# CONTROL & RELAY PANELS

## 1. TYPE OF PANELS

### 1.1. Simplex Panel

Control and Relay panel shall be Simplex type panel and consist of a vertical front. Panel with equipments mounted on front and having wiring access from rear. In case of panel having width more than 800mm, double leaf-doors shall be provided. Doors shall have handles with either built-in locking facility or will be provided with pad-lock.

## 2. CONSTRUCTIONAL FEATURES

2.1. All Control and Relay panels shall be of simplex type design. It is the responsibility of the Contractor to ensure that the equipment specified and such unspecified complementary equipment required for complete-ness of the protective/control schemes are properly accommodated in the panels without congestion and if necessary, provide panels with larger dimensions. No price increase at a later date on this account shall be allowed. However, the width of panels that are being offered to be placed in existing switchyard control rooms, should be in conformity with the space availability in the control room.

2.2. Panels shall be completely metal clad and shall be dust, moisture and vermin proof. The enclosure shall provide a degree of protection not less than IP-4X in accordance with IS: 12063.

2.3. Panels shall be free standing, floor mounting type and shall comprise structural frames completely enclosed with specially selected smooth finished, cold rolled sheet steel of thickness not less than 3 mm for weight bearing members of the panels such as base frame, front sheet and door frames, and 2.0mm for sides, door, top and bottom portions. There shall be sufficient reinforcement to provide level transportation and installation.

2.4. All doors, removable covers and plates shall be gasketed all around with gasket as specified in Section-I (Introduction and general technical requirements). Ventilating louvers, if provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh.

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

2.6. Panels shall have base frame with smooth bearing surface, which shall be fixed on the embedded foundation channels/insert plates. Anti

vibration strips made of shock absorbing materials that shall be supplied by the contractor, shall be placed between panel & base frame.

2.7. Cable entries to the panels shall be from the bottom. Cable gland plate fitted on the bottom of the panel shall be connected to earthing of the panel/station through a flexible braided copper conductor rigidly.

## 3. MOUNTING

3.1. All equipment on and in panels shall be mounted and completely wired to the terminal blocks ready for external connections. The equipment on front of panel shall be mounted flush. No equipment shall be mounted on the doors.

3.2. Equipment shall be mounted such that removal and replacement can be accomplished individually without interruption of service to adjacent devices and are readily accessible without use of special tools. Terminal marking on the equipment shall be clearly visible.

3.3. Contractor shall carry out cut out, mounting and wiring of the items supplied by others, which are to be mounted in his panel in accordance with the corresponding equipment manufacturer's drawings. Cut outs if any, provided for future mounting of equipment shall be properly blanked off with blanking plate.

3.4. The centre lines of switches, push buttons and indicating lamps shall be not less than 750mm from the bottom of the panel. The centre lines of relays, meters and recorders shall be not less than 450mm from the bottom of the panel.

3.5. The center lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Like wise the top lines of all meters, relays and recorders etc. shall be matched.

## 4. PANEL INTERNAL WIRING

4.1. Panels shall be supplied complete with interconnecting wiring provided between all electrical devices mounted and wired in the panels and between the devices and terminal blocks for the devices to be connected to equipment outside the panels. When panels are arranged to be located adjacent to each other all inter panel wiring and connections between the panels shall be furnished and the wiring shall be carried out internally

4.2. All wiring shall be carried out with 1100 Volts grade, single core, stranded FRLS tinned copper conductor wires with PVC insulation. The minimum size of the multi-stranded copper conductor used for internal wiring shall be as follows:

- All circuits except current transformer circuits and voltage transfer circuits meant for energy metering - one no 1.5mm sq. per lead.

- All current transformer circuits one no 2.5 sqmm per lead.

4.3. Voltage transformer circuit (for energy meters): Two 2.5 sqmm. per lead. All internal wiring shall be securely supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters & troughs shall be used for this purpose.

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

4.5. Wire termination shall be made with solderless crimping type and tinned copper lugs, which firmly grip the conductor. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on the wire and shall not fall off when the wire is disconnected from terminal blocks. **All wires directly connected to trip circuit breaker or device shall be distinguished by the addition of red coloured unlettered ferrule.**

4.6. Longitudinal troughs extending throughout the full length of the panel shall be preferred for inter panel wiring. Inter-connections to adjacent panel shall be brought out to a separate set of terminal blocks located near the slots of holes meant for taking the inter-connecting wires.

4.7. Contractor shall be solely responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipments.

## 5. TERMINAL BLOCKS

5.1. All internal wiring to be connected to external equipment shall terminate on terminal blocks. Terminal blocks shall be 1100 V grade and have 10 Amps continuous rating, moulded piece, complete with insulated barriers, stud type terminals, washers, nuts and lock nuts. Markings on the terminal blocks shall correspond to wire number and terminal numbers on the wiring diagrams. All terminal blocks shall have shrouding with transparent unbreakable material.

5.2. Disconnecting type terminal blocks for current transformer and potential transformer secondary leads shall be provided and for balance connector terminal block shall be stud type. Also current transformer secondary leads shall be provided with short circuiting and earthing facilities.

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

5.4. Unless otherwise specified, terminal blocks shall be suitable for connecting the following conductors of external cable on each side

- All CT & PT circuits: minimum of two of 2.5mm Sq. copper.
- AC/DC Power Supply Circuits: One of 10mm Sq. Aluminium.
- All other circuits: minimum of one of 2.5mm Sq. Copper.

5.5. There shall be a minimum clearance of 250mm between the first row of terminal blocks and the associated cable gland plate or panel side wall. Also the clearance between two rows of terminal blocks edges shall be minimum of 150mm.

5.6. Arrangement of the terminal block assemblies and the wiring channel within the enclosure shall be such that a row of terminal blocks is run in parallel and close proximity along each side of the wiring-duct to provide for convenient attachment of internal panel wiring. The side of the terminal block opposite the wiring duct shall be reserved for the Owner's external cable connections. All adjacent terminal blocks shall also share this field wiring corridor. All wiring shall be provided with adequate support inside the panels to hold them firmly and to enable free and flexible termination without causing strain on terminals.

5.7. All necessary cable terminating accessories such as gland plates, supporting clamps & brackets, wiring troughs and gutters etc. for external cables shall be included in the scope of supply.

## 6. PAINTING

6.1. All sheet steel work shall be phosphated in accordance with the IS:6005 "Code of practice for phosphating iron and steel".

6.2. Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning.

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

6.4. After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying.

6.5. The phosphate coating shall be sealed with application of two coats of ready mixed, stoved type zinc chromate primer. The first coat may be "flash dried" while the second coat shall be stoved.

6.6. After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting. The exterior colour of paint shall be of a slightly different shade to enable inspection of the painting.

6.7. A small quantity of finished paint shall be supplied for minor touching up required at site after installation of the panels.

6.8. In case the bidder proposes to follow any other established painting procedure like electrostatic painting, the procedure shall be submitted for POWERGRID's review and approval.

## 7. MIMIC DIAGRAM

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

7.2. Mimic diagram shall be made preferably of anodised aluminium or plastic of approved fast colour material, which shall be screwed on to the panel and can be easily cleaned. Painted overlaid mimic is also acceptable. The mimic bus shall be 2 mm thick. The width of the mimic bus shall be 10mm for bus bars and 7 mm for other connections.

7.3. Mimic bus colour will be decided by the POWERGRID and shall be furnished to the successful Bidder during Engineering.

7.4. When semaphore indicators are used for equipment position they shall be so mounted in the mimic that the equipment close position shall complete the continuity of mimic.

7.5. Indicating lamp, one for each phase, for each bus shall be provided on the mimic to indicate bus charged condition

## 8. NAME PLATES AND MARKINGS

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

8.2. All front mounted equipment shall also be provided at the rear with individual name plates engraved with tag numbers corresponding to the

one shown in the panel internal wiring to facilitate easy tracing of the wiring.

8.3. Each instrument and meter shall be prominently marked with the quantity measured e.g. KV, A, MW, etc. All relays and other devices shall be clearly marked with manufacturer's name, manufacturer's type, serial number and electrical rating data.

8.4. Name Plates shall be made of non-rusting metal or 3 ply lamicoid. Nameplates shall be black with white engraving lettering.

8.5. All the panels shall be provided with nameplate mounted inside the panel bearing LOA No & Date, Name of the Substation & feeder and reference drawing number.

## 9. MISCELLANEOUS ACCESSORIES

9.1. **Plug Point**:

240V, Single phase 50Hz, AC socket with switch suitable to accept 5 Amps and 15 Amps pin round standard Indian plug, shall be provided in the interior of each cubicle with ON-OFF switch.

9.2. **Interior Lighting:**

Each panel shall be provided with a fluorescent lighting fixture **(20 watt tube light or equivalent)** rated for 240 Volts, single phase, 50 Hz supply for the interior illumination of the panel controlled by the respective panel door switch.

9.3. **Switches and Fuses:**

Each panel shall be provided with necessary arrangements for receiving, distributing and isolating of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with miniature circuit breakers (MCB). Selection of the main and sub-circuit MCB rating shall be such as to ensure selective clearance of sub-circuit faults. MCBs shall confirm to IS: 13947. Each MCB shall be provided with one potential free contact and the same shall be wired for annunciation purpose. However voltage transformer circuits for relaying and metering shall be protected by fuses. All fuses shall be HRC cartridge type conforming to IS: 13703 mounted on plug-in type fuse bases. . Fuse carrier base as well as MCBs shall have imprints of the fuse 'rating' and 'voltage'.

9.4. **Space Heater:**

Each panel shall be provided with a space heater rated for 240V, single phase, 50 Hz Ac supply for the internal heating of the panel to prevent condensation of moisture. The fittings shall be complete with switch unit.

## 10. EARTHING

10.1. All panels shall be equipped with an earth bus securely fixed. Location of earth bus shall ensure no radiation interference for earth systems under various switching conditions of isolators and breakers. The material and the sizes of the bus bar shall be at least 25 X 6 sq.mm perforated copper with threaded holes at a gap of 50mm with a provision of bolts and nuts for connection with cable armours and mounted equipment etc for effective earthing. When several panels are mounted adjoining each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply of Contractor. Provision shall be made for extending the earth bus bars to future adjoining panels on either side.

10.2. All metallic cases of relays, instruments and other panel mounted equipment including gland plate, shall be connected to the earth bus by copper wires of size not less than 2.5 sq. mm. The colour code of earthing wires shall be green.

10.3. Looping of earth connections which would result in loss of earth connection to other devices when the loop is broken, shall not be permitted. However, looping of earth connections between equipment to provide alternative paths to earth bus shall be provided.

10.4. VT and CT secondary neutral or common lead shall be earthed at one place only at the terminal blocks where they enter the panel. Such earthing shall be made through links so that earthing may be removed from one group without disturbing continuity of earthing system for other groups.

## 11. INDICATING INSTRUMENTS

All instruments and meters shall be enclosed in dust proof, moisture resistant, black finished cases and shall be suitable for tropical use. All Bus voltage and frequency indicating instruments shall be provided with individual transducers and these shall be calibrated along with transducers to read directly the primary quantities. They shall be accurately adjusted and calibrated at works and shall have means of calibration check and adjustment at site. The supplier shall submit calibration certificates at the time of delivery. However no separate transducers are envisaged for digital bus voltmeters and digital frequency meters and the indicating meters provided in the synchronising equipment.

11.1.1. Unless otherwise specified, all electrical indicating instruments shall have circular 240 degree scale and with a dial of 96mm x 96mm. They shall be suitable for flush mounting.

11.1.2. Instruments dial shall be with white circular scale and black pointer and with black numerals and lettering. The dial shall be free from warping, fading, and decolouring. The dial shall also be free from parallax error.

11.1.3. Instruments shall conform to IS: 1248 and shall have accuracy class of 1.5 or better. The design of the scales shall be such as to have resolution suitable for the application. The marking of centre zero Watt /Var meters shall be IMPORT (on left) and EXPORT (on right) to indicate the direction of active/reactive power flow towards or away from the substation bus bars respectively.

11.1.4. Digital voltage and frequency meters shall be of class: 0.5 and shall have digital display of 4 and half digits with display size, not less than 25mm (height).

## 11.2. TRANSDUCERS

11.2.1. Transducers (for use with Indicating Instruments) shall in general conform to IEC: 688-1

11.2.2. The energy meter capability shall be used for measurement of active power, reactive power, voltage, current and frequency in three phase four wire unbalanced system.

11.2.3. One 33 kV C&R panel shall be installed for each incomer of 33 kV (Line incomer and 33 kV side of transformer). Each panel shall consist of energy meter, protection schemes, indication and control etc.

11.2.4. Voltage signal (440 Volt ac L-L) for voltmeter, PF meter, frequency meter, KW meter etc to be provided in the C&R panel shall be tapped from the respective PTs through a separate / independent copper cable.

## 11.3. ENERGY METER

Contractor shall provide Static TVM energy meter as described in subsequent Chapter 12 of this TS.

## 11.4. ANNUNCIATION SYSTEM

11.4.1. Alarm annunciation system shall be provided in the control board by means of visual and audible alarm in order to draw the attention of the operator to the abnormal operating conditions or the operation of some protective devices. The annunciation equipment shall be suitable for operation on the voltages specified in this specification i.e. **110 Volt DC or as existing DC supply system** of the utility (This shall be verified by the successful bidder before submission of the drawing for approval).

11.4.2. The visual annunciation shall be provided by annunciation facia, mounted flush on the top of the control panels.

11.4.3. The annunciator facia shall be provided with translucent plastic window for alarm point with approximate size of 35mm x 50mm. The facia plates shall be engraved in black lettering with respective inscriptions. Alarm inscriptions shall be engraved on each window in not more than three lines and size of the lettering shall not be less than 5 mm.

11.4.4. Each annunciation window shall be provided with two white lamps in parallel to provide safety against lamp failure. Long life lamps shall be used. The transparency of cover plates and wattage of the lamps provided in the facia windows shall be adequate to ensure clear visibility of the inscriptions in the control room from the location of the operator's desk.

11.4.5. All Trip facia shall have red colour and all Non-trip facia shall have white colour.

11.4.6. The annunciation system shall work in co-ordination with the existing annunciation system (hooter or bell) in the substation. If the same is not provided, hooter shall be supplied for above purpose.

11.4.7. Sequence of operation of the annunciator shall be as follows:

| Sl No | Alarm condition | Fault contact | Visual Annunciation | Audible Annunciation (by Hooter) |
|---|---|---|---|---|
| ***1.*** | ***Normal*** | ***Open*** | ***Off*** | ***OFF*** |
| 2. | Abnormal | Close | Flashing | ON |
| 3. | Accept push button pressed | Close | Steady on | OFF |
| | | Open | Steady on | OFF |
| 4. | Reset push button is pressed | Close | On | OFF |
| | | Open | OFF | OFF |

| | | | | |
|---|---|---|---|---|
| 5. | Lamp test Push button pressed | Open | Steady on | OFF |
| 6. | Alarm Test | Open | Flashing | ON |

11.4.8. Audible annunciation for the failure of DC supply to the annunciation system shall be provided and this annunciation shall operate on 240 Volts AC supply. On failure of the DC to the annunciation system for more than 2 or 3 seconds. (adjustable setting), a bell shall sound. A separate push button shall be provided for the cancellation of this audible alarm alone but the facia window shall remain steadily lighted till the supply to annunciation system is restored.

11.4.9. A separate voltage check relay shall be provided to monitor the failure of supply (240V AC) to the scheme mentioned in Clause above. If the failure of supply exists for more than 2 to 3 seconds. this relay shall initiate visual and audible annunciation. This annunciation shall operate on Annunciation DC and buzzer shall sound.

## 11.5. SWITCHES

11.5.1. Control and instrument switches shall be rotary operated type with escutcheon plates clearly marked to show operating position and circuit designation plates and suitable for flush mounting with only switch front plate and operating handle projecting out.

11.5.2. The selection of operating handles for the different types of switches shall be as follows :

| | | |
|---|---|---|
| Breaker, Isolator control switches | : | Pistol grip, black |
| Selector switches | : | Oval or knob, black |
| Instrument switches | : | Round, knurled, black |

11.5.3. The control switch of breaker and isolator shall be of spring return to neutral type. The switch shall have spring return from close and trip positions to "after close" and "after trip" positions respectively.

11.5.4. Instrument selection switches shall be of maintained contact (stay put) type. Voltmeter transfer switches for AC shall be suitable for reading all line- to-line and line-to-neutral voltages for non effectively earthed systems and for reading all line to line voltages for effectively earthed systems.

11.5.5. The contacts of all switches shall preferably open and close with snap action to minimize arcing. Contacts of switches shall be spring assisted

and contact faces shall be with rivets of pure silver or silver alloy. Springs shall not be used as current carrying parts

11.5.6. The contact combination and their operation shall be such as to give completeness to the interlock and function of the scheme.

11.5.7. The contact rating of the switches shall be as follows :

| Description | Contact rating in Amps |
|---|---|
| Continuous | 110 V DC, 10 Amp |
| Make and carry | 110 V DC, 30 Amp. |
| Break for Resistive load | 110 V DC, 20 Amp. |

## 11.6. INDICATING LAMPS

11.6.1. Indicating lamps shall be of multiple LED panel mounting type with rear terminal connections. Lamps shall have translucent lamp covers to diffuse lights coloured red, green, amber, clear white or blue as specified. The lamp cover shall be preferably of screwed type, unbreakable and moulded from heat resisting material.

11.6.2. Lamps and its parts shall be interchangeable and easily replaceable from the front of the panel. Tools, if required for replacing the bulbs and lenses shall also be included in the scope of supply.

11.6.3. The indicating lamps shall withstand 120% of rated voltage on a continuous basis.

## 11.7. POSITION INDICATORS

11.7.1. Position indicators of "SEMAPHORE" type shall be provided when specified as part of the mimic diagrams on panels for indicating the position of circuit breakers, isolating/earthing switches etc. The indicator shall be suitable for semi-flush mounting with only the front disc projecting out and with terminal connection from the rear. Their strips shall be of the same colour as the associated mimic.

11.7.2. Position indicator shall be suitable for DC Voltage as specified. When the supervised object is in the closed position, the pointer of the indicator shall take up a position in line with the mimic busbars, and at right angles to them when the object is in the open position. When the supply failure to the indicator occurs, the pointer shall take up an intermediate position to indicate the supply failure.

11.7.3. The rating of the indicator shall not exceed 2.5 W.

11.7.4. The position indicators shall withstand 120% of rated voltage on a continuous basis.

## 11.8. INPUT SIGNAL TO SAS SYSTEM

The following digital input of 33kV bays shall be provided through IEDs in the remote SAS system:

i) Status of CB, Isolator.
ii) CB trouble
iii) CB operation/closing lockout
iv) Trip circuit faulty
v) Hand reset trip alarm status of relay
vi) Back-up overcurrent & earth fault protection Operated
vii) DC source fail.
viii) Transformer WTI/OTI alarm, WTI/OTI trip, Buchholz trip and Buchholz Alarm.

## 11.9. Numerical Protection RELAYS (IEDs)

11.9.1. All the communicable numerical protection relays (IEDs) complying with IEC-61850 on all feeders which shall be networked on Ethernet to communicate with substation remote SAS/SCADA system on IEC-61850. These IEDs shall also be used for control & monitoring the switchgear from SAS. In addition to status of devices and equipment trip/alarms, Metering data shall also be made available to remote SAS/SCADA station from protection IEDs. Further, Trivector meters with Modbus protocol are also envisaged, which will be connected in daisy-chain-link to communicate to remote station SAS. Modbus to IEC 61850 converter shall be provided for integration with remote SAS.

It is also envisaged that required alarm /trip points related to equipments i.e. circuit breaker and transformer etc. from relay i/o point shall be wired to annunciation system.

The Bidder's scope shall include the followings:

a) Communicable Numerical Protection Relays (with IEC 61850) in each of the feeders.

b) IED's / Numerical Relays shall have Graphical Display to facilitate settings, relay operations and to view measurement, event and alarm etc.

c) Relays shall have built in Local/Remote Switch.

d) Cat5e Ethernet cable for connection of Numerical Relays (IEDs) to Ethernet switches. Optical cable shall be used between Ethernet switch and SDH Equipment and among Ethernet switches.

e) Required number of Ethernet switches mounted in Outdoor/Indoor Switchgear panels for communication with IEDs on IEC 61850 protocol.

f) The SAS/SCADA system has been envisaged as part of main EHV substation. Bidder shall facilitate in successful Integration of IEDs to the remote SAS/SCADA system through Ethernet switches.

11.9.2. All Numerical relays shall be of types, proven for the application satisfying requirements specified elsewhere and shall be subject to Employer's approval. Numerical Relays shall have appropriate setting ranges, accuracy, resetting ratio, transient overreach and other characteristics to provide required sensitivity to the satisfaction of the Employer.

11.9.3. All numerical relays shall be rated for control supply voltage as mentioned elsewhere under system parameters and shall be capable of satisfactory continuous operation between 80-120% of the rated voltage. Making, carrying and breaking current ratings

of their contacts shall be adequate for the circuits in which they are used. Threshold voltage for binary inputs shall be suitably selected to ensure avoidance of mal operation due to stray voltages and typically shall be more than 70% of the rated control supply voltage.

11.9.4. All IEDs shall have freely programmable optically isolated binary inputs (BI) and potential free binary output (BO) contacts as per approved scheme. These I/O points shall be used for wiring of status of devices (CBs/Isolators), equipment trip/ alarms status etc. Failure of a control supply and de-energization of a relay shall not initiate any circuit breaker operation.

11.9.5. Relays shall have event recording feature, recording of abnormalities and operating parameters with time stamping. Event records & alarms shall be stored in Non-volatile memory and failure of control supply shall not result in deletion of any of these data.

11.9.6. All Numerical relays shall have features for electrical measurements including voltage, current, power (active & reactive), frequency, power-factor and energy parameters.

11.9.7. All numerical relays shall have provision of both current (CT) and voltage (VT) inputs as required for protection & measurement purposes using protection cores[DO1].

11.9.8. All numerical relays shall have key pad / keys to allow relay setting from relay front. Relay to be self or hand reset type which shall be software selectable. Manual resetting shall be possible from remote.

11.9.9. Relays shall have suitable output contact for circuit breaker failure protection (LBB) logic.

11.9.10. Relays shall have self diagnostic feature with continuous self check for power failure, program routines, memory and main CPU failures and a separate output contact for indication of any failure.

11.9.11. Contractor shall submit applicable Type Test reports for Numerical relays as per IEC including report for IEC 61850 protocol from accredited lab.

11.9.12. IED shall be provided for protection, control and monitoring of the bay equipments. One no. IED shall be provided for each no. of bays.

11.9.13. Its control function shall include control & monitoring of Circuit breaker and monitoring of Isolator status.

11.9.14. It shall include protective function as mentioned for transformer / feeder numerical protection IED as applicable . Functional requirement, as applicable, of protective relays specified under clause 11.10 shall be met.

11.9.15. Each IED shall have communication port based on IEC61850 protocol for integration with SAS.

11.9.16. IED shall be capable of integration with the remote EHV substation automation system based on IEC61850

11.9.17. The IED shall be of modular in construction with adequate capacity for the estimated binary hardwired Inputs & Outputs plus 20% spare capacity. Requirement for external IO modules shall be avoided as far as possible.

11.9.18. IEDs offered shall be of state of the art microprocessor based architecture and employ digital numerical technology. Following power interruption and/or communications failure the IED shall be arranged to restart automatically.

11.9.19. Time synchronisation of IEDs with UTC time shall be done over the IEC61850 field LAN

11.9.20. It shall be suitable for analog inputs from current transformers with 1A / 5A rated secondary and voltage transformers with 63.5V (phase to neutral voltage) rated secondary.

11.9.21. The IED shall be able to integrate analog input channels and digital input / output channel as a minimum to meet the protection, control & monitoring scheme requirement for the bay.

11.9.22. Plant alarms and indications will be derived as digital input from volt free contacts.

11.9.23. The command outputs shall be designed to provide select and execute outputs. The period of the command pulse shall be configurable between 0.1 second and 15 seconds on point basis. The command pulses shall reset immediately after the command is executed. Controls transmitted between the operator workstation of remote SAS / SCADA and the IED shall comprise a select, check back & execute sequence (or other means of providing high message security).

11.9.24. Each IED shall be equipped with Local HMI facilities, enabling control of Circuit Breaker from IED whenever required. The Local HMI facilities preferably shall be accomplished by means of Graphical LCD display embedded into the front panel of the IED. Display will show simplified SLD diagram (with device identification number) showing status of bay switching equipment (circuit breaker & isolators). Other display type will be multiple displays of analog values readings / reports, Alarm panel displays, Diagnostic/ on-line configuration displays etc.

11.9.25. A common Audible alarm with accept / reset push button shall be provided for each IED which shall be initiated from respective IED on tripping event.

## 11.10. PROTECTION:

### 11.10.1. Numerical Transformer Protection Relay

a. The relay shall have instantaneous as well as time delayed three over current (50) and one earth fault (50N) protections.

b. The over current element should have the minimum setting adjustable between 20-200% of CT secondary rated current

c. The earth fault element of relay shall be suitable for detection of earth fault currents in the range of 5% to 80% of the CT rated current (IDMT)

d. For transformers of rating 5MVA and above, definite time delayed Stand by earth fault protection shall be provided having a pick up setting range of 10% to 40% with a timer delay of 0.3 sec to 3 sec.

e. Transformer troubles like Buchholz, Winding temperature, Oil temperature & Pressure Relief Device trips (as applicable) shall be wired to separate binary inputs of the relay and shall be configured to issue trip command to the breaker.

f. Trip circuit supervision shall be provided to monitor the circuit breaker trip circuit both in pre-trip and post-trip conditions.

g. Protection core of PT/VT shall also be wired to the protection relay.

### 11.10.2. Numerical Line Protection Relay

a. The relay shall have instantaneous as well as time delayed three over current (50) and one earth fault (50N) protections.

b. The over current element should have the minimum setting adjustable between 20-200% of CT secondary rated current.

c. The earth fault element of relay shall be suitable for detection of earth fault currents in the range of 5% to 80% of the CT rated current.

d. Trip circuit supervision shall be provided to monitor the circuit breaker trip circuit both in pre-trip and post-trip conditions.

e. Protection core of PT/VT shall also be wired to the protection relay.

## 11.11. Integration of IEDs with SAS of remote 132kV substation:

All protective relay (IEDs) shall be connected to Ethernet switch on IEC61850 which shall then be connected to local SDH equipment by optical fibre cable for integration to SAS server at a remote 132kV substation via WAN. It shall be responsibility of the Contractor to connect up to the local SDH equipment. SAS/SCADA at remote 132kV

substation shall be in the scope of a separate contract. However, the Contractor will do all necessary coordination and extend all required inputs for successful integration of the substation IEDs in the SAS/SCADA of remote 132kV substation.

Each Ethernet switch shall have minimum 03 spare ports ( at least one port of each type used) for future use.

Trivector meter are also envisaged to communicate with remote SAS/SCADA through MODBUS /IEC protocol convertor and all wiring etc. shall be in the scope of contractor

## 11.12. HEAVY DUTY TRIP

There shall be high speed master trip hand reset lock out relay which shall receive inputs from all transformer protection relays and send command to trip coil of the circuit breaker directly.

Master trip (86) relay with self-reset type for Line protection and Electrical reset type for Transformer shall be provided. Electrical reset shall be possible through IED & remote Substation SAS.

## 11.13. SUPERVISION

**I.** DC supply supervision shall also be provided having adequate contacts for providing connection to alarm.

## 11.14. Ethernet switch

1. Ethernet switches shall be 'substation hardened', and shall comply with IEC61850 for communications with IEDs. The Ethernet switches shall be of managed type with two (2) No. of Fiber optic cable ports and at least Sixteen (16) Copper ports to achieve the LAN configuration. More no. of switches or higher ports switch can also be supplied to meet all IEDs requirements for the LAN. The Ethernet switches shall have features to support the redundant rings. **These switches shall be mounted in the switchgear Panels**. The FO ports shall be Single-mode 1000Mbps ports. Copper ports shall be 10/100Mbps ports.
2. Necessary software for configuration of Ethernet switches.

11.15. **CONFIGURATION OF C&R PANELS (33kV)-**Each panel shall consist of following:

| | 33kV feeder | 33kV Transformer |
|---|---|---|

| | | |
|---|---|---|
| Ammeter (for each bay) | 3 nos | 3 nos |
| Wattmeter (for each line, transformer) | 1 no | 1 no |
| Varmeter ( for each bay, transformer) | 1 no | 1 no |
| Trivector Meter | 1 no | 1 no |
| CB control switch(for each breaker) | 1 no | 1 no |
| Red indicating lamp(for each Circuit breaker ) | 1 no | 1 no |
| Red indicating lamp(for each isolator ) | 1 no | 1 no |
| Green indicating lamp(for each Circuit breaker ) | 1 no | 1 no |
| Green indicating lamp(for each isolator ) | 1 no | 1 no |
| White indicating lamp(DC healthy lamp ) | 1 no | 1 no |
| CB spring charge indicator (Mechanical) | 1 no | 1 no |
| Annunciation windows(For Each Transformer, Feeder with associated annunciation relays ) | 1 Set | 1 Set |
| Push button (for each control panel Alarm accept/reset/lamp test) | 3 nos | 3 nos |
| Mimic to represent SLD In all control panels | lot | lot |
| Voltmeter with selector | 1 no | 1 no |
| Cut out, mounting (For transformers wiring for WTI and selector switch) | ------- | Lot |
| Master Trip Relay (86) | 1 set | 1 set |
| DC supply Supervision relay As per scheme requirement | 1 nos | 1 nos |
| Flag relays, aux relays, timers, trip relays etc as per scheme requirements | 1 Set | 1 Set |
| Bus frequency meter (Digital) For each main bus | 1 no | 1 no |
| Bus healthy indication lamps For each bus | 3 nos | 3 nos |
| Protection IED's for each bay | 1 nos | 1 nos |
| Modbus-IEC61850 protocol convertor | 1 Lot for all 33kv panels | |
| Ethernet Switch per Substation as required | 1 Lot for all 33kv panels | |

**Note :**

1 For transformer feeders, all equipments of control panel shall be provided separately for HV sides.

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

3 Each line /HV side of transformer shall be considered as one feeder for above purpose.

4 33V and 11kV Numerical Relay(IED) for line feeder and transformer feeder should be interchangeable.