impedance biased differential** type and shall have operate and restrain characteristics. f) The scheme shall be **for additional two bays as per station layout**, however **central unit shall be compatible for minimum 24 bays** and busbar protection scheme shall be upgradeable accordingly. g) Be inoperative for through faults, but shall operate correctly and positively for faults within the protected zone(s) even under condition of CT saturation. h) Operate selectively for each zone of bus bars for all type of faults, phase to phase or phase to ground faults even for high resistive faults. i) Have **maximum operating time of 20 to 30 ms,** including trip relay, for all type of faults. j) Incorporate **continuous supervision for CT secondary** against any possible open circuit and if it occurs shall render the relevant zone of protection inoperative and provide an alarm output. k) The Bus bar Protection shall have a distributed **structure comprising a Central Unit and Bay Units**. All the Bay Units and the Central Unit shall be located in Busbar protection panel. l) The secondary of the bay CT's shall be connected directly to the respective Bay Unit. **Ratio correction shall be through software means**. External auxiliary CT's shall not be used in the connections to the Bay Units for compensating different CT ratios. m) Filtering and evaluation of the analogue quantities (bay level currents) shall be performed in the Bay Units. The Central Unit shall evaluate the differential currents for each phase and for each zone. The tripping contacts on the Bay Unit shall be directly wired to trip the respective bay breaker, which may have one or two trip coils. The contacts should be of adequate rating. **n)** The Bay Units shall be connected to the Central unit **by means of fiber optic cables**. The

		communication between the Bay Units and the Central Unit shall be effected by means of a deterministic protocol. In case of **any interruption** in the communication between the Central Unit and any Bay Unit, the corresponding **zone shall be blocked**. An **alarm shall also be given.** o) The normally open and normally closed auxiliary contacts of the isolators of each bay shall be connected to the respective Bay Unit. The Bay Units shall send the information regarding the positions of the isolators to the Central Unit at regular intervals and the image of the bus bar shall be formed in software form in the Central Unit. External relays shall not be used for forming the image of the bus bar. p) The normally open (NO) and normally closed (NC) auxiliary contacts on each isolator shall be used for selection of bus bar zones. q) **No CT switching relays shall be used** for connecting correct CT inputs to the protected zone. If both isolators of a particular bay are closed, an audible isolator alarm shall be given and the bus bar zones should act as single zone. This monitoring of the integrity of the isolator auxiliary contacts shall be performed in software form without the use of external relays and timers. r) To enhance security, the Bus bar Protection scheme shall have **two independent measurement and tripping criteria**. A trip signal shall be initiated only if both criteria are simultaneously satisfied. Neither criterion shall be voltage dependent. s) Preferably, these two criteria shall be the stabilized differential current and the phase (directional) comparison of currents in the different bays. t) Where suppliers are offering check zone feature for the low impedance bus bar protection, have to prove that check zone will operate reliably under all conditions and for all internal faults. u) The Bus bar Protection shall be insensitive to transients and harmonics and be fully reliable and selective even under CT saturation conditions. v) The Bus bar Protection shall be capable of operating with **CT's of widely different ratios** with different rated secondary currents. The **matching** of CT ratio in each bay shall be done by a **simple setting via the HMI** without the use of external auxiliary CT's. **w)** The numerical bus bar protection shall be with extensive **self-supervision and diagnostic**

		facilities. x) The HMI programme should **graphically display the bus bar configuration and the bus bar image.** The HMI programme shall facilitate setting of the protection **and read out of various information** such as bus differential current in each zone, phase currents, positions of the isolators & breakers, etc. The HMI programme shall also permit dialogue with the protection from a remote location without the need for additional software. The HMI programme should be based on MS Windows environment. **y)** The HMI programme shall facilitate free assignment of the Opto coupler inputs and signal relay / trip relay outputs to a given list of inputs and outputs. It shall be possible to **programme** the **output relays to be of the latched or non-latched type.** **z)** The Bus bar Protection shall include a **Disturbance Recorder function in central unit as well as each Bay Unit,** which shall record the bay phase currents. The sampling frequency of this Disturbance Recorder function shall be selectable from 2400 Hz, 1200 Hz or 600 Hz. The recording period shall be at least 1.5 seconds. The system shall, preferably, **as an option**, **permit recording of bay level voltages as well.** aa) The Bus bar Protection shall also include an Event Recorder function. The Event Record buffer in the Central Unit shall accommodate at least 1000 events while that in each Bay Unit shall accommodate at least 100 events. bb) The Disturbance Recorder and Event Recorder buffer memory shall be of non-volatile type and shall not require the use of batteries. cc) When the bus tiebreaker is equipped with one set of CT's only and when the bus tiebreaker is in open position, the Bus bar Protection shall exclude this CT in the evaluation of the Bus bar Protection measurement. This will ensure that, when the bus tiebreaker is in open position and a fault occurs between the CT and the bus tiebreaker, the faulted bus section is selectively tripped and isolated without any delay. The healthy bus section will not be tripped. dd) A Local Display Unit (LDU) shall be provided on the Central Unit and on each Bay Unit. ee) The LDU on the Central Unit shall permit read out of the following information: • Differential currents in each Bus bar zone and

		each phase on line as well as at the time of fault. • Alarm conditions • Trip conditions • State of all the inputs and outputs in the Central Unit • Setting values • Phase currents (and optionally, phase voltages) in each bay • State of all the inputs and outputs in each bay • Positions of the isolators in each bay • Positions of the breakers in each bay • Setting values • Resetting of output relays ff) The LDU on each Bay Unit shall permit read out of the following information: • Phase currents (and optionally, phase voltages) in each bay • Alarm conditions • Trip conditions • State of all the inputs and outputs in the respective bay • Positions of the isolators in the respective bay • Position of the breaker in the respective bay • Setting values • Resetting of output relays gg) Provide sufficient number of potential free contacts to cater the needs of connection to alarm annunciation. Data acquisition and optional trip facility to be connected by purchaser where needed. hh) Shall have **immunity against system transients**. **ii)** Include **continuous DC supply supervision.** jj) Incorporate clear zone indication. kk) **Should not operate during the change over operation of a circuit** from one bus to another bus and during normal load flow in bus bars. ll) Trip both the breakers i.e. the breakers being bypassed and the transfer breaker if the bus fault occurs during the change over operation. mm) **Have provision to reset trip bus through a single push button** to be provided for the purpose. nn) It shall be possible to prepare the Bus bar Protection to include, in the protection scheme, future bays as and when they are added. In such cases, the system shall be **easily extendable by adding Bay Units for the new bays and activating the same in the Bus bar Protection**.

		Such extension work shall not require any other wiring changes to the existing system. oo) The bus bar protection offered shall have communication port for integrating with the local station automation or to a station monitoring system. One of the protocols offered for the communication port shall be an international standard protocol IEC 61850. pp) Be supplied along with all suitable Original Customized licensed software & communication cable for local and remote communications, analysis of fault etc. qq) The bay unit shall have built-in Breaker Failure feature. **Rated Parameters:** **Bus Bar Protection Functions:** 1. Min fault current pick-up: (I_{kmin}) 500 to 6000 A In steps of 100 A 2. Neutral current Detection: 100 to 6000 A 3. Stabilizing factor (K): 0.7 to 0.9 in steps of 0.05 4. Diff current Alarm: 5 to 50% of I_{kmin} 2 to 10 s Time Delay 5. Isolator alarm time delay: 0.5 to 90 s 6. Typical tripping time: 20 to 30 ms 7. CT ratio per feeder: 50 to 10000/1 A **Check Zone:** 8. Min fault current pick-up: (I_{kmin}) 500 to 6000 A In steps of 100 A 9. Stabilizing factor (K): 0.0 to 0.9 in steps of 0.05 10. CT ratio per feeder: 50 to 10000/1 A **Analog Inputs (Bay or Peripheral or Field Unit):** 1. No. of Bays: Bays at respective s/s + 2 2. Current Rating: 1A, 50 Hz ±2.5 Hz, ≤0.2 VA 5. Thermal Ratings: • Continuous 4xIn • For 10 s Minimum 10xIn • For 1 s 100xIn 4. Auxiliary Supply: 48 to 250 V DC ±15 %, 11 W **Binary Inputs/ Outputs:** 1. Operating Time: 3 ms 2. Max Operating Volt: 24 to 250 V DC

		3. Max Cont rating: ≥ 8 A 4. Max make & Carry: ≥ 30 A (0.5 s) 5. Max making power: ≥ 3300 W (at 110 V DC) 6. Binary O/P Reset: Programmable 7. Breaking Current: Heavy Duty N/O Contact: ≤ 0.3 A Signaling Contact: ≤ 0.1 A 8. No. of I/P per bay unit: 20 Opto-couplers 9. No. of I/P for central unit: 8 Opto-couplers 10. Pickup current for I/P: ≥ 10 mA 11. Operating Time for I/P: < 1 s 12. Nos of Output – Bay unit: 16 Nos 13. Nos of Output – Central Unit: 08 Nos **Auxiliary Supply:** 1. Input Voltage: 220/110 V DC, ± 20 % 2. Load: 10 W (Bay Unit) 100 W (Central Unit) 3. Front plate Signal: Green LED 4. Switch: ON/ OFF **Optical Interface:** 1. Number of Cores: 2 fiber cores per bay unit 2. Core/ sheath diameter: 62.5/ 125 µm (multi-mode) 3. Max permissible attenuation: ≤ 5 db 4. Connector: Type FST for 62.5 µm OFC **Event Recorder:** It shall have event recording facility for minimum last 50 Operational/ fault events. **Disturbance Recorder:** 1. Independent setting for pre-fault and post-fault period 2. Format: COMTRADE **Local & Remote communication:** 1. Serial interface for connecting a PC, either directly or via a modem. 2. System interface for connecting to a control system via IEC 61850 3. System interfaces via IEC 61850 protocol for inter bay bus supports. 4. Time synchronization IRIG-B / SNTP - as per the requirement (finalized during detail engineering)

		Communication ports: • Front - RS232 / RJ45 / Optical • Rear - Fiber optic / RJ45
14	**UNDER VOLTAGE RELAY**	The relay shall 1) Be triple pole type. 2) Be static type. 3) Have range from 40 to 80% 4) be provided with Hand reset flag/LED type operation indicator. 5) Have minimum two potential free NC contact. Self-reset type. 6) have sufficient potential free contacts to cater for HMI reporting & DR i.e. minimum 2 Nos of Alarm contacts
15	**OVER VOLTAGE RELAY**	The relay shall 1) be static/numerical type 2) monitor all three phases 3) have adjustable voltage setting range of 100 – 150% of rated voltage & adjustable time setting range of 0 to 10 seconds continuously or in step of 1 Sec. 4) have independent alarm & trip out put contacts. 5) have drop off to pick up ratio equal to or greater than 95%. 6) be provided with Hand reset flag/LED type operation indicator. 7) have sufficient potential free contacts to cater for for HMI reporting & DR i.e. minimum 2 Nos of Trip and 2 Nos of Alarm contacts Note: In case of numerical relay, it shall have following parameters (A) • Front Port - RS232 / RJ45 / USB (If numerical), • Rear Port - Fiber optic / Electrical Ethernet • Communication protocol: IEC 61850 • Time Synchronization: - IRIG-B / SNTP - as per the requirement (finalized during detail engineering) • store at least last 3 fault records viz. Fault current, Faulty Phase etc with time stamp. • Disturbance Recording facility for minimum 3 sec for each fault. • continuous self-hardware & software monitoring and diagnostic feature. Other Features: (B) Input-Outputs Binary inputs: Min 8 nos. and suitable for Station Aux DC. Outputs:

		• Trip contacts: Minimum 2 N/O contacts with - Continuous carry 5 A - Make & Carry for 0.5 s 30 A - Make & Carry for 3.0 s 15 A • Alarm contacts: Minimum 4 Nos. and suitable for Station Aux. DC (Programmable at site) (C) Housing • Flush Mounting • Screw Terminals ('O' Lug for CT connection) • Degree of Protection IP51 (D) Temperature and humidity (a) Ambient temp -10 to 55 ^{o}C (b) Relative humidity 10% to 90% Non Condensing (c) Operate range 0-95% (d) Storage temp. -40 to 70 ^{o}C
16	**OVER FLUX RELAY**	The relay shall; i). The relay shall be static/numerical type ii). Operate on the principle of voltage to frequency ratio and shall be phase to phase connected. iii). Have inverse time characteristics, matching with transformer over fluxing withstand capability curve. iv). Provide an independent `alarm' with the time delay continuously adjustable between 0.1 to 6 seconds. v). Tripping time shall be governed by v/f vs. time characteristic of the relay. vi). V/F setting shall be adjustable from 1.0 to 1.5 times rated flux. vii). Have a set of characteristics for various time multiplier settings. The maximum operating time of the relay shall not exceed 3 seconds and 1.5 seconds at `V/F' values of 1.4 and 1.5 times of rated values respectively. viii). have an accuracy of operating time, better than ± 10% Have a resetting ratio of 95% or better, rated voltage 110V AC. 50Hz. ix). have sufficient potential free contacts to cater for for HMI reporting & DR i.e. minimum 2 Nos of Trip and 2 Nos of Alarm contacts x). Include hand reset LED for Alarm & Trip operated indication. Note: In case of numerical relay, it shall have following parameters (A)

		• Front Port - RS232 / RJ45 / USB (If numerical), • Rear Port - Fiber optic / Electrical Ethernet • Communication protocol: IEC 61850 • Time Synchronization: - IRIG-B / SNTP - as per the requirement (finalized during detail engineering) • Store at least last 3 fault records viz. Fault current, Faulty Phase etc with time stamp. • Disturbance Recording facility for minimum 3 sec for each fault. • Continuous self-hardware & software monitoring and diagnostic feature. Other Features: (B) Input-Outputs Binary inputs: Min 6 Nos. and suitable for Station Aux DC. Outputs: • Trip contacts: Minimum 2 N/O contacts with - Continuous carry 5 A - Make & Carry for 0.5 s 30 A - Make & Carry for 3.0 s 15 A • Alarm contacts: Minimum 4 Nos. and suitable for Station Aux. DC (Programmable at site) (C) Housing • Flush Mounting • Screw Terminals ('O' Lug for CT connection) • Degree of Protection IP51 (D) Temperature and humidity (a) Ambient temp -10 to 55 ^{o}C (b) Relative humidity 10% to 90% Non Condensing (c) Operate range 0-95% Storage temp. -40 to 70 ^{o}C

SCHEDULE – B

GUARANTEED TECHNICAL PARTICULARS

(TO BE FILLED IN BY THE BIDDER AND FURNISH WITH TECHNICAL BID)

The bidder must fill up all the point of GTP for offered item/s. Instead of indicating "refer drawing, or as per IS/IEC", the exact value/s must be filled in.

	Description	Bidder's Comment
A	**CONTROL & PROTECTION PANELS**	
1.	Make	
2.	Panel Details 1. Material of panel 2. Type of panel 3. Swing frame front door 4. Front openable only 5. Transparent perplex door at front 6. Equipment mounting front side of the panel 7. Over all Dimension (H x W x D) mm 8. Base channel Size Thickness 9. Anti-vibration pad Thickness 10. No. of doors and on which side of the panel. 11. Thickness of sheet steel (a) Front (b) Door Frame (c) Base Frame (d) Side (e) Cubicle roof (f) Door (g) Gland plates 12. Inter panel cutout dimensions H x W mm 13. Gland plate Nos and Size 14. Louvers 15. Lifting eye bolts 16. Degree of protection	
3.	Details of painting 1. IS `Code of Practice for phosphating 2. Sheet steel treatment process 3. Powder coating with electrostatic spray 4. Paint shed no. and IS of colour. a) External b) Internal 5. Paint thickness 6. Paint shall be free from 7. Finished paint appearance after process	
4.	Mounting details	

	1. Mounting on 2. Duly flush to	
5.	Largest package by transport (1) Gross weight (2) Overall dimensions of package	
6.	GA drawing	
7.	Minimum height of switches & Push buttons	
8.	Minimum height of Relays and meters	
B	**PANEL WIRING**	
1.	Insulation class and type	
2.	Voltage grade	
3.	It shall be single core multi strand flexible wire.	
4.	Conductor used	
5.	Size of wiring conductor for following. 1) PT Circuits 2) CT Circuits 3) DC supply circuits 4) AC circuits 5) Earthing	
6.	Colour code of wiring for following. 1) PT Circuits – R, Y, B & Neutral 2) CT Circuits – R, Y, B & Neutral 3) CVT Circuits – R, Y, B & Neutral 4) DC supply circuits 5) AC supply circuits 6) Earthing	
7.	Type of Lugs, Sleeves Ferrules	
8.	Special ferrules for Trip coil wires	
9.	Panel internal wiring inner side of Terminal blocks	
10.	Applicable standard	
C	**TERMINAL BLOCKS**	
1.	Make	
2.	Voltage grade	
3.	Current rating	
4.	Type and model No. of TB for a) CT, CVT, PT wiring b) Other DC-AC wiring	
5.	Size of wire that can be connected to a) CT, CVT, PT wiring b) Other DC-AC wiring	
6.	No. of spare terminals uniformly distributed	
7.	Minimum clearance from bottom to gland plate	

8.	Type	
9.	High voltage withstand capability	
10.	Protective transparent plastic cover for all TBs	
11.	Applicable standard	
D	**EARTHING**	
1.	Conductor material and type for Panel earthing Equipment earthing	
2.	Size of the earthing conductor Panel earthing Equipment earthing	
3.	Length of earth bus	
4.	Size of coupling earth link	
5.	Extension coupling earth link provided at both the ends of earth bus	
6.	Equipment earthing directly to earth bus without any looping	
E	**CIRCUIT LABLE**	
1.	Material	
2.	Colour	
3.	Name plate label details	
F	**CONTROL SWITCHES FOR CIRCUIT BREAKERS:**	
1.	Make	
2.	Type of switch 1) Type switch for breaker 2) Type of switch for other applications	
3.	Rating of contacts 1) Voltage 2) Make and carry continuously. 3) Make and carry for 0.5 sec. 4) Break resistive load with L/R ratio of 40 ms.	
4.	Whether locking arrangement provided.	
5.	Type of handle standard	
6.	Dimensions	
7.	Red Base or Handle for Breaker control switch	
8.	Mounting details and drawing no.	
9.	Detailed technical literature furnished.	
10.		
G	**PUSH BUTTONS**	
1.	Make	
2.	Type	
3.	Contact type(momentary/maintained)	

4.	Whether shrouding provided to prevent inadvertent operation.	
5.	Whether integral engraved integral plates provided.	
6.	No. of NO/NC contacts.	
H	**AUXILIARY RELAYS**	
1.	Make	
2.	Type & Designation	
3.	Mounting	
4.	Nominal voltage and % variation	
5.	Contacts (hand reset/self-reset)	
6.	No. of pairs of contacts i) Make contacts ii) Break contacts	
7.	Speed operation of relay	
8.	Pick up / drop off ratio	
9.	Burden of relay – VA	
10.	(i) Contact rating (ii) Voltage (iii) Making current and duration (iv) Breaking current a) Resistive b) Inductive 0.3 PF c) Inductive L/R 10m sec 40m sec	
11.	Detailed literature furnished.	
12.	Standard	
I	**CONTACT MULTIPLICATION REPLY:**	
1.	Whenever auxiliary relay is used as contact multiplication purpose, the relay should be latched & electrically reset type.	
2.	Other specification as Auxiliary relay. i) Make ii) Type and designation iii) Nominal voltage and % variation. iv) Contacts, hand reset/self reset. v) No. of pairs of contacts. a) Make contacts b) Break contacts vi) Speed of operation of relay vii) Pick up/drop off ratio viii) Burden of relay – VA ix) i)Contact rating ii)Voltage iii)Make current and duration x) Breaking current a) Resistive b) Inductive 0.3 PF c) Inductive L/R	

	10m sec. 40m sec.	
3.	Detailed literature furnished.	
4.	Standard	
J	**TRIP CIRCUIT SUPERVISION RELAYS**	
1.	Make	
2.	Type designation	
3.	Rating	
4.	i) Operating principal ii) Literature write-up enclosed.	
5.	Minimum voltage for satisfactory operation.	
6.	Burden	
7.	Monitoring of breaker trip coil in both open and close position provided.	
8.	Safety resistor provided to limit the current if the relay coil is short circuited.	
9.	Output contacts i) No. of NO/NC contacts ii) Rating of contacts	
10.	Time delay on drop off	
11.	Type of indication	
12.	Standard	
13.	Any other relevant details.	
K	**TRIPPING RELAYS**	
1.	Make	
2.	Type designation	
3.	Rating	
4.	i) Operating principal ii) Literature write up enclosed	
5.	Operating time at rated voltage.	
6.	Relay suitable for being continuously monitored.	
7.	Electrical reset contacts i) No. of NO & NC contacts ii) Rating of contacts.	
L	**ENERGY METER**	
1.	Make Model Accuracy class	
M	**DISTANCE RELAYS**	
1.	Make	
2.	Type designation	
3.	Whether comply to Principle Technical Parameters as per Annexure III, Section-II	
4.	Whether Numerical measurement.	
5.	Auxiliary DC Voltage with permissible tolerance	
6.	CT input, specify whether selectable at site. Permissible over load	

7.	PT input with permissible over load.	
8.	Type and no. of measuring elements.	
9.	No. of zones.	
10.	Type and no. of starting units.	
11.	Minimum operating current for each element.	
a	**Max. Reactive reach range**	
1.	First zone element	
2.	Second zone element	
3.	Third zone element	
4.	Fourth (Reverse) zone element	
5.	Power Swing	
6.	Load Encroachment	
b	**Max. Resistive reach range**	
1.	First zone element	
2.	Second zone element	
3.	Third zone element	
4.	Fourth (Reverse) zone element	
5.	Power Swing	
6.	Load Encroachment	
7.	Minimum and maximum line length in Km for which the fault can be detected	
8.	Reset ratio for Distance Protection function	
9.	Reset ratio for SOTF	
10.	Type of power swing blocking (state type and characteristic)	
c	**Operating time range**	
1.	First zone	
2.	Second zone	
3.	Third zone	
4.	Fourth (Reverse) zone element	
5.	PS Blocking timer	
6.	PS De-blocking timer	
7.	Relay characteristics angle range for Measuring units	
8.	Starting units	
9.	Power swing blocking relays	
10.	Whether suitable for any communication scheme.	
11.	Have all carrier auxiliary relays been provided (give technical particulars)	
12.	No. of Binary Inputs and their ratings.	
13.	No. of Binary outputs and their ratings.	
14.	Tripping time carrier (maximum and minimum)	
d	**Type of auto re-close scheme and time range for;**	
1.	Dead time	
2.	Reclaim time	

e	**VA burden of each phase relay.**	
1.	Current circuit	
2.	Potential circuit	
3.	DC circuits	
4.	Whether continuous self-monitoring and diagnostic feature is available..	
5.	Relay characteristics available	
6.	Change in characteristics possible	
7.	Burden on CT and VT per phase.	
8.	No. of tripping relays provided	
9.	No. of NO/NC contacts of each tripping relays suitable for use in auto reclosure scheme.	
10.	All aux. relays for the scheme provided.	
11.	All external resistors as required provided.	
12.	Carrier ON/OFF provided.	
13.	Auto re-closure scheme with check relay as per specification in annexure III	
f	**Measurements of functions list here.**	
1.	No. of Disturbance Records and their different time periods.	
2.	Manual online testing facility provided through test plug without isolation of any circuit from panel TB.	
3.	Communication Protocols	
4.	Time Synchronization	
g	**Parametric points**	
1.	Relay type	
2.	Site selectable CT 1A/5A	
3.	Modular design	
4.	Built in DC supervision	
5.	Self-diagnostic feature covering all parts of relay	
6.	5 Zone -direction selectable	
7.	Independent measuring loop for all types of faults	
8.	Quadrilateral / Polygon characteristic	
9.	MHO Characteristics preferably for Ph-Ph faults	
10.	Independently adjustable reactive and resistive reach	
11.	Adjustable characteristic angle	
12.	Memory voltage for directional discrimination for close faults based on positive sequence only	
13.	Distance -	
14.	Max. operating time including carrier with CVT being used	
15.	Independent time setting for each zone	
16.	PUTT, POTT and blocking communication scheme compatibility	
17.	MMI -	

18.	Front port	
19.	Rear port	
20.	Mutual zone sequence compensation	
21.	Reset ratio	
22.	Typical operating time	
23.	Power swing blocking and tripping mentioned and without use of external timers	
24.	Fuse failure feature	
25.	Loss of voltage feature	
26.	Binary input	
27.	Binary O/P -	
28.	Disturbance record -	
29.	DR sampling rate -	
30.	Current reversal feature	
31.	Week end feed feature	
32.	SOTF	
33.	Breaker failure feature	
34.	Dead line detection feature	
35.	1/3 Phase A/R	
36.	Nos of shots	
h	**Syn. Check**	
1.	Operating modes	
2.	Phase angle difference	
3.	Voltage difference	
4.	Reset ratio	
5.	Frequency difference limit	
6.	Time delay	
7.	Load Encroachment	
8.	Load Encroachment reach	
9.	Battery status monitoring	
10.	Built in distance to fault locator	
11.	Broken conductor feature	
12.	IDMT O/C-E/F feature	
13.	Time Sync. -	
14.	IEC 61850-8-1 communication protocol	
15.	PU/DO ratio for Over voltage protection	
16.	Terminal connection	
17.	Deg. Of protection	
N	**DISTANCE CUM DIFFERENTIAL RELAYS**	
a	**Distance Protection**	
1.	Make	
2.	Type designation	
3.	Whether comply to Principle Technical Parameters as per Annexure III, Section-II	
4.	Whether Numerical measurement.	
5.	Auxiliary DC Voltage with permissible tolerance	

6.	CT input, specify whether selectable at site. Permissible over load	
7.	PT input with permissible over load.	
8.	Type and no. of measuring elements.	
9.	No. of zones.	
10.	Type and no. of starting units.	
11.	Minimum operating current for each element.	
b	**Max. Reactive reach range**	
1.	First zone element	
2.	Second zone element	
3.	Third zone element	
4.	Fourth (Reverse) zone element	
5.	Power Swing	
6.	Load Encroachment	
c	**Max. Resistive reach range**	
1.	First zone element	
2.	Second zone element	
3.	Third zone element	
4.	Fourth (Reverse) zone element	
5.	Power Swing	
6.	Load Encroachment	
7.	Minimum and maximum line length in Km for which the fault can be detected	
8.	Reset ratio for Distance Protection function	
9.	Reset ratio for SOTF	
10.	Type of power swing blocking (state type and characteristic)	
d	**Operating time range**	
1.	First zone	
2.	Second zone	
3.	Third zone	
4.	Fourth (Reverse) zone element	
5.	PS Blocking timer	
6.	PS De-blocking timer	
7.	Relay characteristics angle range for Measuring units	
8.	Starting units	
9.	Power swing blocking relays	
10.	Whether suitable for any communication scheme.	
11.	Have all carrier auxiliary relays been provided (give technical particulars)	
12.	No. of Binary Inputs and their ratings.	
13.	No. of Binary outputs and their ratings.	
14.	Tripping time carrier (maximum and minimum)	
e	**Type of auto re-close scheme and time range for**,	
1.	Dead time	

2.	Reclaim time	
f	**VA burden of each phase relay.**	
1.	Current circuit	
2.	Potential circuit	
3.	DC circuits	
4.	Whether continuous self-monitoring and diagnostic feature is available..	
5.	Relay characteristics available	
6.	Change in characteristics possible	
7.	Burden on CT and VT per phase.	
8.	No. of tripping relays provided	
9.	No. of NO/NC contacts of each tripping relays suitable for use in auto-reclosure scheme.	
10.	All aux. relays for the scheme provided.	
11.	All external resistors as required provided.	
12.	Carrier ON/OFF provided.	
13.	Auto re-closure scheme with check relay as per specification in annexure III	
14.	Measurements of functions list here.	
15.	No. of Disturbance Records and their different time periods.	
16.	Manual online testing facility provided through test plug without isolation of any circuit from panel TB.	
17.	Communication Protocols	
18.	Time Synchronization	
19.	Is the scheme exactly as per specification?	
20.	If not, list out deviations.	
g	**Parametric points**	
1.	Site selectable CT 1A/5A	
2.	Modular design	
3.	Built in DC supervision	
4.	Self-diagnostic feature covering all parts of relay	
5.	5 Zone -direction selectable	
6.	Independent measuring loop for all types of faults	
7.	Quadrilateral / Polygon characteristic	
8.	MHO Characteristic preferably for Ph-Ph faults	
9.	Independently adjustable reactive and resistive reach	
10.	Adjustable characteristic angle	
11.	Memory voltage for directional discrimination for close faults based on positive sequence only	
12.	Distance -	
13.	Max. operating time including carrier with CVT being used	
14.	Independent time setting for each zone	
15.	PUTT, POTT and blocking communication	

	scheme compatibility	
16.	MMI -	
17.	Front port	
18.	Rear port	
19.	Mutual zone sequence compensation	
20.	Reset ratio	
21.	Typical operating time	
22.	Power swing blocking and tripping mentioned and without use of external timers	
23.	Fuse failure feature	
24.	Loss of voltage feature	
25.	Binary input	
26.	Binary O/P	
27.	Disturbance record	
28.	DR sampling rate	
29.	Current reversal feature	
30.	Week end feed feature	
31.	SOTF	
32.	Breaker failure feature	
33.	Dead line detection feature	
34.	1/3 Phase A/R	
35.	Nos of shots	
h	**Syn. Check**	
1.	Operating modes	
2.	Phase angle difference	
3.	Voltage difference	
4.	Reset ratio	
5.	Frequency difference limit	
6.	Time delay	
7.	Load Encroachment	
8.	Load Encroachment reach	
9.	Battery status monitoring	
10.	Built in distance to fault locator	
11.	Broken conductor feature	
12.	IDMT O/C-E/F feature	
13.	Time Sync. -	
14.	IEC 61850-8-1 communication protocol	
15.	PU/DO ratio for Over voltage protection	
16.	Terminal connection	
17.	Deg. Of protection	
i	**Line Differential Protection**	
1.	Working Principle	
2.	Slope Characteristics	
3.	Display & Measurement of Differential as well as Restrain current	
4.	Exchange of telegrams via-	
5.	Communication formats	

6.	Redundant communication channel for protection	
7.	It shall communicate analogue as well as digital signals to remote end.	
8.	Communication options	
9.	Line charging current compensation feature	
10.	Distance/ Differential Protection function selection	
11.	Communication coordination	
j	**Super vision**	
1.	Monitor individual communication links continuously and switchover to standby link after preset time in case of failure of one link.	
2.	It shall supervise individual telegrams.	
3.	It shall detect reflected telegrams.	
4.	It shall detect change in communication delay time.	
5.	It shall measure delay time for remote end along with dynamic compensation of the same in differential protection algorithm.	
6.	It shall also supervise maximum permissible delay time.	
7.	It shall generate alarm for heavily disturbed communication link.	
k	**Technical Parameters**	
1.	Minimum Operating current	
2.	slope (single/Dual)	
3.	End section (Signal /Dual)	
4.	High set Operating current	
5.	2nd Harmonics blocking	
6.	Typical operating time	
7.	Operating time for high set	
8.	Charging current comp.	
l	**Remote Communication**	
1.	Analog signal transfer	
2.	Binary signal transfer	
3.	Remote Communication module dual modules suitable for	
4.	Synchronization mode	
5.	Time delay alarm	
6.	Time delay	
7.	Asymmetric delay	
8.	Max. Transmission delay	
O	**BACKUP IMPEDANCE RELAY**	
1.	Make	
2.	Type & designation	
3.	Whether comply to Principle Technical Parameters as per Annexure III, Section-II	
4.	Whether Numerical measurement.	

5.	Auxiliary DC Voltage with permissible tolerance.	
6.	CT input with Permissible over load.	
7.	PT input with permissible over load.	
8.	Type and no. of measuring elements.	
9.	No. of zones.	
10.	Type and no. of starting units.	
11.	Relay characteristics	
12.	Impedance setting range	
13.	Timer range	
a	Relay characteristics angle range for;	
1.	Measuring units	
2.	Starting units	
b	Max. VA burden per phase.	
1.	Current circuit	
2.	Potential circuit	
3.	DC circuits	
4.	Whether continuous self-monitoring and diagnostic feature is available.	
5.	(A) • Front Port • Rear Port • Communication protocol • Time Synchronization: • Nos of fault records storage and parameters • Disturbance Recording duration for each fault. • Continuous self-hardware & software monitoring and diagnostic feature.	
6.	B) Input-Outputs Nos of Binary inputs Nos of Outputs Nos of Trip contacts Nos of Alarm contacts	
7.	C) Housing • Mounting • Screw Terminals ('O' Lug for CT connection) • Degree of Protection (D) Temperature and humidity (a) Ambient temp (b) Relative humidity (c) Operate range (d) Storage temp.	
P	**DIRECTION O/C & E/F PROTECTION RELAY**	
1.	Features	
2.	Shall be Numerical type.	
3.	Shall have 2 over current and 1 Earth Fault	

	element.	
4.	TRUE RMS Measurement.	
5.	Have selectable and front panel programmable normal inverse, very inverse, extremely inverse & long inverse IEC/ANSI Characteristic.	
6.	Selectable CT Secondary. I.e. 1A / 5A	
7.	High set over current with selectable time delay.	
8.	High set Earth fault with selectable time delay	
9.	Have adjustable characteristic angle, lead/ lag, for Directional over current/ Earth Fault respectively.	
10.	Shall decide directionality by internally derived zero sequence quantity through software.	
11.	Shall have in built Breaker Failure Protection.	
12.	Include hand reset Flag/LED indicators for fault.	
13.	Readable Human Machine Interface with LCD display.	
14.	Should be able to store at least last 3 fault records viz. Fault current, Faulty Phase etc. with time stamp.	
15.	Shall have Disturbance Recording facility for minimum 3 sec for each fault.	
16.	Self-monitoring.	
17.	Relay offered shall be communicable type.	
18.	Be supplied along with all suitable Original Customized licensed software & communication cable for local and remote communications, analysis of fault etc	
a	**Parametric points**	
	Analogue inputs	
1.	Rated Current	
2.	Power consumption	
3.	Over load capability	
4.	Rated Voltage	
b	**Power**	
1.	Auxiliary Supply	
2.	Power consumption	
3.	Ripple (peak to peak)	
c	**Relay Settings**	
1.	Over Current	
2.	Earth Fault	
3.	High set O/C	
4.	High set E/F	
5.	Time multiplier for IDMT	
6.	Time delay for high set element:	
7.	Pick up	
8.	Reset current	
9.	Operating Time	

10.	MTA characteristic angle range: For O/C For E/F	
d	**Other Features**	
1.	Binary inputs	
2.	Binary Outputs (Trip/Signaling)	
e	**Contact Ratings**	
1.	i)Make and carry continuously ii)Make and carry for 0.5 sec. iii)Break resistive load and inductive load with 40m sec. time constant iv)Whether self-reset or hand reset	
f	**Communication**	
1.	Front Port	
2.	Rear Port	
3.	Communication Protocol	
4.	Time Synchronization	
g	**Housing**	
1.	Flush Mounting	
2.	Screw Terminals (‘O’ Lug for CT Connection	
3.	Degree of Protection IP54	
h	**Temperature and humidity**	
1.	Ambient temp.	
2.	Relative humidity	
3.	Operating range	
4.	Storage temp.	
Q	**NON-DIRECTIONAL OVERCURRENT AND EARTH FAULT RELAY**	
	Features	
1.	Shall be Numerical type.	
2.	Shall have 2 over current and 1 Earth Fault element.	
3.	TRUE RMS Measurement.	
4.	Have selectable and front panel programmable normal inverse, very inverse, extremely inverse & long inverse IEC/ANSI Characteristic.	
5.	Selectable CT Secondary. I.e. 1A / 5A	
6.	High set over current with selectable time delay.	
7.	High set Earth fault with selectable time delay	
8.	Shall have in built Breaker Failure Protection.	
9.	Include hand reset Flag/LED indicators for fault.	
10.	Readable Human Machine Interface with LCD display.	
11.	Should be able to store at least last 3 fault records viz. Fault current, Faulty Phase etc with time stamp.	
12.	Shall have Disturbance Recording facility for minimum 3 sec for each fault.	

13.	Self-monitoring.	
14.	Relay offered shall be communicable type.	
15.	Be supplied along with all suitable Original Customized licensed software & communication cable for local and remote communications, analysis of fault etc	
a	**Parametric points**	
	Analogue inputs	
1.	Rated Current	
2.	Power consumption	
3.	Over load capability	
4.	Rated Voltage	
b	**Power**	
1.	Auxiliary Supply	
2.	Power consumption	
3.	Ripple (peak to peak)	
c	**Relay Settings**	
1.	Over Current	
2.	Earth Fault	
3.	High set O/C	
4.	High set E/F	
5.	Time multiplier for IDMT	
6.	Time delay for high set element:	
7.	Pick up	
8.	Reset current	
9.	Operating Time	
d	**Other Features**	
1.	Binary inputs	
2.	Binary Outputs (Trip/Signaling)	
e	**Contact Ratings**	
1.	i)Make and carry continuously ii)Make and carry for 0.5 sec. iii)Break resistive load and inductive load with 40m sec. time constant iv)Whether self-reset or hand reset	
f	**Communication**	
1.	Front Port	
2.	Rear Port	
3.	Communication Protocol	
4.	Time Synchronization port	
g	**Housing**	
1.	Flush Mounting	
2.	Screw Terminals (‘O’ Lug for CT Connection	
3.	Degree of Protection IP54	
h	**Temperature and humidity**	
1.	Ambient temp.	
2.	Relative humidity	

3.	Operating range	
4.	Storage temp.	
R	**DIFFERENTIAL RELAYS**	
1.	Make	
2.	Type and designation	
3.	Whether comply to Principle Technical Parameters as per Annexure III, Section-II	
4.	Whether Numerical measurement.	
5.	True RMS measurement	
6.	Whether continuous self-monitoring and diagnostic feature is available	
7.	Current circuit rating	
8.	Operating principle	
9.	Number of poles	
a	**Max. V.A burden**	
13.	Operating circuit	
14.	Restraining circuit	
15.	Min. Operating current	
16.	Is the slope setting variable.	
17.	Setting ranges available	
18.	Aux. Power	
19.	Power consumption	
20.	Ripple	
21.	Operating circuit	
22.	Restraining circuit	
23.	2nd and 5th harmonic restrain	
24.	Whether internal angle and ratio correction is available	
b	**Operating time**	
1.	at 2 x In	
2.	At 10 x In	
3.	Time take to energize the trip coil of the break for initiation of fault current as in (I and II) above.	
4.	Resetting ratio	
5.	Adjustable bias setting.	
6.	Three pole instantaneous high set units provided.	
7.	Burden on CT input	
8.	Burden on VT input	
c	**Current input rating**	
1.	Continuous	
2.	For 1 sec	
3.	For 3 sec	
4.	Dynamic	
5.	Voltage input rating	
6.	Nos of Input	
7.	Output contacts and their ratings.	

d	**Shall have the following functions.**	
1.	Differential Protection	
2.	Restricted Earth Fault Protection	
3.	Thermal Over Load Detection	
4.	Over Fluxing Protection	
5.	LBB	
6.	Details of Disturbance Recording facility.	
7.	Descriptive leaflet Ref. No.(to be enclosed)	
e	**Parametric points**	
1.	DC Supervision	
2.	Diff. Current:	
3.	Diff. High Current	
4.	Bias Diff Current	
5.	Bias slope limit	
6.	2nd Harmonic Rest.ratio	
7.	5th Harmonic Rest.ratio	
f	**Over flux protection**	
1.	V/f Alarm	
2.	Time delay for alarm	
3.	Characteristic Values V/f	
4.	Time delay for each V/f	
g	**REF Protection**	
1.	Differential current	
h	**LBB Feature**	
1.	Current range	
2.	Time delay	
3.	Operating time	
4.	Communication Port	
5.	Communication Protocol	
6.	Time synchronization	
7.	Terminals	
8.	Deg. Of protection	
9.	Amp. Temp.	
10.	Humidity	
11.	Operating range	
12.	Storage temp.	
13.	Display	
14.	MMI	
S	**RESTRICTED EARTH FAULT RELAY**	
1.	Make	
2.	Type	
3.	Whether comply to Principle Technical Parameters as per Annexure III, Section-II	
4.	Whether it is high impedance?	
5.	Maximum VA burden	
6.	(A)	

	• Front Port • Rear Port • Communication protocol • Time Synchronization: • Nos of fault records storage and parameters • Disturbance Recording duration for each fault. • Continuous self-hardware & software monitoring and diagnostic feature.	
7.	B) Input-Outputs Nos of Binary inputs Nos of Outputs Nos of Trip contacts Nos of Alarm contacts	
8.	C) Housing • Mounting • Screw Terminals ('O' Lug for CT connection) • Degree of Protection (D) Temperature and humidity (a) Ambient temp (b) Relative humidity (c) Operate range (d) Storage temp.	
a	**Operating time**	
1.	Minimum	
2.	Maximum	
3.	Description leaflet Ref. no.	
4.	No. of contacts make and carry for 0.5 sec and break type.	
5.	Whether contacts self-reset or hand reset.	
b	**Contact ratings**	
1.	Make and carry continuously	
2.	Make and carry for 0.5 sec.	
3.	Break resistive load and inductive load with 40 m. sec. time current.	
4.	Setting range.	
c	**Parametric points**	
1.	2-3 line LCD Display	
2.	LED Indication	
3.	IEC -61850 Compatible	
4.	Operating time	
T	**UNBALANCE CURRENT PROTECTION RELAY**	
1.	Make	
2.	Model type	
3.	Suitable for rated current of 1 amp	

4.	Shall be of numerical type	
5.	Shall have two stages to set alarm & tripping at different values of current	
6.	Shall have a local user interface (MMI) comprising of a 2-3-line alphanumeric LCD display and a soft touch key pad to access the settings, events and records in the relay.	
7.	Shall have hand reset flag/LED indicator	
8.	Shall be high speed with typical operating time of less than 25 ms	
9.	Shall be able to store at least last 3 fault records viz. Fault current, Faulty Phase etc with time stamp.	
10.	Shall have Disturbance Recording facility for minimum 3 sec for each fault	
11.	Shall have continuous self-hardware & software monitoring and diagnostic feature	
12.	Shall be communicable type and support IEC 61850 protocol.	
13.	Shall have on line testing facility as per clause no. 5.11.4.	
14.	Shall be supplied along with all suitable Original Customized licensed software & communication cable for local and remote communications, analysis of fault etc.	
15.	Analogue input: Rated Current: Power consumption Over load capability	
16.	Auxiliary Supply Power consumption Ripple (peak to peak)	
17.	Relay settings: Unbalance Current Pick-up range Reset ratio	
18.	Nos of Binary inputs	
19.	Nos of Outputs	
20.	Communication Front Rear Protocol Time Synchronization	
21.	Housing Flush mounting Screw type terminals (‘O’ Lug for CT connection) Degree of Protection	

22.	Temperature and humidity Ambient temp Relative humidity Operate range Storage temp	
U	**BUS DIFFERENTIAL RELAY**	
1.	Make	
2.	Type designation	
3.	Whether comply to Principle Technical Parameters as per Annexure III, Section-II	
a	**Bus Bar Protection Functions**	
1.	Min fault current pick-up range (Ikmin) --	
2.	Neutral current Detection range	
3.	Stabilizing factor (K)	
4.	Diff current Alarm setting range	
5.	Time Delay for (4) above	
6.	Isolator alarm time delay setting	
7.	Typical tripping time	
b	**Check Zone**	
1.	Min fault current pick-up range (Ik min)	
2.	Stabilizing factor (K)	
c	**Analog Inputs (Bay or Peripheral or Field Unit)**	
1.	Minimum no. of Bays which can be connected with central unit	
2.	Current Rating	
3.	Thermal Ratings	
4.	Continuous	
5.	For 10 s, Minimum 10xIn	
6.	For 1 s, 100xIn	
7.	Voltage Rating	
8.	Auxiliary Supply	
d	**Binary Inputs/ Outputs**	
1.	Operating Time	
2.	Max Operating Volt	
3.	Max Cont. rating	
4.	Max make & Carry	
5.	Max making power	
6.	No. of Binary O/P per Bay Unit	
7.	No. of Binary O/P from Central Unit	
8.	Whether Binary O/P Reset Programmable	
9.	Breaking Current	
10.	Heavy Duty N/O Contact	
11.	Signaling Contact	
12.	No. of I/P per bay unit	
13.	No. of I/P for central unit	
14.	Pickup current for I/P	
15.	Operating Time for I/P	

e	**Auxiliary Supply**	
1.	Input Voltage	
2.	Load (Bay Unit)	
3.	Load (Central Unit)	
4.	Front plate Signal	
5.	Switch	
6.	Redundant power Supply **(Optional)**	
f	**Optical Interface**	
1.	Number of Cores	
2.	Core/ sheath diameter	
3.	Max permissible attenuation	
4.	Connector	
g	**Event Recorder**	
1.	It shall have event recording facility for minimum last 50 Operational/ fault events	
h	**Disturbance Recorder**	
1.	Independent setting for pre-fault and post-fault period	
2.	Format	
i	**Local & Remote communication**	
1.	Whether agreed for Testing & Commissioning of the panels at site.	
2.	Whether agreed for 24 Months Performance Guarantee	
3.	Whether agreed for Demonstration of the offered panel or any loose item to be used in the panel, if asked before the opening of the price bid.	
4.	Whether agreed for Training if asked by the purchaser.	
5.	Whether Schedule B and G duly stamped and signed attached.	
6.	TOOLS	
7.	Whether Optional tools required for testing/ commissioning/ maintenance is listed and price for the same is given	
8.	SPARES Whether list of recommended spares for normal maintenance for period of 5 years furnished.	
j	**Parametric points**	
1.	Filtering and evaluation of Analogue qty at bay level	
2.	Tripping to trip coil directly from Bay units	
3.	BU to CU connection, communication	
4.	Blocking of zone in case of communication failure and annunciation thereof	
5.	Busbar image in central unit in software form without any external relays	
6.	Isolator integrity monitoring through software	

	without any external relay and annunciation thereof	
7.	DR/Event function in CU as well as BU with nonvolatile buffer memory	
8.	DR Sampling freq. and total duration	
9.	Nos of events	
10.	Blind zone detection &CB failure feature	
11.	Differential current display of each zone on line as well as at the time of fault	
12.	Continuous DC supervision	
13.	Central unit compatibility	
14.	Binary O/P - CU and BU	
15.	Current reversal technique for B/C	
16.	CT Ratio per feeder	
k	**Communication Port**	
1.	Front	
2.	Rear	
V	**UNDER VOLTAGE RELAY**	
1.	Make	
2.	Model Type	
3.	Shall be triple pole type.	
4.	Shall be static type	
5.	Shall have range from 40 to 80%	
6.	Shall be provided with Hand reset flag/LED type operation indicator	
7.	have sufficient potential free contacts to cater for HMI reporting & DR i.e. minimum 2 Nos of Alarm contact	
W	**OVER VOLTAGE RELAY**	
1.	Make	
2.	Model Type	
3.	Shall be static/numerical type	
4.	Shall monitor all three phases	
5.	Shall have adjustable voltage setting range of 100 – 150% of rated voltage & adjustable time setting range of 0 to 10 seconds continuously or in step of 1 Sec.	
6.	Shall have independent alarm & trip out put contacts	
7.	Shall have drop off to pick up ratio equal to or greater than 95%.	
8.	Shall be provided with Hand reset flag/LED type operation indicator	
9.	have sufficient potential free contacts to cater for for HMI reporting & DR i.e. minimum 2 Nos of Trip and 2 Nos of Alarm contacts	

10.	In case of numerical relay, it shall have following parameters • Front Port, • Rear Port • Communication protocol • Time Synchronization: • Nos of fault records storage and parameters • Disturbance Recording duration for each fault. • Continuous self-hardware & software monitoring and diagnostic feature.	
11.	*(B) Input-Outputs* *Nos of Binary inputs* *Nos of Outputs* *Nos of Trip contacts* *Nos of Alarm contacts*	
12.	*C) Housing* • *Mounting* • *Screw Terminals ('O' Lug for CT connection)* • *Degree of Protection* *(D) Temperature and humidity* (a) *Ambient temp* (b) *Relative humidity* (c) *Operate range* (d) *Storage temp.*	
X	**OVER FLUXING RELAYS**	
1.	Make	
2.	Type designation	
3.	Whether comply to Principle Technical Parameters as per Annexure III, Section-II	
4.	Static or Numerical	
5.	Rating (V/Hz)	
6.	Operating principal	
7.	Setting range	
8.	No. of stages in relay	
9.	No. of timers provided and range of time settings available.	
10.	Burden	
11.	Auxiliary relays as necessary to make scheme complete provided.	
12.	No. and rating of protective and auxiliary relay	

	contacts.	
13.	Write up on the relay enclosed.	
14.	Note: In case of numerical relay, it shall have following parameters • Front Port, • Rear Port • Communication protocol • Time Synchronization: • Nos of fault records storage and parameters • Disturbance Recording duration for each fault. • Continuous self-hardware & software monitoring and diagnostic feature.	
15.	(B) Input-Outputs Nos of Binary inputs Nos of Outputs Nos of Trip contacts Nos of Alarm contacts	
16.	C) Housing • Mounting • Screw Terminals ('O' Lug for CT connection) • Degree of Protection (D) Temperature and humidity (a) Ambient temp (b) Relative humidity (c) Operate range (d) Storage temp.	
Y	**FUSE FAILURE RELAY**	
17.	Make	
18.	Type designation	
19.	Whether comply to Principle Technical Parameters as per Annexure III, Section-II	
20.	i) Rating V AC	
21.	i) Operating principle ii) Literature write up enclosed	
22.	Operating time	
23.	Burden	
24.	Output contacts i) No. of NO and NC contacts ii) Rating of contacts	
25.	i) Additional fuses required at line VT ii) Arc fuses provided	

Z	**DC SUPERVISION RELAY**	
26.	Make	
27.	Type designation	
28.	Whether comply to Principle Technical Parameters as per Annexure III, Section-II	
29.	General design	
30.	DC rating (voltage)	
31.	Output contacts	
32.	Any other data	

ANNEXURE: A

List of typical Input, Output & LEDs for various Relays/IEDs for various types of carrier schemes and Bus bar bay configurations:

Sr. No.	IED	Typical Input	Typical Output	Typical LED Configuration
A	**400 / 220 kV Feeder bays (Two Main Bus with PLCC BCU)**			
1	21.1	SOTF Initiation (From BCU)	21.1 Operated / Tripped (To 21.2)	R-Ph Fault
2		SOTF Initiation (From TNC Switch)	To BCU (21.1 Faulty) WD Contact	Y-Ph Fault
3		21.2 Operated / Tripped	To TC - 1 Main CB	B-Ph Fault
4		21.2 Operated / Tripped (LBB Start)	To TC - 1 Main CB	Z1 Trip
5		21.2 R-Ph LBB Initiation	To TC - 1 Main CB	Z2 Trip
6		21.2 Y-Ph LBB Initiation	To TC - 2 Main CB	Z3 Trip / Z4 Trip
7		21.2 B-Ph LBB Initiation	To TC - 2 Main CB	Carrier Aided Trip
8		86A Operated (LBB Initiation)	To TC - 2 Main CB	SOTF Operated
9		86A Operated (LBB Start)	To 86A (A/R L/O / Power swing / Multi Phase / Z2 / Z3 / DEF Faults)	A/R Operated
10		86B Operated (LBB Initiation)		A/R Block
11		86B Operated (LBB Start)	To 96 (LBB Trip)	VT Fuse Fail
12		Bus Bar PU Operated / Tripped	To Bus bar PU (LBB Start)	LBB Operated
13		96 LBB Trip relay Operated / Tripped	To Bus bar PU (LBB Initiation R-Ph)	PSB Operated
14		Main CB Spring Charged	To Bus bar PU (LBB Initiation Y-Ph)	Broken Conductor
15		Main CB Gas Pressure Normal	To Bus bar PU (LBB Initiation B-Ph)	O/V Operated
16		Main CB Gas Pressure Low	To CB Closing (A/R)	
17		Main CB Lockout	TO BCU (21.1 Operated)	
18		Main CB R-Ph Open	Test Kit feedback	
19		Main CB Y-Ph Open	To 86A (DT Receive)	
20		Main CB B-Ph Open		
21		CRP DC Source - 2 Fail		

22		21.2 IED Faulty		
23		59.1 O/V Operated (Only for 400kV Line)		
B	**400kV / 220kV Feeder Bay (Two Main Bus with hardwired PLCC signals) Following shall be considered over and above 400kV / 220kV Feeder Bays (Two Main Bus with PLCC BCU)**			
1	21.1	Direct Trip Receive Channel - 1	Direct Trip Send Channel - 1 (21.1 O/V Stage-2, LBB Trip)	
2		Direct Trip Send Channel - 1	Direct Trip Send Channel - 2 (21.1 O/V Stage-2, LBB Trip)	
3		Carrier Healthy Channel - 1	Carrier Send Channel - 1	
4		Carrier Healthy Channel - 2		
5		Carrier Receive Channel - 1		
C	**400kV / 220kV Feeder Bay (Main & Main cum Transfer Bus / 3 Bus with PLCC BCU) Following shall be considered over and above 400kV / 220kV Feeder Bays (Two Main Bus with PLCC BCU)**			
1	21.1		To TC - 1 BC Cum TBC CB	
2			To TC - 1 BC Cum TBC CB	
3			To TC - 1 BC Cum TBC CB	
4			To TC - 2 BC Cum TBC CB	
5			To TC - 2 BC Cum TBC CB	
6			To TC - 2 BC Cum TBC CB	
7			To BC Cum TBC Bay 86A	
8			To BC Cum TBC Bay 86A (DT Receive)	
9			To BC Cum TBC Bay Bus bar PU (LBB Start)	
10			To BC Cum TBC Bay Bus bar PU (LBB Initiation R-Ph)	
11			To BC Cum TBC Bay Bus bar PU (LBB Initiation Y-Ph)	
12			To BC Cum TBC Bay Bus bar PU (LBB Initiation B-Ph)	

D	**400 / 220 kV Feeder bays (Two Main Bus with PLCC BCU)**			
1	21.2	SOTF Initiation (From BCU)	21.2 Operated / Tripped (To 21.1)	R-Ph Fault
2		SOTF Initiation (From TNC Switch)	To 21.1 (21.2 Faulty) WD Contact	Y-Ph Fault
3		21.1 Operated / Tripped	To TC - 1 Main CB	B-Ph Fault
4		86A Operated (LBB Initiation)	To TC - 1 Main CB	Z1 Trip
5		86A Operated (LBB Start)	To TC - 1 Main CB	Z2 Trip
6		86B Operated (LBB Initiation)	To TC - 2 Main CB	Z3 Trip / Z4 Trip
7		86B Operated (LBB Start)	To TC - 2 Main CB	Carrier Aided Trip
8		Bus Bar PU Operated / Tripped	To TC - 2 Main CB	SOTF Operated
9		96 LBB Trip relay Operated / Tripped	To 86B (A/R L/O / Power swing / Multi Phase / Z2 / Z3 / DEF Faults)	A/R Operated
10		Main CB Spring Charged		A/R Block
11		Main CB Gas Pressure Normal	To Bus bar PU (LBB Start)	VT Fuse Fail
12		Main CB Gas Pressure Low	To Bus bar PU (LBB Initiation R-Ph)	PSB Operated
13		Main CB Lockout	To Bus bar PU (LBB Initiation Y-Ph)	Broken Conductor
14		Main CB R-Ph Open	To Bus bar PU (LBB Initiation B-Ph)	O/V Operated
15		Main CB Y-Ph Open	To 21.1 (LBB Start)	
16		Main CB B-Ph Open	To 21.1 (LBB Initiation R-Ph)	
17		CRP DC Source - 1 Fail	To 21.1 (LBB Initiation Y-Ph)	
18		BCU Faulty	To 21.1 (LBB Initiation B-Ph)	
19		21.1 IED Faulty	To CB Closing (A/R)	
20		59.1 O/V Operated (Only for 400kV Line)	TO BCU (21.2 Operated)	
21			Test Kit feedback	
22			To 86B (DT Receive)	
E	**400kV / 220kV Feeder Bay (Two Main Bus with hardwired PLCC signals) Following shall be considered over and above 400kV / 220kV Feeder Bays (Two Main Bus with PLCC BCU)**			

1	21.2	Direct Trip Receive Channel - 2	Direct Trip Send Channel - 1 (21.2 O/V Stage-2)	
2		Direct Trip Send Channel - 2	Direct Trip Send Channel - 2 (21.2 O/V Stage-2)	
3		Carrier Healthy Channel - 1	Carrier Send Channel - 2	
4		Carrier Healthy Channel - 2		
5		Carrier Receive Channel - 2		
F	**400kV / 220kV Feeder Bay (Main & Main cum Transfer Bus with PLCC BCU) Following shall be considered over and above 400kV / 220kV Feeder Bays (Two Main Bus with PLCC BCU)**			
1	21.2		To TC - 1 BC Cum TBC CB	
2			To TC - 1 BC Cum TBC CB	
3			To TC - 1 BC Cum TBC CB	
4			To TC - 2 BC Cum TBC CB	
5			To TC - 2 BC Cum TBC CB	
6			To TC - 2 BC Cum TBC CB	
7			To BC Cum TBC Bay 86B	
8			To BC Cum TBC Bay 86B (DT Receive)	
9			To BC Cum TBC Bay Bus bar PU (LBB Start)	
10			To BC Cum TBC Bay Bus bar PU (LBB Initiation R-Ph)	
11			To BC Cum TBC Bay Bus bar PU (LBB Initiation Y-Ph)	
12			To BC Cum TBC Bay Bus bar PU (LBB Initiation B-Ph)	
G	**132 kV Feeder bays (Two Main Bus with PLCC BCU)**			
1	21	SOTF Initiation (From BCU)	21 Operated / Tripped (To 67)	R-Ph Fault
2		SOTF Initiation (From TNC Switch)	To BCU (21 Faulty) WD Contact	Y-Ph Fault
3		O/C E/F Backup	To TC - 1 Main CB	B-Ph Fault

		Protection Operated		
4		86A Operated (LBB Initiation)	To TC - 2 Main CB	Z1 Trip
5		86A Operated (LBB Start)	To 96 (LBB Trip)	Z2 Trip
6		86B Operated (LBB Initiation)	TO BCU (21 Operated)	Z3 Trip
7		86B Operated (LBB Start)	Test Kit feedback	Z4 Trip
8		Bus Bar PU Operated / Tripped	To 86A (DT Receive)	Carrier Aided Trip
9		96 LBB Trip relay Operated / Tripped	To 86A (A/R L/O / Power swing / Multi Phase / Z2 / Z3 / DEF Faults)	SOTF Operated
10		Main CB Spring Charged		A/R Operated
11		Main CB Gas Pressure Normal	To Bus bar PU (LBB Start)	A/R Block
12		Main CB Gas Pressure Low	To Bus bar PU (LBB Initiation)	VT Fuse Fail
13		Main CB Lockout		PSB Operated
14		Main CB Open		Broken Conductor
15		CRP DC Source - 2 Fail		O/V Operated
16		BCU Faulty		
17		Backup Relay Faulty		
H	**132 kV Feeder bays (Two Main Bus with hardwired PLCC signals) Following shall be considered over and above 132 Feeder Bays (Two Main Bus with PLCC BCU)**			
1	21	Direct Trip Receive	Direct Trip Send (O/V, LBB)	
2		Direct Trip Sent	Carrier Send	
3		Carrier Healthy		
4		Carrier Receive		
5				
I	**132 kV Feeder bays (Two Main Bus)**			
1	67	CB Open	To BCU (67 Fail) WD Contact	O/C R-Ph Operated
2		86B Operated	To BCU (67 Operated)	O/C Y-Ph Operated
3		CRP DC Source - 1 Fail	To 21 (67 Operated)	O/C B-Ph Operated

4		BCU Faulty	Test Kit feedback	O/C High set Operated
5		86A Operated		E/F Operated
6		96 LBB Trip relay Operated / Tripped		E/F highest Operated
7		21 Relay Operated / Tripped		VT Fuse Fail
J	**400/220 kV, 220/132kV, 220/66kV, 220/33kV & 132kV/66kV Transformer bays**			
1		HV Main CB Open R-Ph	To 86A (Differential, O/F Protection Trip)	Differential protection operated
2		HV Main CB Open Y-Ph	To LV 86A	R-Ph Fault
3		HV Main CB Open B-Ph	To 64R (87T Operated)	Y-Ph Fault
4		LV CB Open (R, Y & B Phase in series)	To 67 (87T Operated)	B-Ph Fault
5		86A Operated (LBB Initiation)	To NIFPS Trip	Differential High set Operated
6		86A Operated (LBB Start)	To 96 (LBB Trip)	Thermal O/L Operated
7		86B Operated (LBB Initiation)	Test Kit feedback	LBB Initiation
8		86B Operated (LBB Start)	To 86A of Bus Coupler Cum TBC Bay(Differential, O/F Protection Trip)	LBB Operated
9	87T	HV REF Protection Operated	To BCU (87T Fail) WD Contact	Over Flux Alarm
10		LV REF Protection Operated		Over Flux Trip
11		O/C & E/F Protection Operated		2nd Harmonic Block
12		Bus Bar PU Operated / Tripped		5th Harmonic Block
13		96 LBB Trip relay Operated / Tripped		Transformer Trouble Trip
14		NIFPS Trip		
15		PRV - 1 Trip		
16		PRV - 2 Trip		
17		Oil Temperature Trip		
18		Buchholz Trip		
19		Winding Temperature		

		Trip		
20		OLTC OSR R-Ph Trip		
21		OLTC OSR Y-Ph Trip		
22		OLTC OSR B-Ph Trip		
23		OLTC PRV Trip		
24		BCU Faulty		
K	**400 / 220 kV, 220/132kV & 132kV/66kV Transformer bays**			
1	64R	NIFPS Alarm	To 87T (64R Fail) WD Contact	REF Relay Operated
2		87T Operated	To 86B Trip relay	REF Relay Faulty
3		CRP DC Source - 2 Fail	To LV 86B Trip relay	
4			Test Kit feedback	
5			To BC Cum TBC 86B	
6			To 87T (67 Operated)	
7			To NIFPS Trip	
L	**220/66kV & 220/33kV Transformer bays**			
1	64R HV	87T Operated	To BCU (64RHV Fail) WD Contact	REF Relay Operated
2		O/C & E/F Protection Operated	To 86B Trip relay	REF Relay Faulty
3		OLTC Low Oil Alarm	To LV 86B Trip relay	
4		Buchholz Alarm	Test Kit feedback	
5		Cooling Trouble	To BC Cum TBC 86B	
6		Winding Temperature Alarm	To 87T (64R HV Operated)	
7		Oil Temperature Alarm	To NIFPS Trip	
8		Main Tank Low Oil Alarm		
M	**220/66kV & 220/33kV Transformer bays**			
1	64R LV	CRP DC Source - 2 Fail	To BCU (64RHV Fail) WD Contact	REF Relay Operated
2			To 86A Trip relay	REF Relay Faulty

3			To LV 86A Trip relay	
4			Test Kit feedback	
5			To BC Cum TBC 86A	
6			To 67 (64R LV Operated)	
7			To NIFPS Trip	
N	**400 / 220 kV, 220/132kV, 220/66kV & 132kV/66kV Transformer bays**			
1	67	LV REF Protection Operated	TO BCU (67 Fail) WD Contact	O/C R-Ph Operated
2		NIFPS Alarm	To 86B Trip relay	O/C Y-Ph Operated
3		Deluge Valve Trip	To LV 86B Trip relay	O/C B-Ph Operated
4		Sudden Pressure Trip	Test Kit feedback	O/C high set Operated
5		Online Breather Alarm	To 87T (67 Operated)	E/F Operated
6		Air Cell Rupture Alarm	To BC Cum TBC 86B	E/F high set Operated
7		CRP DC Source - 1 Fail	To 64HV REF (67 Operated)	VT Fuse Fail
8			To NIFPS Trip	
O	**400kV, 220kV, 132kV, 66kV & 33kV Bus Coupler**			
1	67	CB Open	To BCU (67 Fail) WD Contact	Non Dir. O/C R-Ph Operated
2		BCU Faulty	To 86 Trip relay	Non Dir. O/C Y-Ph Operated
3		CRP DC Source - 1 Fail	To BCU (67 Operated)	Non Dir. O/C B-Ph Operated
4		86 Operated	Test Kit feedback	E/F Operated
5		96A LBB/BB Protection Operated	To 96A (LBB Trip)	LBB Operated
6		96B LBB/BB Protection Operated	To 96B (LBB Trip)	Relay Faulty
7		86 Operated (LBB Initiate)		O/C high set Operated
8		Bus bar PU Operated (BB/LBB)		E/F high set Operated
9				VT Fuse Fail
P	**400kV & 220kV Reactor**			

1	87R	HV Main CB Open R-Ph	To 86A (Differential, O/F Protection Trip)	Differential protection operated
2		HV Main CB Open Y-Ph	To 64R (87T Operated)	R-Ph Fault
3		HV Main CB Open B-Ph	To 21R (87T Operated)	Y-Ph Fault
4		CRP DC Source - 2 Fail	To NIFPS Trip	B-Ph Fault
5		86A Operated (LBB Initiation)	To 96 (LBB Trip)	Differential High set Operated
6		86A Operated (LBB Start)	Test Kit feedback	Thermal O/L Operated
7		86B Operated (LBB Initiation)	To 86A of Bus Coupler Cum TBC Bay(Differential, O/F Protection Trip)	LBB Initiation
8		86B Operated (LBB Start)	To BCU (87R Fail) WD Contact	LBB Operated
9		REF Protection Operated		Over Flux Alarm
10		21R Protection Operated		Over Flux Trip
11		Bus Bar PU Operated / Tripped		VT Fuse Fail
12		96 LBB Trip relay Operated / Tripped		Reactor Trouble Trip
13		NIFPS Trip		
14		PRV - 1 Trip		
15		PRV - 2 Trip		
16		Oil Temperature Trip		
17		Buchholz Trip		
18		Winding Temperature Trip		
19		Deluge Valve Trip		
20		Sudden Pressure Trip		
21		BCU Faulty		
Q	**400kV & 220kV Reactor**			
1	64R	NIFPS Alarm	To 87T (64R Fail) WD Contact	REF Relay Operated
2		87R Operated	To 86B Trip relay	REF Relay Faulty

3		CRP DC Source - 2 Fail	Test Kit feedback	
4		21R Protection Operated	To BC Cum TBC 86B	
5		Buchholz Alarm	To 87T (REF Operated)	
6		Air Cell Rupture Alarm	To NIFPS Trip	
7		Online Breather Alarm	To 21R (REF Operated)	
R	**400kV & 220kV Reactor**			
1	21R	87T Operated	To BCU (21R Fail) WD Contact	R-Ph Trip
2		O/C & E/F Protection Operated	To 86B Trip relay	Y-Ph Trip
3		OLTC Low Oil Alarm	To LV 86B Trip relay	B-Ph Trip
4		Buchholz Alarm	Test Kit feedback	Backup Impedance Operated
5		Cooling Trouble	To BC Cum TBC 86B	
6		Winding Temperature Alarm	To 87R (21R Operated)	
7		Oil Temperature Alarm	To 64R (21R Operated)	
8		Main Tank Low Oil Alarm	To NIFPS Trip	
9		CRP DC Source - 1 Fail		
10		LV REF Protection Operated		

Remark: Above is the typical list and actual requirement may vary as per interfaces of different projects/tender.

ANNEXURE: B

List of typical GOOSE signals between various IEDs for Main and Main cum Transfer bus system:

Typical List of GOOSE signals	
From M1 to PLCC BCU	**Notes**
Carrier send CH-1	For PLCC
DT send CH-1	
From PLCC BCU to M1	
Carrier receive CH-1	A/R IN/OUT, Carrier IN/OUT & DT IN/OUT GOOSE signal from HMI /BCU to M1. Switch IN/OUT to be programmed in Function key of respective IEDs for consistency in inputs in case of trouble of HMI/BCU
DT receive CH-1	
Carrier healthy CH-1	
Carrier healthy CH-2	
From Feeder BCU to PLCC BCU	
DT send CH-1	For DT send
DT send CH-2	
From PLCC BCU to Feeder BCU	
DT receive CH-1	For Direct Trip to 86A & 86B
DT receive CH-2	
GOOSE from BCU/HMI/M-1 to M-2	
M1 A/R block	To block A/R
GOOSE from BC Cum TBC BCU to Feeder Bay M-1 in Transfer Mode	
BC Cum TBC CB Close Command from TNC/BCU	For SOTF Initiation
BC Cum TBC CB Gas pressure normal	For Auto-Reclose, DT, etc. during bay in transfer mode
BC Cum TBC CB Spring charged	
BC Cum TBC CB Lockout	
BC Cum TBC LBB reset	
BC Cum TBC LBB optd	

BC Cum TBC 86A/86B reset	
BC Cum TBC B/B Protn. Optd.	
BC Cum TBC B/B Protn. Reset	
BC Cum TBC CB R-Ph Open	
BC Cum TBC CB Y-Ph Open	
BC Cum TBC CB B-Ph Open	
GOOSE from BC Cum TBC BCU to Feeder Bay BCU in Transfer Mode	
BC Cum TBC CB Trip from TNC/BCU	For DT from own feeder BCU
From M1 to BC Cum TBC BCU	
BC Cum TBC CB close command	For Auto-reclose
LBB Trip	For LBB Tripping
From M1 to all other bay Main/LBB relay	
LBB protection Optd - Bus-1 Trip	For LBB trip
LBB protection Optd - Bus-2 Trip	For LBB trip
From HMI/BCU to all other IEDs	
Bay on "Normal" Mode	For N-I-T selection
Bay on "Inter" Mode	
Bay on "Transfer" Mode	
N-I-T Lock	
BC Cum TBC BCU to all other IEDs	
BC Cum TBC CB R-Phase Open	For PT selection, On Line Transfer, N-I-T, LBB Logic, etc.
BC Cum TBC CB Y-Ph Open	
BC Cum TBC CB B-Ph Open	
BC Cum TBC CB close	
BC Cum TBC Bus-1 Iso Close	
BC Cum TBC Bus-2 Iso Close	

BC Cum TBC Bus-1 Iso Open	
BC Cum TBC Bus-2 Iso Open	
BC in BC mode	
BC in TBC mode	
From M2 to PLCC BCU	
Carrier send CH-2	For PLCC
DT send CH-2	
From PLCC BCU to M2	
Carrier receive CH-2	A/R IN/OUT, Carrier IN/OUT & DT IN/OUT GOOSE signal from HMI /BCU to M2. Switch IN/OUT to be programmed in Function key of respective IEDs for consistency in inputs in case of trouble of HMI/BCU
DT receive CH-2	
Carrier healthy CH-1	
Carrier healthy CH-2	
GOOSE from BCU/HMI/M-2 to M-1	
M2 A/R block	To block A/R
GOOSE from BC Cum TBC BCU to Feeder Bay M-2 in Transfer Mode	
BC Cum TBC CB Close Command from TNC/BCU	For SOTF Initiation
BC Cum TBC CB Gas pressure normal	For Auto-Reclose, DT, etc. during bay in transfer mode
BC Cum TBC CB Spring charged	
BC Cum TBC CB Lockout	
BC Cum TBC LBB reset	
BC Cum TBC LBB optd	
BC Cum TBC 86A/86B reset	
BC Cum TBC B/B Protn. Optd.	
BC Cum TBC B/B Protn. Reset	
BC Cum TBC CB R-Ph Open	
BC Cum TBC CB Y-Ph Open	
BC Cum TBC CB B-Ph Open	

From M2 to BC Cum TBC BCU	
BC Cum TBC CB close command	For Auto-reclose
GOOSE from BC Cum TBC BCU to 87T/87R in Transfer Mode	
BC Cum TBC CB Gas pressure normal	For CB closing, etc. when bay in transfer mode
BC Cum TBC CB Spring charged	
BC Cum TBC CB Lockout	
BC Cum TBC LBB reset	
BC Cum TBC LBB optd	
BC Cum TBC 86A & 86B reset	
BC Cum TBC 86A & 86B Optd.	
BC Cum TBC B/B Protn. Optd.	
BC Cum TBC B/B Protn. Reset	
BC Cum TBC CB Trip Command from TNC/BCU	
BC Cum TBC CB Close Command from TNC/BCU	
From 87T/87R to BC Cum TBC BCU	
LBB Trip	For LBB Tripping
From 87T to own bay BCU	
LV CB Open	For 89T I/L
From 87T/87R to all other bay Main/LBB relay	
LBB protection Optd - Bus-1 Trip	For LBB trip
LBB protection Optd - Bus-2 Trip	
From BC 51/67 to all other bay Main/LBB relay	
LBB protection Optd - Bus-1 Trip	For LBB trip
LBB protection Optd - Bus-2 Trip	

Remark:

- Above is the typical list and actual requirement may vary as per interfaces of different projects/tender.

- For Two main bus configuration, GOOSE signals for BC cum TBC bay & N-I-T selection shall not be considered.
- In case of hardwired carrier scheme, GOOSE for carrier scheme shall not be considered.
- In case of hardwired LBB, GOOSE for LBB operation shall not be considered.