SECTION – 2.16

CONTROL AND RELAY PANELS

1.0.0 INTRODUCTION

This section covers the requirements of relay panels for 132kV AIS Substation.

2.0.0 SCOPE OF WORK

2.1.0 The scope of work shall include the following equipment.

- Relay panel for each of transmission line feeders (Double circuit transmission lines Namely Line-3 and Line-4) , transformer feeder (One 70 MVA 132/11 kV) , Bus coupler and bus bar protection for existing 132kV Substation.

2.2.0 Conceptual Single line diagram (including protection) for the Substation is shown in the enclosed tender drawing.

2.3.0 Bidders may consider the use of BCPU. However, in case the BCPU does not meet the required functionality and hardware criteria for control and monitoring as per tender specifications and system requirements, a separate BCU (Bay Control Unit) shall be provided.

2.4.0 Dedicated and separate numerical relays shall be provided by the Bidder as indicated in the SLD. In case additional relays are required to meet the project requirements and tender specifications, the same shall be provided accordingly.

2.5.0 The Bidder shall provide adequate space in C&R panels for installation of PMUs, including all necessary wiring up to terminal blocks. Any unused cutouts shall be properly blanked, maintaining good aesthetics.

2.6.0 The Bidder shall quote optional costs in the price schedule for supply, installation, testing, commissioning, and integration of PMUs with SLDC, as specified in the tender. Supply of PMUs shall be undertaken only after written confirmation from GIPCL

2.7.0 For Detail specification of PMU, bidder is requested to refer relevant section of tender document.

2.8.0 Separate PMUs shall be provided for each bay of double circuit transmission line (GIPCL and GSS end). However, if the PMU has provision for multiple instrument transformer inputs, a common PMU may be accepted, subject to meeting all measurement and performance requirements.

2.9.0 All required approvals from STU/SLDC/GETCO/RPC or any other concerned statutory authority are in the scope of the Bidder.

3.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest version of the relevant IS / IEC standards including amendments, if any, except where modified and / or supplemented by this specification. Some of the applicable standards are listed below:

a) IEC 60255 Electrical relays
b) IEC 60359 Expression of the performance of electrical & electronic measuring Equipment
c) IS 3231 Electrical relays for power system protection
d) IS 3842 Electrical relay for AC systems

4.0.0 TECHNICAL REQUIREMENTS

4.1.0 Relay Details

4.1.1 All main protective relays shall be of fully numerical type. The relays shall have features for continuous monitoring of all the components and power supply and healthy indication lamps. Any failure may be indicated with external alarm (On local annunciator and remote system). The relays shall have programmable output relays to configure trip and other alarm functions.

The communication protocol shall be as per IEC 61850 and communication interface and should have Interoperability during integration of numerical relays to communicate over IEC61850 protocol with RTU/SAS/IEDs/SCADA/EnMS system of different OEMs. The relays shall have adequate number of digital inputs and outputs as per system requirement and tender specifications.

4.1.2 The numerical protective relays including all IED's shall be capable of measuring and storing values of an all analogue and digital channels concurrently for all events, faults and disturbance recordings with a time stamping (synchronized with Master clock) .
Disturbance recording shall provide adequate pre-fault and post-fault time duration, accuracy and resolution to comply with the requirements of SLDC/GETCO or other applicable statutory authorities.
In case the disturbance recording function within the IEDs is not adequate, a separate disturbance recorder shall be provided.

4.1.3 All numerical relays shall be draw out / withdrawable type to the extent possible.

4.1.4 All AC operated relays shall be suitable for operation at 50Hz. 110V VT secondary and current operated relays for 1A CT secondary. All DC operated relays and timers shall be designed for the DC voltage specified, and shall operate satisfactorily between 80% and 110% of rated voltage. Voltage operated relays shall have adequate thermal capacity for continuous operation.

4.1.5 Line protection

i. The maximum fault current could be as high as 31.5kA but the minimum fault current could be as low as 20% of rated current of CT secondary.

ii. The protective relays shall be suitable for use with electromagnetic voltage transformers having non-electronic damping and transient response as per IEC. EMVT shall be used for metering in this plant.

iii. The numerical distance protection relay shall have the following built-in features:

- Monitoring the VT supply and provision of VT fuse failure blocking
- Instantaneous transient free high set units
- Detection of open conductor / phase
- Fuse failure protection
- Residual compensation & weak in feed protection
- Current reversal guard protection feature

iv. Distance to fault locator shall have the following features:

- Maximum registering time of less than 2 cycles
- Direct display unit
- Both phase to phase fault & phase to earth fault covered
- Measuring units
- " On - line" type
- Mutual zero sequence compensation unit
- Accuracy of 3% or better

4.1.6 Bus Bar Protection

(a) Each 132kV bus bar shall be covered with a duplicated centralized low impedance high-speed bus bar protection scheme. Bus bar protection of each 132kV bus shall operate so as to achieve better security. However De-Centralized (Distributed) Busbar Protection system is also acceptable subject to compliance of tender specifications and project requirement.

In case of De-Centralize Busbar protection system minimum one number of spare input (ready to use) shall be kept for owners future use.

(b) Each bus bar protection scheme shall have the following features:

1. Maximum operating time up to trip impulse to trip relay for all types of faults of 25 milliseconds at 5 times setting value
2. Selective operation for each bus bar
3. Hundred percent security up to specified fault level for each voltage level
4. Continuous supervision for CT secondary against any possible open circuit and rendering the relevant zone of protection inoperative and initiating an alarm in case of an open circuit
5. No false operation during normal load flow in bus bars
6. Clear zone indication
7. Phase segregated and triple pole type
8. Independent zones of protection (If bus section is provided then each side of bus section shall have separate set of bus bar protection schemes)
9. Individual high speed electrically reset tripping relays for each feeder
10. Transient free in operation
11. Continuous D.C. supplies supervision
12. No tripping for differential current below load current of heaviest loaded feeder. Vendor shall submit application check for the same.
13. Protection 'IN/OUT' switch for each zone
14. Trip relays, CT switching relays(if applicable), as well as additional power supply modules, input modules etc. as may be required to provide a bus bar protection scheme for the complete bus arrangement
15. Stability for all through fault conditions up to the maximum fault level.
16. Not affected by CT saturation and long cable length.
17. Tripping of remote end for feeder breaker

(c) The bus bar protection relay shall be numerical with the following features:

1. Low impedance biased differential type with selectable pickup & slope setting
2. In-built check zone check feature
3. LBB protection
4. Inbuilt disturbance recorder

4.1.7 Distance protection relay shall have the following minimum features:

- Non-switched type with separate measurements for all phase to phase and phase to ground faults (minimum four zones)
- Stepped time distance characteristics and three independent zones (zone 1, zone 2 and zone 3).
- Mho or quadrilateral or other suitably shaped characteristics for zone 1, zone 2 and zone 3.
- Permissive under reach / over reach / blocking communication mode
- Potential free contacts for carrier aided tripping, auto reclosing, breaker failure, etc.
- Power swing blocking protection
- Current reversal guard feature
- Compatible with communication equipment and can be used for permissive / under reach / over reach / blocking scheme
- Facility for synchronization of internal clock with GPS
- The maximum operating time shall be 40ms for all faults with source impedance ratio of 4 and shall be 45ms for three phase faults and 60ms for all other faults with source impedance ratio of 15
- Adjustable characteristic angle setting range of 30-85 degree or independent resistance and reactance setting

- Two independent continuously variable time setting range of 0-3 seconds for zone 2 and 0-5 seconds for zone 3
- Resetting time of less than 55ms including resetting time of trip relays
- Variable residual compensation
- Ensure correct operation during close up three phase faults and other adverse conditions and shall operate instantaneously when circuit breaker is closed to zero volt three phase fault.
- Weak end infeed feature

4.1.8 Line Differential relay shall have the following minimum features:

Line differential protection relay with built in distance function. Further, matching Line differential protection relays for remote ends shall be provided. The line current differential relay with built-in distance protection function shall be capable of being selected to differential function with back up distance function or shall activate back up distance automatically when the differential relay is out of service.

Communication for current differential protection shall be provided through a direct fiber-optic link with matching relay at the GSS end. All necessary communication hardware & accessories shall be supplied at both GIPCL and GSS end. The communication interface shall comply with IEEE C37.94.

4.1.9 The transformer differential relay shall have the following minimum features:

- Second and fifth harmonic restraint
- Unrestrained transient free instantaneous units with variable settings
- Biased differential with selectable pick up & slope settings
- Built-in ratio / phase angle corrections.
- Dedicated separate sets of CT input for each winding.

4.1.10 Restricted earth fault relay shall have the following minimum features:

- Single pole type
- Current / voltage operated high impedance type
- Current setting range of 10-40% of 1A or suitable voltage setting range
- Suitable non-linear resistor to limit peak voltage to 1000V

4.1.11 Directional IDMT earth fault relay shall have the following minimum features:

- IDMT characteristic with a definite minimum time of 3 sec. at 10 times setting
- Setting range of 20-80% of rated current
- Characteristic angle

4.1.12 Overvoltage protection relay shall have the following minimum features:

- Two independent stages
- Adjustable setting range of 100-170% of rated voltage with adjustable time delay range of 1 to 60 seconds in 1st stage and 100-200ms in 2nd stage
- Drop-off to pick-up ratio greater than 95%

4.1.13 Over fluxing relay shall have the following minimum features:

- Operation on the principle of voltage to frequency ratio and shall be phase to phase connected
- Inverse time characteristics matching with transformer over fluxing withstand capability

- Independent alarm with time delay continuously adjustable between 0.1 to 6 seconds at values of v/f between 100% to 130% of rated values
- Maximum operating time shall not exceed 3 seconds and 1.5 seconds at v/f values of 1.4 and 1.5 times the rated values, respectively.
- Operating time accuracy better then ±10%
- Resetting ratio of 95% or better

4.1.14 Backup phase over current protection relay shall have the following minimum features:

- IDMT characteristics with a definite minimum time of 3 sec at 10 times setting
- Variable setting range of 50-200% of rated current
- Characteristic angle

4.1.15 Backup earth fault protection relay shall have the following minimum features:

- IDMT characteristics with a definite minimum time of 3 sec at 10 times setting
- Variable setting range of 20-80% of rated current
- Characteristic angle

4.1.16 Auto reclosing shall have the following minimum features:

- Continuously variable dead time range of 0.1-2 seconds
- Continuously variable reclaim time range of 5-300 seconds
- Facility to select auto reclosure and non-auto reclosure modes
- Suitable for multiple shot auto reclose operations
- Dead line charging
- Check synchronizing

4.1.17 Local breaker back-up relay shall have the following minimum features:

- Triple pole type
- Operating and resetting time of less than 15ms
- Setting range of 20-80% of rated current
- Continuously adjustable setting range of 0.1-1 second

4.1.18 High speed tripping relay shall have the following minimum features:

- Operating time shall not exceed 10ms and shall reset within 20ms
- Separate relay for coil supervision
- Operation indicators for each

4.1.19 Trip Circuit Supervision Relay for Circuit Breaker :

- Trip circuit supervision relay for breaker shall be capable of monitoring the healthiness of each trip coil and associated circuit of circuit breaker during both ON and OFF conditions.
- Trip circuit supervision relay for master trip relay (86) shall be capable of monitoring the healthiness of each coil.
- The relay shall have time delay on drop-off of not less than 200ms and shall be provided with operation indications for each phase.

4.1.20 Master Trip Relay (For each relay panel / protection system)

- Separate Master Trip Relay (86) shall be provided.

4.1.21 Secondary Injection Test facility.

- Relay test Block shall be provided for online testing of all numerical relays.
- Test block shall have facility of CT, PT, Trip Circuit, auxiliary supply, logical inputs and output contacts. Test block shall be mounted below and in front of the panel.
- For measuring instruments (MFM, PQM etc.), separate / dedicated TTB and shall be connected in such a way that it facilitates testing / checking / removal / replacement activates without affecting other measuring instruments connected to same core of CT/PT. TTB shall be of 3 phase-4 wire type. TTB shall be mounted below and in front of the panel. TTB shall be of large size and shall be of SCREW type. (e.g. Dev industries model no 4SF)

4.1.22 Where applicable, carrier receive relays shall be provided.

4.1.23 Necessary auxiliary relays, timers, contact multiplication relays etc. shall be provided as per requirement of protection schemes.

4.1.24 Supervision relays for lockout relays, DC control supply monitoring relays, AC supply monitoring relays etc. shall be provided.

4.1.25 The protective relays shall be suitable for efficient and reliable operation of the protection scheme described in the specification.

4.1.26 All protective relays, auxiliary relays and timers except lock out relays and interlocking relays specified shall be provided with self-reset type contacts. All protective relays 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 / Alarm circuits of protections located outside the board such as Buchholz relays, OLTC Surge Relay, PRV's, conservator Protection Relay, MOG oil and winding temperature (for all windings), fire protection etc.

4.1.27 Timers shall be of solid state type. Time delay in terms of milliseconds obtained by the external capacitor resistor combination is not permitted.

4.1.28 For numerical relays necessary software and hardware (including laptop and suitable cable for connection with the communication port on the relay) to up down load the data to / from the relay from / to the personal computer installed in the substation shall be provided. The relay shall have suitable communication facility for connectivity to SAS.

4.1.29 For details of bay control & protection units (BCPU) and requirement of communication ports bidder shall refer SAS section.

4.1.30 For details of PMU refer section 2.30

4.1.31 Type of offered relay shall be latest numerical high-end version with highest display size and features available. The relays shall have minimum 2 DI, 2 DO & 2 LEDs for Customer/Client's future use (wired up to TB).

4.2.0 Configuration of Relay Panels

4.2.1 Separate relay panels shall be provided for each of the following feeders:

(a) Each Line feeder of double circuit line
(b) Transformer feeder (One for 70 MVA 132/11 kV Transformer)
(c) Bus coupler breaker
(d) Bus bar protection
(e) All relay panel shall be provided with annunciator (with large window) and at least 3 spare windows wired up to TB shall be provided for future use by Customer/Client.

4.2.2 Line Feeder shall have the following protections / equipment / components as a minimum:

- Line Differential Protection (OPGW is available)
- Distance Protection (21L) with Switch on to fault (SOTF)
- Busbar Protection relay Main and Check Zone-1 (87B1 + 87C1)
- Busbar Protection relay Main and Check Zone-2 (87B2 + 87C2)
- Local Breaker Backup (50LBB1 & 50 LBB-2)
- Direction Overcurrent (67)
- Direction Earth Fault (67N)
- Overcurrent (50,51)
- Earth Fault (50N,51N)
- Under frequency Protection (81U)
- Over frequency Protection (81O)
- Df/Dt protection function with anti-islanding scheme(87R)
- Undervoltage Protection (27)
- Overvoltage Protection (59) (Two Stage)
- Auto Reclosing (79) (Three Phase)
- Synchronism system with bypass facility (dead bus closing, double frequency meter, double voltmeter etc.)
- *BCPU (Bay Control and Protection Unit) or BPU (Bay Protection Unit) & BCU (Bay Control Unit)
- PMU (Phasor Measurement Unit)
- PQM (Power Quality Meter)

4.2.3 Transformer Feeder shall have the following protections / equipment / components as a minimum:

- Transformer Differential (87T)
- Restricted Earth Fault for HV side (64HV)
- Direction Overcurrent (67)
- Directional Earth Fault (67N)
- Overcurrent Instantaneous (50) and IDMT (51)
- Earth Fault Instantaneous (50N) and IDMT (51N)
- Over fluxing (24)
- Thermal Overload (49)
- Undervoltage Protection (27)
- Overvoltage Protection (59)
- Local Breaker Backup (50LBB1 & 50 LBB2)
- Busbar Protection relay Main and Check Zone-1 (87B1 + 87C1)
- Busbar Protection relay Main and Check Zone-2 (87B2 + 87C2)
- Winding Temperature Alarm and Trip Relay (49WX and 49WY)
- Oil Temperature Alarm and Trip Relay (49OX and 49OY)
- Buchholz relay (63)
- PRV1, PRV2, OSR (Oil Surge Relay of OLTC) and MOG
- BCPU or BPU & BCU

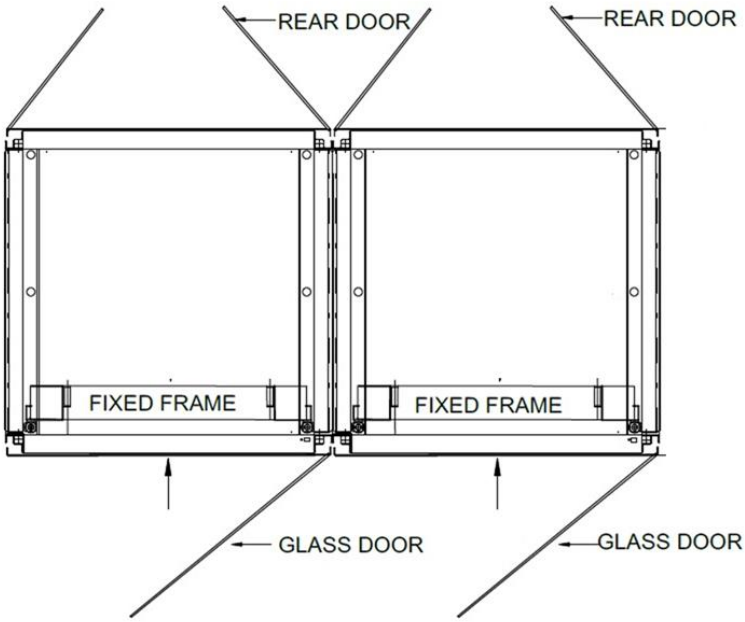
4.2.4 Bus Coupler Feeder shall have the following protections / equipment / components as a minimum:

- Busbar Protection relay Main and Check Zone-1 (87B1 + 87C1)
- Busbar Protection relay Main and Check Zone-2 (87B2 + 87C2)
- Local Breaker Backup (50LBB1 & 50 LBB2)
- Overcurrent (50,51)
- Earth Fault (50N,51N)
- Undervoltage Protection (27)

- Overvoltage Protection (59)
- Check Synchronization (25C), with bypass facility (Dead bus closing), Double Frequency Meter and double voltmeter etc.
- BCPU or BPU & BCU

5.0.0 CONSTRUCTIONAL FEATURES

5.1.0 Relay panels shall be of simplex type design and all main components shall be flush mounted on the front side (Fixed one, i.e. not moving on hinges) of the panel and Toughened glass door shall be provided on front side. Rear side of the panel shall be of single or double door (approximately 180 degree opening) for easy access to internally mounted components. It shall consist of CRCA sheet steel with thickness not less than 3mm for weight bearing panels and 2mm for other panels and shall provide a degree of protection not less than IP 31. Panels shall be free standing, floor-mounting type. All doors and removable covers of panels shall be gasketed all around. Anti-vibration pads shall be placed between panel and base frame. Cable entries to the panels shall be from the bottom. Each panel shall be provided with a minimum of 300 thick removable gland plate and each panel shall be powder coated with painting thickness shall not be less than 85 micron. For ease of reference, a simplified sketch is attached hereunder.



5.2.0 The center lines of switches, push buttons and indicating lamps shall be not less than 750mm from the bottom of the panel. The center lines of relays and recorders shall be not less than 450mm from the bottom of the panel. The center lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Likewise, the top lines of all relays and recorders etc. shall be matched. No equipment shall be mounted on the doors.

5.3.0 Panels shall be supplied complete with interconnecting wiring provided between all electrical devices mounted 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.

5.4.0 All wiring shall be carried out with 1.1 kV grade, single core, stranded copper conductor wires with PVC insulation. The wiring shall be color coded (R-Phase Red, Y-Phase Yellow, B-Phase Blue, Earth Green, unique colors for DC and AC wiring). The minimum size of the multi-

stranded copper conductor used for internal wiring shall be 2.5sq.mm for CT/VT circuit and 1.5sq.mm for other circuits.

5.5.0 Terminal blocks shall be 1.1 kV grade and have 10A continuous rating, molded piece, complete with insulated barriers, stud type terminals (screw driver operated), 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.

5.6.0 Disconnecting type terminal blocks for current transformer and voltage transformer secondary leads shall be provided. Also, current transformer secondary leads shall be provided with short circuiting and earthing facilities.

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

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

5.9.0 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.

5.10.0 Nameplates shall be made of SS304 or, better with blue engraving lettering.

5.11.0 240V, single phase, AC socket with switch suitable to accept 5A and 15A pin round standard Indian plug, shall be provided in the interior of each cubicle with ON-OFF switch.

5.12.0 Each panel shall be provided with a LED lamp rated for 240V, single phase, AC supply for the interior illumination of the panel controlled by the respective panel door switch.

5.13.0 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) for AC circuits and DC circuits. Each MCB shall be provided with one potential free contact and the same shall be wired for annunciation purpose in relay panel as well as SAS.

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

5.15.0 All panels shall be equipped with an earth bus of at least 25 X 6 sq. mm. 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 color code of earthing wires shall be green. VT and CT secondary neutral or common lead shall be earthed at one place only at the terminal blocks where they enter the panel.

5.16.0 Two sets of contacts of all relay functions and relay healthy status shall be wired up to terminal block for use as annunciation and substation automation system (SAS) input.

5.17.0 All the protection relays shall be numerical type provided with communication port to facilitate interfacing with SAS. It shall be possible to carry out / modify settings of relays from SAS. Necessary software shall be loaded in SAS.

5.18.0 Meaningful labels / inscriptions for all components like LED Indicating Lamps, Push buttons, Relays, MFM's, Meters, TTB's etc.

5.19.0 "Relay Healthy" feedback to SAS system for all numerical relays shall be provided.

5.20.0 LED Alarm labels for all numerical relay are properly printed and provided on each relay.

5.21.0 The numerical relays supplied shall be of latest firmware and hardware versions and cyber security compliant as per latest CEA regulations.

5.22.0 Optimum use of functionality of selected numerical relays shall be enusred by

- Configuring user defined labels.
- Supervision functions
- Measurements and recording functions
- Disturbance recording and analysis
- Fault recording.
- Event recording.
- Maintenance recording functions settings,
- Programmable scheme logics.
- Communication to SAS systems.
- Analogue inputs, Relay outputs, opto inputs and Alarm LED's. etc.

5.23.0 **DC Distribution Scheme**

5.24.1 The relay panels shall be provided with two (2) numbers of 110V DC feeders in loop-in / loop-out fashion. Each of the above feeder shall be fed from separate section of DC board. Manually operated 3 position, selector switch with positions called source-I, independent, source II, shall be provided to select any one for main I supply for that panel and other as main II supply.

5.24.2 Each incoming supply shall have MCB and supervised by supply supervision relay having NC contacts with time delayed drop-off. Loss of supply shall be wired for annunciation and SAS. DC supply shall be monitored on local panels by LEDs before and after selection.

5.24.3 The supervision relay shall have time delayed drop off type NC contact for annunciation, failure of annunciation supply shall also be combined and annunciated on 240V AC operated annunciation system. In turn, the failure of AC annunciation supply shall be annunciated in normal DC operated annunciation. It shall all be provided with additional contacts for event recording and remote annunciation.

6.0.0 DRAWINGS, DATA AND MANUAL

6.1.0 **To Be Submitted After Award of Contract:**

- Technical data sheets
- Dimensional general arrangement drawing
- Protection scheme diagram & single line diagram
- ICF files , other configuration details for SAS/ EnMS / SCADA integration before FAT
- Relay setting calculation and protection co-ordination
- Interconnection / wiring diagram
- Catalogues / drawings.
- Quality plan
- Test certificates
- O&M manual

7.0.0 TESTS

The equipment offered shall be of type tested and proven type. Type test reports shall be furnished for approval. All routine and acceptance tests in accordance with the latest version of applicable standard for all equipment shall be conducted. List of routine tests for relay panel are listed below.

- Power frequency voltage (dry) test on the main circuit
- Voltage test on control and auxiliary circuits
- Verification of wiring as per approved drawings
- Functional tests
- Testing of relays.
- Measurement of resistance of the main circuit