

VOLUME-II

**TECHNICAL SPECIFICATION FOR C & R PANELS AND SUBSTATION
AUTOMATION SYSTEM**

Section-1

DETAILED TECHNICAL SPECIFICATION FOR RELAY & PROTECTION PANELS

This specification provides for the design, fabrication, and manufacturing of panels with relays, meters and other associated equipments with provision for wiring of all equipments. The equipments shall be capable of working satisfactorily in the environmental conditions:

1.0 CONSTRUCTIONAL FEATURES

- 1.1 The Panels are to be of simplex type and having wiring access from front side. The panel shall be provided with swing door on front side and transparent protective door covering the front swing door on which the relays and associate equipments shall be mounted.
- 1.2 Relay panels shall be of simplex type design as indicated. It is the responsibility of the Contractor to ensure that the equipment specified and such unspecified complementary equipment required for completeness of the protective/control schemes is 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.
- 1.3 Panels shall be completely metal enclosed and shall be dust, moisture and vermin proof. The enclosure shall provide a degree of protection not less than IP-42.
- 1.4 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 3.0 mm for weight bearing members of the panels such as base frame, front sheet and door frames, and 2.0 mm for sides, door, top and bottom portions. There shall be sufficient reinforcement to provide level transportation and installation.
- 1.5 All doors, removable covers and panels shall be gasketed all around with neoprene gaskets. Ventilating louvers, if provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh.
- 1.6 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 true and smooth.

- 1.7 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 which shall be supplied by the contractor, shall be placed between panel & base frame.
- 1.8 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.
- 1.9 Relay panels of modern modular construction would also be acceptable.

2. MOUNTING:

- 2.1. 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.
- 2.2. 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.
- 2.3. The Contractor shall carry out cut out, mounting and wiring of the free issue 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.
- 2.4. 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
- 2.5. The centre 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.
- 2.6. No equipment shall be mounted on the doors.

3.0 PANEL INTERNAL WIRING:

- 3.1. 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

- 3.2. All wiring shall be carried out with 1100V grade, single core, stranded copper conductor wires with PVC insulation. The minimum size of the multi-stranded copper conductor used or internal wiring shall be as follows:
- All circuits except current transformer circuits and voltage transfer circuits meant for energy metering - one 1.5mm sq. per lead.
 - All current transformer circuits one 2.5 sq.mm lead.
 - Voltage transformer circuit (for energy meters): Two 2.5 mm sq. per lead.
- 3.3. 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.
- 3.4. 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.
- 3.5. Wire termination shall be made with solder less 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.
- 3.6. 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.
- 3.7. Contractor shall be solely responsible for the completeness and correctness of the internal wiring and for the proper functioning of the connected equipments.

4. TERMINAL BLOCKS:

- 4.1. 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.

- 4.2. 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.
- 4.3. At least 20% spare terminals shall be provided on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.
- 4.4. 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 6mm Sq. Aluminium.
 - All other circuits: minimum of one of 2.5mm Sq. Copper.
- 4.5. 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.
- 4.6. 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 Employer's external cable connections if any. 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.
- 4.7. The number and sizes of the Employer's multi core incoming external cables if any, will be furnished to the Contractor after placement of the order. All necessary cable terminating accessories such as gland plates, supporting clamps & brackets, wiring troughs and gutters etc. (except glands & lugs) for external cables shall be included the scope of supply.

5.0 PAINTING:

- 5.1. All sheet steel work shall be phosphated in accordance with the IS: 6005 "Code of practice for phosphating iron and steel".
- 5.2. Oil, grease, dirt and swarf shall be thoroughly removed by emulsion cleaning.
- 5.3. 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.
- 5.4. After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying.

- 5.5. 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.
- 5.6. 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.
- 5.7. A small quantity of finished paint shall be supplied for minor touching up required at site after installation of the panels.
- 5.8. In case the bidder proposes to follow any other established painting procedure like electrostatic painting, the procedure shall be submitted for APTRANSCO's review and approval.
- 5.9. Painting Shade of panels shall be Shade 631 of IS5 (Light Grey, Semi Glossy Finish)

6.0 NAME PLATES AND MARKINGS:

- 6.1. 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 nameplates shall be provided for circuit/feeder designation.
- 6.2. 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.
- 6.3. All relays and other devices shall be clearly marked with manufacturer's name, manufacturer's type, serial number and electrical rating data.
- 6.4. Name Plates shall be made of non-rusting metal or 3 ply lamicoid. Name plates shall be black with white engraving lettering.
- 6.5. All the panels shall be provided with name plate mounted inside the panel bearing LOA No & Date, Name of the Substation & feeder and reference drawing number.

7.0 MISCELLANEOUS ACCESSORIES:

- 7.1. 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.
- 7.2. Interior Lighting: Each panel shall be provided with a fluorescent lighting fixture rated for 240 Volts, single phase, 50 Hz supply for the interior illumination of the

panel controlled by the respective panel door switch. Adequate lighting shall also be provided for the corridor in Duplex panels.

- 7.3. 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 conform 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'.
- 7.4. 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.

8. EARTHING:

- 8.1. 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.
- 8.2. Provision shall be made on each bus bar of the end panels for connecting Substation earthing grid. Necessary terminal clamps and connectors for this purpose shall be included in the scope of supply of Contractor.
- 8.3. 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.

- 8.4. Looping of earth connections which would result in loss of earth connection to other devices when the loop is broken, shall not be permitted. Earthing may be done in such a manner that no circulating current shall flow in the panel.
- 8.5. 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.
- 8.6. An electrostatic discharge point shall be provided in each panel connected to earth bus via 1 Mega Ohm resistor.

9.0 ENERGY METERS:

Electronic Trivector meters shall be static type conforming to IEC 687 and suitable for bidirectional power flow and for CT/CVT or IVT connection. The static meter shall measure active and reactive energy both import and export, by 3 phase 4 wire principle with ABT feature suitable for balanced/unbalanced 3phase load. Accuracy of meter shall be 0.2 for active energy and 0.5 for reactive energy. The active and reactive energy shall be directly computed in CT & VT primary values and stored in four different registers as KWH (E), KWH(I), KVARH(E) and KVARH(I) along with a plus sign for export and minus sign for import. CT secondary is 1 A, PT secondary and CVT secondary is $110/\sqrt{3}$ V, the appropriate ratios of CT and CVT separately or VT will be given in the detailed order. Meters shall compute the energy sent out/received, from/to the station bus bar during each successive 15 minute block and store in the respective registers. Meter shall display on demand the energy sent out/received during the previous 15 minute block. Further the meter shall continuously integrate the energy readings of each register upto that time. All these readings shall be displayed on demand. Cumulative reading of each register shall be stored in non-volatile memory at the end of each hour of day starting from 01 hours.

Each meter shall have a unique identification code provided by purchaser and shall be marked permanently on the front and also on the non-volatile memory. The voltage monitoring of all the three voltages shall be provided.

The meter shall normally operate with power drawn from VT supplies. Power supply to the meter shall be healthy even with a single phase VT supply. An automatic back up shall be provided by a built in life time battery and shall not need replacement for at least ten years with a continuous VT interruption of even two years. Date and time of VT interruption and restoration shall be automatically stored in non-volatile memory.

The meter shall have an optical port at the front of the meter for data collection by a hand held device and RS 485 port for remote communication. The meter shall conform to open protocol modem for remote communication.. The meter shall have pulse outputs to test accuracy and for connecting it to time of day tariff equipment.

10.0 RELAYS:

- 10.1. All relays shall conform to the requirements of IS: 3231/IEC-60255/IEC 61000 or other applicable standards. Relays shall be suitable for flush or semi-flush mounting on the front with connections from the rear.
- 10.2. All main protective relays shall be of fully numerical type and shall comply as per IEC 61850 standard for communication. Further, the test levels of EMI as indicated in IEC 61850 shall be applicable. All the relays shall be directly connected to the inter bay bus using fiber optic cables and shall support peer to peer communication. The relays shall generate GOOSE messages as per IEC 61850 standards for interlocking and also to ensure interoperability with third party relays. Each relay should also generate an ICD file in XML format for engineering/ integration to a vendor independent SCADA system.
- 10.3. All protective relays shall be in draw out or plug-in type/modular cases with proper testing facilities. Necessary test plugs/test handles shall be supplied loose and shall be included in contractor's scope of supply.
- 10.4. All AC operated relays shall be suitable for operation at 50 Hz. AC Voltage operated relays shall be suitable for 110 Volts VT secondary and current operated relays for 1 amp 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.
- 10.5. 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 suiting contact duties of protective relays and monitoring of control supplies and circuits, lockout relay monitoring 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 relay coils and contacts, including 20% spare contacts (DI, DO & Analogue). Auxiliary relays also shall be provided with 20% spare contacts. 2 Nos. interposing relays are to be provided for each bay. All spare contacts shall be wired up to terminal blocks for future use.

- 10.6. All protective relays, auxiliary relays and timers except the 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 circuits of protections located outside the board such as Buchholz relays, oil and winding temperature protection, sudden pressure devices, fire protection etc.
- 10.7. Timers shall be of solid state type. Time delay in terms of milliseconds obtained by the external capacitor resistor combination is not preferred and shall be avoided.
- 10.8. No control relay which shall trip the power circuit breaker when the relay is de-energised shall be employed in the circuits.
- 10.9. Provision shall be made for easy isolation of trip circuits of each relay for the purpose of testing and maintenance.
- 10.10. Auxiliary seal-in-units provided on the protective relays shall preferably be of shunt reinforcement type. If series relays are used the following shall be strictly ensured:
 - (a) The operating time of the series seal-in-unit shall be sufficiently shorter than that of the trip coil or trip relay in series with which it operates to ensure definite operation of the flag indicator of the relay.
 - (b) Seal-in-unit shall obtain adequate current for operation when one or more relays operate simultaneously.
 - (c) Impedance of the seal-in-unit shall be small enough to permit satisfactory operation of the trip coil on trip relays when the D.C. Supply Voltage is minimum.
 - (d) Trip-circuit seal-in is required for all trip outputs, irrespective of the magnitude of the interrupted current. The trip-circuit seal-in logic shall not only seal-in the trip output(s), but also the relevant initiation signals to other

scheme functions, (e.g. initiate signals to the circuit-breaker failure function, reclosing function etc.), and the alarm output signals.

- (e) Two methods of seal-in are required, one based on the measurement of AC current, catering for those circumstances for which the interrupted current is above a set threshold, and one based on a fixed time duration, catering for those circumstances for which the interrupted current is small (below the set threshold).
- (f) For the current seal-in method, the seal-in shall be maintained until the circuit breaker opens, at which time the seal-in shall reset and the seal-in method shall not now revert to the fixed time duration method. For this seal-in method, the sealing shall be maintained for the set time duration. For the line protection schemes, this time duration shall be independently settable for single- and three-pole tripping.
- (g) Seal-in by way of current or by way of the fixed duration timer shall occur irrespective of whether the trip command originates from within the main protection device itself (from any of the internal protection functions), or from an external device with its trip output routed through the main protection device for tripping.

Trip-circuit seal-in shall not take place under sub-harmonic conditions (e.g. reactor ring down).

- 10.11. All protective relays and alarm relays shall be provided with one extra isolated pair of contacts wired to terminals exclusively for future use.
- 10.12. The setting ranges of the relays offered, if different from the ones specified shall also be acceptable if they meet the functional requirements.
- 10.13. 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 APTRANSCO.
- 10.14. The bidder shall include in his bid a list of installations where the relays quoted have been in satisfactory operation.
- 10.15. All relays and their drawings shall have phase indications as R-Red, Y-yellow, B-blue
- 10.16. For numerical relays, the scope shall include the following:

- (a) Necessary software and hardware to up/down load the data to/from the relay from/to the personal computer installed in the substation. However, the supply of PC is not covered under this clause.
- (b) The relay shall be capable of supporting IEC 61850 communication standard.
- (c) The relay shall have time synchronizing facility which is compatible to IEC61850.

10.17. The relays should have two communication ports viz. Front Ethernet RJ45/RS232 port for local communication for relay settings, modifications, extraction and analysis of fault/event/ disturbance records from a laptop and a Rear fiber optic port on IEC61850 standard for remote communication to SCADA system.

10.18. The relays shall have the following tools for fault diagnostics

- Fault record – The relay shall have the facility to store fault records with information on cause of trip, date, time, trip values of electrical parameters.
- Event record – The relay shall have the facility to store sufficient number stamped event records with 1ms resolution.
- Disturbance records – At least 5 records shall be provided in the offered Numerical relays. Pre-fault time shall not be less than 100milli seconds and the post fault time shall not be less than 2 seconds (adjustable).If another system disturbance occurs during post fault run time, the recorder shall also be able to record this subsequent disturbance. The sampling rate shall not be less than 1000Hz.The data shall not be lost on failure of auxiliary power supply. However the total memory of acquisition unit shall not be less than 5 seconds. Each record shall store data from all the analogue channels, at least 8, used in the relay for protection and at least 16 digital channels. The data from DR function shall be available in IEEE/COMTRADE format and shall be compatible with the relay test kit.

11.0 TRANSMISSION LINE PROTECTION:

11.1. The line protection relays are required to protect the line and clear the faults on line within shortest possible time with reliability, selectivity and full sensitivity to all type of faults on lines.

The general concept is to have two fast operating numerical distance protection schemes preferably with two different operating principals the voltage of one relay being fed from Bus PT and the voltage of the other relay from line CVT, the currents of the two relays being fed from different CT cores. The main-I and main-

II protections having equal performance requirement specially in respect of time as called Main-I and Main-II for 220KV transmission lines. The general concept is to have fast operating numerical distance protection scheme with back-up directional OC&EF (BCU) for 132 KV feeders.

- 11.2. The Transmission system for which the line protection equipment are required is shown in the reference drawing/document(s). The length of lines and the line parameters (Electrical Constants) shall be provided during detailed engineering.
- 11.3. The maximum fault current could be as high as 40 kA but the minimum fault current could be as low as 20% of rated current of CT secondary. The starting & measuring relays characteristics should be satisfactory under these extremely varying conditions.
- 11.4. The protective relays shall be suitable for use with voltage transformers having non-electronic damping and transient response as per IEC.
- 11.5. Disturbance Recorder, Fault Recorder and Distance to fault Locator functions shall be provided as an integral part of line protection relay, shall be acceptable provided these meet the technical requirements as specified in the respective clauses.
- 11.6. Auto reclose relay function shall be part of bay control unit or else it can be built-in the main protection IED.
- 11.7. The following protections shall be provided for each of the Transmission lines:

For 220KV

Main-I: Numerical, Communicable Distance Protection scheme complying to IEC 61850 standard.

Main-II: Numerical, Communicable Distance protection scheme complying to IEC 61850 standard – of a different make.

For 132KV

Main: Numerical distance protection scheme complying to IEC61850 standard.

Backup: Directional OC & EF Protection complying to IEC61850 standard. This backup protection can be offered as part of Bay Control Unit.

For 33KV

Non Directional OC & EF Protection complying to IEC61850 standard can be offered as a part of Bay Control Unit.

- 11.8. The detailed description of the above line protections is given here under.
- 11.9.1. Main-I & Main-II Numerical, communicable and complaint to IEC 61850 communication standard Distance Protection scheme:

- (a) Shall have continuous self monitoring and diagnostic feature.
- (b) Shall be non-switched type with separate measurements for all phase to phase and phase to ground faults (6 loops)
- (c) Shall have stepped time-distance characteristics and four independent zones with selectable direction and minimum operating current of 10-30% settable.
- (d) Shall have suitably shaped characteristics for all zones to prevent relay operation during maximum load conditions.
- (e) Shall have following maximum operating time under given set of conditions and with VT being used on line (with all filters included).
 - (i) For 220 KV lines:
Maximum operating time 30ms for all type of faults
 - (ii) For 132 KV lines:
Maximum operating time not more than 40ms for all type of faults.
- (f) The relay shall have an adjustable characteristics angle setting range of 30 -85 degree or shall have independent resistance(R) and reactance (X) setting.
- (g) Shall have two independent continuously variable time setting range of 0-3 seconds for zone-2 and 0-5 seconds for zone-3.
- (h) Shall have resetting time of less than 35 milli-seconds (including the resetting time of trip relays)
- (j) Shall have variable residual compensation.
- (k) Shall have memory circuits with defined characteristics in all three phases to ensure correct operation during close-up 3 phase faults and other adverse conditions and shall operate instantaneously when circuit breaker is closed to zero-volt 3 phase fault
- (l) Shall have weak end in-feed feature
- (m) Shall have a continuous current rating of two times of 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 for a period of 1 sec.
- (n) Shall be provided with necessary self reset type trip duty contacts for completion of the scheme (Minimum number of these trip duty contacts shall be four per phase) either through built in or through separate high speed trip relays . Making capacity of these trip contacts shall be 30 amp for 0.2 seconds with an inductive load of $L/R > 10$ mill seconds. If separate high speed trip

relays are used, the operating time of the same shall not be more than 10 milliseconds

- (o) Shall be suitable for use in permissive under reach / over reach /blocking communication mode.
- (p) Shall have suitable number of potential free contacts for inter Tripping, Auto reclosing, CB failure, Disturbance recorder & Data acquisition system.
- (q) Include power swing blocking protection which shall
 - have suitable setting range to encircle the distance protection described above.
 - block tripping during power swing conditions, programmable for individual zones.
 - release blocking in the event of actual fault
- (r) Include fuse failure protection which shall monitor all the three fuses of CVT and associated cable against open circuit.
 - inhibit trip circuits on operation and initiate annunciation.
 - have an operating time less than 7 milliseconds
 - remain inoperative for system earth faults
- (s) Include a directional back up Inverse Definite Minimum Time (IDMT) earth fault relay with normal inverse characteristics as per IEC 60255-3 as a built in feature or as a separate unit for transmission lines
- (t) In case the numerical distance relay is not having the built in feature as per above clause (t), the same can be supplied as an independent relay
- (u) Must have a current reversal guard feature.

12.0 Back-up Directional Over Current and Earth fault protection scheme in transmission line:

- (a) Shall have three over current and one earth fault element(s) which shall be either independent or composite unit(s)
- (b) Shall be of Numerical type
- (c) Shall include necessary CVT fuse failure relays for alarm purposes.
- (d) Over current shall
 - have IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting
 - have a variable setting range of 50-200% of rated current

- have a characteristic angle of 30/45 degree lead
- include hand reset flag indicators or IEDs.

(e) Earth current shall

- have IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting
- have a variable setting range of 20-80% of rated current
- have a characteristic angle of 45/60 degree lag
- include hand reset flag indicators or IEDs.
- include necessary separate interposing voltage transformers or have internal feature in the relay for open delta voltage to the relay.

12.1. All trip relays used in transmission line protection scheme shall be of self/electrical reset type depending on application requirement.

13. Circuit Breaker related functions:

This shall include following function:

13.1. AUTO RECLOSING function for 220 KV shall be part of the bay control unit or part of distance protection scheme and shall

- have single phase or/and three phase reclosing facilities.
- have a continuously variable single phase dead time range of 0.1-2 seconds.
- have a continuously variable three phase dead time range of 0.1-2 seconds.
- have a continuously variable reclaim time range of 5-300 seconds.
- incorporate a selection menu to select single phase/three phase/single and three phase auto reclosure and non-auto reclosure mode
- have facilities for selecting check synchronizing or dead line charging features. It shall be possible at any time to change the required through programming.
- be of single shot type.
- be acceptable as built in with Bay control unit for 220kV lines
- include check synchronizing relay which shall
 - have a time setting continuously variable between 0.5-5 seconds with a facility of additional 10 seconds.
 - have a response time within 200 milli seconds with the timer disconnected.
 - have a phase angle setting not exceeding 35 degree.

- have a voltage difference setting not exceeding 10%.
- include dead line charging relay which shall have two sets of relays and each set shall be able to monitor the three phase voltage where one set shall be connected to the line CVTs with a fixed setting of 20% of rated voltage and the other set shall be connected to the bus CVTs with a fixed setting of 80% of rated voltage.
- incorporate necessary auxiliary relays and timers to give comprehensive scheme.

13.2. LOCAL BREAKER BACK-UP PROTECTION SCHEME (for 220 KV):

Local Breaker Backup Protection (Stuck breaker protection) shall have following features.

- (a) be triple pole type.
- (c) have an operating time of less than 15 milli seconds
- (d) have a resetting time of less than 15 milli seconds
- (e) have three over current elements,
- (f) have a setting range of 5-150% of rated current
- (g) have a continuous thermal withstand two times rated current irrespective of the setting
- (h) have a timer with continuously adjustable setting range of 0-35sec
- (i) have necessary auxiliary relays to make a comprehensive scheme.
- (j) be arranged to get individual initiation from the corresponding phase of main protections of line for each over current element. However, common three phase initiation is acceptable for other protections and transformer equipment protections.

In case of Bus bar panel LBB as part of BB Protection or stand alone is acceptable.

In case of PTR C&R Panel LBB as part of BCU is acceptable as it is a CB related function.

In case of feeder C &R Panels LBB is a part of distance scheme or BCPU is acceptable.

13.3. TRIP CIRCUIT SUPERVISION RELAY (Circuit breaker protection)

- (a) The relay shall be capable of monitoring the healthiness of each 'phase' trip-coil and associated circuit of circuit breaker during 'ON' and 'OFF' conditions.

- (b) The relay shall have adequate No. of contacts for providing connection to alarm and event logger.
- (c) The relay shall have time delay on drop-off of not less than 200 milli seconds and be provided with operation indications for each phase.

13.4. CLOSE CIRCUIT SUPERVISION RELAY (Circuit breaker protection)

- (a) The relay shall be capable of monitoring the healthiness of each 'phase' close-coil and associated circuit of circuit breaker during 'ON' and 'OFF' conditions.
- (b) The relay shall have adequate contacts for providing connection to alarm and event logger.

14.0 TRANSFORMER PROTECTION:

14.1. Numerical Transformer differential protection complaint to IEC 61850 standard scheme shall

- (a) be triple pole type, with faulty phase identification/ indication
- (b) have an operating time not greater than 30 milli seconds at 5 times the rated current
- (c) have three instantaneous high set over-current units
- (d) have an adjustable bias setting range of 20-50%
- (e) be suitable for rated current of 1 Amp.
- (f) have second harmonic or other inrush proof features and also should be stable under normal over fluxing conditions. Magnetizing inrush proof feature shall not be achieved through any intentional time delay e.g. use of timers to block relay operation or using disc operated relays
- (g) have an operating current setting of 15% or less
- (h) use of external CT for ratio and vector group correction is not acceptable.
- (i) The relays shall have the following tools for fault diagnostics
 - Fault record – The relay shall have the facility to store fault records with information on cause of trip, date, time, trip values of electrical parameters.
 - Event record – The relay shall have the facility to store sufficient number of stamped event records with 1ms resolution.
 - Disturbance records – At least 5 records shall be provided in the offered Numerical relays. Pre-fault time shall not be less than 100milli seconds and the post fault time shall not be less than 2 seconds (adjustable).If another system

disturbance occurs during a post fault run time, the recorder shall also be able to record this subsequent disturbance. The sampling rate shall not be less than 1000Hz. However the total memory of acquisition unit shall not be less than 5 seconds. The data shall not be lost on failure of auxiliary power supply. Each record shall store data from all the analogue channels, at least 8, used in the relay for protection and at least 16 digital channels. The data from DR function shall be available in IEEE/COMTRADE format and shall be compatible with the relay test kit.

14.2. Over fluxing protection Relays shall

- (a) operate on the principle of Voltage to frequency ratio and shall be phase to phase connected
- (b) have inverse time characteristics, matching with transformer over fluxing withstand capability curve.
- (c) provide an independent 'alarm' with the time delay continuously adjustable between 0 to 30.0 seconds at values of 'v/f' between 100% to 180% of rated values
- (d) tripping time shall be governed by 'v/f' Vs. time characteristics of the relay
- (e) 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, the rated values, respectively.
- (f) have an accuracy of operating time, better than $\pm 2\%$.
- (g) have a resetting ratio of 95 % or better.
- (h) Be acceptable as a built in feature of numerical transformer differential relay.

14.3. Numerical Restricted Earth Fault Protection shall

- (a) be single pole type
- (b) be of current/voltage operated high impedance type
- (c) have a current setting range of 10-40% of 1 Amp./ have a suitable voltage setting range.
- (d) be tuned to the system frequency
- (e) be used for HV and LV winding.
- (f) be acceptable as a built in feature of numerical transformer differential relay

14.4. Numerical Over Current and Earth fault protection scheme with high set feature

- (a) Shall have three over current and one earth fault element(s) which shall be either independent or composite unit(s).
- (b) The scheme shall include necessary VT fuse failure relays for alarm purposes
- (c) Over current relay shall
 - have directional IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 50-200% of rated current
 - have low transient, over reach high set instantaneous unit of continuously variable setting range 500-2000 % of rated current
 - have a characteristic angle of 30/45 degree lead
 - include hand reset flag indicators or IEDs.
- (d) Earth fault relay shall
 - have directional IDMT characteristic with a definite minimum time of 3.0 seconds at 10 times setting and have a variable setting range of 20-80% of rated current.
 - have low transient, over reach high set instantaneous unit of continuously variable setting range 200-800 % of rated current.
 - have a characteristic angle of 45/60 degree lag
 - include hand reset flag indicators or IEDs.
 - include necessary separate interposing voltage transformers or have internal feature in the relay for open delta voltage to the relay.

Numerical non-directional/Directional over current and earth fault protections as inbuilt feature of the BCU separately for HV&LV acceptable.

15.0 TRIPPING RELAY:

High Speed Tripping Relay shall

- (a) be instantaneous (operating time not to exceed 5 milli-seconds).
- (b) reset within 20 milli seconds
- (c) be 220 V D.C. operated
- (d) have adequate contacts to meet the requirement of scheme, other functions like auto-reclose relay, LBB relay as well as cater to associated equipment like event logger, Disturbance recorder, fault Locator, etc.
- (e) be provided with operation indicators for each element/coil.

16.0 DC SUPPLY SUPERVISION RELAY:

- (a) The relay shall be capable of monitoring the failure of D.C. supply to which, it is connected.
- (b) It shall have adequate potential free contacts to meet the scheme requirement.
- (c) The relay shall have a 'time delay on drop-off' of not less than 100 milli seconds and be provided with operation indicator/flag.

17.0 BUS BAR PROTECTION (For 220 KV):

17.1 Numerical busbar differential protection scheme with full compliance to IEC 61850 standards shall be provided for 220KV voltage levels.

17.2 Each Bus Bar protection scheme shall

- (a) have maximum operating time up to trip impulse to trip relay for all types of faults of 25 milli seconds at 5 times setting value.
- (b) operate selectively for each bus bar
- (c) give hundred percent security up to 40 KA fault level for 220KV.
- (d) incorporate continuous supervision for CT secondary against any possible open circuit and if it occurs, shall render the relevant zone of protection inoperative and initiate an alarm
- (e) not give false operation during normal load flow in bus bars.
- (f) incorporate clear zone indication.
- (g) be of phase segregated and triple pole type
- (h) provide independent zones of protection.
- (i) include individual high speed electrically reset tripping relays for each feeder
- (j) be transient free in operation
- (k) include continuous D.C. supplies supervision.
- (l) not cause tripping for the differential current below the load current of heaviest loaded feeder . Bidder shall submit application check for the same.
- (m) CT switching and External Zone formation is not acceptable.
- (n) include protection 'IN/OUT' switch for each zone.
- (o) shall include trip relays, for all the bay or breakers under this specification as well as for the future bays as per the Single line diagram for new substations.

Suitable panels to mount these in switchyard are also included in the scope of the work.

- (p) shall incorporate continuous supervision for CT secondaries and shall render the relevant zones of protection in operative against possible open circuit and protection transferred to check zone only.

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

17.4 The Bus Bar protection relays shall be equipped with built-in DR and Event recorder

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

- (a) The test terminal blocks (TTB) to be provided shall be fully enclosed with removable covers and made of moulded, non-inflammable plastic material with boxes and barriers moulded integrally. All terminals shall be clearly marked with identification numbers or letters to facilitate connection to external wiring. Terminal block shall have shorting, disconnecting and testing facilities for CT circuits.

18.0 DISTANCE TO FAULT LOCATOR

- (a) be part of distance relay
- (b) be 'On-line' type
- (c) be suitable for breaker operating time of 2 cycles
- (d) have built-in display unit
- (e) the display shall be directly in percent of line length or kilometres without requiring any further calculations
- (f) have an accuracy of 2% or better for the typical conditions defined for operating timings measurement of distance relays .

- (g) The above accuracy should not be impaired under the following conditions:

- presence of remote end infeed
- predominant D.C. component in fault current
- high fault arc resistance
- severe CVT transients

(h) shall have mutual zero sequence compensation unit if fault locator is to be used on double circuit transmission line.

(i) built in feature of line distance relay is acceptable provided the requirements of above clauses are met

19.0 TIME SYNCHRONISATION EQUIPMENT:

19.1 The Time synchronisation equipment shall receive the co-ordinated Universal Time (UTC) transmitted through Geo Positioning Satellite System (GPS) and synchronise equipments to the Indian Standard Time in a substation. The time synchronization shall be realized using the SNTP protocol at inter bay bus.

19.2 Time synchronisation equipment shall include antenna, all special cables and processing equipment etc.

19.3 It shall be compatible for synchronisation of Event Loggers, Disturbance recorders and SCADA at a substation through individual port or through Ethernet realised through optic fibre bus.

19.4 Equipment shall operate up to the ambient temperature of 50 degree centigrade and 100% humidity.

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

19.6 Equipment shall meet the requirement of IEC 60255 for storage & operation.

19.7 The system shall be able to track the satellites to ensure no interruption of synchronization signal.

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

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

19.10. Time synchronisation equipment shall be suitable to operate from 220V DC as available at Substation.

19.11. Equipment shall have real time digital display in hour, minute, second (24 hour mode) & have a separate time display unit to be mounted on the top of relay panels having display size of approx. 100 mm height.

20 TYPE TESTS:

20.1 The reports for following type tests shall be submitted by the bidder for the Protective relays, Fault locator, Disturbance recorder and Event Logger

- (a) Insulation tests as per IEC 60255-5
- (b) High frequency disturbance test as per IEC 60255-4 (Appendix -E) -Class III (not applicable for electromechanical relays)
- (c) Fast transient test as per IEC 1000-4, Level III (not applicable for electromechanical relays)
- (d) Relay characteristics, performance and accuracy test as per IEC 60255
 - Steady state Characteristics and operating time
 - Dynamic Characteristics and operating time for distance protection relays and current differential protection relays
 - For Disturbance recorder and Event logger only performance tests are intended under this item.
- (e) Tests for thermal and mechanical requirements as per IEC 60255-6
- (f) Tests for rated burden as per IEC 60255-6
- (g) Contact performance test as per IEC 60255-0-20 (not applicable for Event logger, Distance to fault locator and Disturbance recorder)

20.2 Steady state & Dynamic characteristics test reports on the distance protection relays, as type test, shall be based on test programme specified on simulator/network analyser/PTL. Alternatively, the files generated using Electromagnetic transient Programme (EMTP) can also be used for carrying out the above tests. Single source dynamic tests on transformer differential relay shall be/ should have been conducted based on general guidelines specified in CIGRE committee 34 report on Evaluation of characteristics and performance of Power system protection relays and protective systems.

21. TROPICALISATION:

Control room will be normally air-cooled/air- conditioned. All equipments shall however be suitable for installation in a tropical monsoon area having hot, humid climate and dry and dusty seasons with ambient conditions specified in the

specification. All control wiring, equipment and accessories shall be protected against fungus growth, condensation, vermin and other harmful effects due to tropical environment.

22. RELEVANT REFERENCE STANDARDS:

IS-3231 Electrical relays for power system protection.

IS-8686 Static protective relays.

IS-2147 Degree of protection of cubicles.

IS-1248 & IS-2419 Indicating instruments.

IS-6236 Records.

IS-2705 Current transformers.

IS-3156 Voltage Transformers.

IS-4237 General requirement for switches and control gear for voltages not exceeding 1 KV.

IS-0722 Energy meters, control switches (LV switching devices for control and auxiliary circuits).

IS-0337, 0337-1 Energy meters, control switches (LV switching devices for control and auxiliary circuits).

IS-0297 (Part 1-3) Dimensions for mechanical structures of the 482.6 mm (19") series.

IS-0375 Marketing and arrangement for switchgear, bus bars main connection and auxiliary wiring.

IS-6875 Control Switches (CLV switching devices for control and aux. circuits).

IS-0005 Colour for ready mix paints.

IS-1554 (Part-I) PVC insulated cables upto and including 1000 Volts.

IS-3842 (Part-I – VII) Application guide for protection.

IS-9224 (Part-II) HRC cartridge fuse links.

IS-6005 Code of practice for phosphating iron and steel.

IES-2555-1-0 Electrical relays – All or nothing electrical relays.

ICE-255-3,5,6,7,8,10,11,12,13,16 Electrical relays for various specifications.

ICE-255-21-2-3

ICE-255-22-1,2,3,4 Electrical relays – vibration & disturbance etc., test.

ICE-255-23 Electrical relays – contract performance.

BILL OF MATERIALS

220/132kV TRANSFORMER HV/LV CONTROL PANEL

S.No.	Description of Items	Qty.
1	Bay Control Unit (BCU) for HV --- HV LBB ---Under Voltage --- Over Voltage ---Under Frequency ---CB Trouble Alarms & Trips ---Transformer Trouble Alarms & Trips --- Metering & Measurement --- Event Recorder	1 No.
2	Bay Control Unit (BCU) for LV ---CB Trouble Alarms & Trips --- Metering & Measurement --- LV LBB	1 No.
3	Trip Coil Supervision Relay for HV and LV	8 Nos.
4	Emergency CB TNC Switches for HV and LV	2 Nos.
5	Opening Auxiliary Relays for CB and Isolator Operations for HV Side	3 Nos.
6	Opening Auxiliary Relays for CB and Isolator Operations for LV side	3 Nos.
7	Closing Auxiliary Relays for CB and Isolator Operations for HV Side	2 Nos.
8	Closing Auxiliary Relays for CB and Isolator Operations for LV side	2 Nos.
9	Electronic Trivector Meter with 0.2 Class of Accuracy with ABT feature and AMR compatible (with RS 485 and Front Optical port) to be provided on HV & LV side with TTB.	2 Nos.
10.	Supervision relays for 86, 96 and 50ZX	3 Nos.
	Any other item required for Satisfactory operation of complete system is to be provided.	
<ul style="list-style-type: none">• All IEDs shall be IEC 61850 Compliant and should have Medium size HMI.• The BCU must be capable to control and Monitor all the parameters connected to Transformer Bay• All the IEDs should have sufficient No. of I/Os to accommodate interlocks, status and anything required for satisfactory operation of Substations.		

BILL OF MATERIALS

220/132kV TRANSFORMER HV/LV RELAY PANEL

S.No.	Description of Items	Qty.
1.	Numerical Transformer Differential Relay with IEC 61850 compatible and shall communicate with SAS ---Over Flux --- Disturbance recorder, Fault Recorder	1 No.
2	Numerical Non Directional Over Current and Directional Earth Fault Relay with High Set Feature for HV with IEC 61850 compatible and shall communicate with SAS. (part of HV BCU is acceptable)	1 No.
3	Numerical Non Directional Over Current and Directional Earth Fault Relay with High Set Feature for LV with IEC 61850 compatible and shall communicate with SAS. (part of LV BCU is acceptable)	1 No.
4	DC Supervision Relay	2 No.
5	BUS-I & II PT Selection Relays	2 Nos.
6	3 Phase Master Inter Trip Relay for HV with adequate no of Contacts (Group-A & Group-B) (Electrically resettable)	2 Nos.
7	Trip Relay for LV with adequate no of Contacts (Electrically resettable)	1 No.
8	Trip Relay for LBB with adequate no of Contacts	1 No.
9	BUS Bar Trip Relay with adequate no of Contacts	1 No.
	Any other item required for Satisfactory operation of complete system is to be provided.	
<ul style="list-style-type: none">● All IEDs shall be IEC 61850 Compliant and should have Medium size HMI.● The BCU must be capable to control and Monitor all the parameters connected to Transformer Bay.● All the IEDs should have sufficient No. of I/Os to accommodate interlocks, status and anything required for satisfactory operation of Substations.		

BILL OF MATERIALS
220 kV FEEDER CONTROL PANEL

S.No.	Description of Items	Qty.
1	Bay Control Unit (BCU) --- CB Troubles and Alarms --- Metering & Measurement --- Event Recorder	1 No.
2	Trip Coil Supervision Relay	6 Nos.
3	Closing Auxiliary Relays for CB and Isolator Operations	3 Nos.
4	Opening Auxiliary Relays for CB and Isolator Operations	4 Nos.
5	PT/CVT Selection Switch	1 No.
6	Emergency CB TNC Switch	1 No.
7	Electronic Trivector Meter with 0.2 Class of Accuracy with ABT feature and AMR compatible (with RS 485 and Front Optical port) to be provided with TTB	1 No.
	Any other item required for Satisfactory operation of complete system is to be provided.	
	<ul style="list-style-type: none"> • All IEDs shall be IEC 61850 Compliant and should have Medium size HMI. • The BCU must be capable to control and Monitor all the parameters connected to 220 kV Bay. • All the IEDs should have sufficient No. of I/Os to accommodate interlocks, status and anything required for satisfactory operation of Substations. 	

BILL OF MATERIALS

220 kV FEEDER RELAY PANEL

S.No.	Description of Items	Qty.
1	Numerical Distance Protection Relay with IEC 61850 i. PSB ii. SOTF iii. FFR iv. Auto Reclosure v. Fault Locator vi. Open conductor vii. LBB viii. Carrier tripping. ix. Disturbance recorder, Fault Recorder etc Note: Main II Relay should be of other make.	2 Nos.
2	3-Phase Master Trip Relay with adequate no. of Contacts and Electrically resettable (Group-A & Group-B)	2 Nos.
3	DC Supervision Relays	2 Nos.
4	LBB Trip Relay with adequate no. of Contacts	1 No.
5	1-Phase Trip Relays (Self Reset) with adequate no. of Contacts	6 Nos.
6	Bus Bar Trip Relay with adequate no. of Contacts	1 No.
7	Voltage Selection Relays	3 Nos.
8	Carrier Scheme Auxiliary Relays	6 Nos.
9	PT/CVT Selection Switch	2 Nos.
10	Carrier Selector Switch In/Out	2 Nos.
11	Supervision relays for 86, 96 and 50ZX	3 Nos.
	Any other item required for Satisfactory operation of complete system is to be provided.	
	<ul style="list-style-type: none">• All IEDs shall be IEC 61850 Compliant and should have Medium size HMI.• The BCU must be capable to control and Monitor all the parameters connected to 220kV Bay.• All the IEDs should have sufficient No. of I/Os to accommodate interlocks, status and anything required for satisfactory operation of Substations.	

220kV BUS COUPLER PANEL

S.No.	Description of Items	Qty.
1	Bay Control Unit (BCU) --- CB Troubles and Alarms ---Event Recorder	1 No.
2	Bus Bar Trip Relay with adequate no. of Contacts	1 No.
3	Closing Auxiliary Relay for CB	1 No.
4	Opening Auxiliary Relay for CB	2 Nos.
5	Trip Coil Supervision Relays	6 Nos.
6	DC Supervision Relay	1 No.
7	Closing Auxiliary Relays for Isolator Operations	2 Nos.
8	Opening Auxiliary Relays for Isolator Operations	2 Nos.
9	Emergency CB TNC Switch	1 No.
10	Supervision relays for 86, 96 and 50ZX	3 Nos.
	Any other item required for Satisfactory operation of complete system is to be provided.	
	<ul style="list-style-type: none"> All IEDs shall be IEC 61850 Compliant and should have Medium size HMI. The BCU must be capable to control and Monitor all the parameters connected to 220kV BUS Coupler. All the IEDs should have sufficient No. of I/Os to accommodate interlocks, status and anything required for satisfactory operation of Substations. 	

BILL OF MATERIALS

220kV BUS BAR PANEL

S.No.	Description of Items	Qty.
1	Numerical Centralized Bus Bar panel & Tripping Relays with IEC 61850 Compliant and shall communicate SAS. (For Single Bus system having Bus Sectionalizer with CB for 12 bays)	1 No.
2	Bus Bar In & Out Switch	1 No.
3	DC Supervision Relay	1 No.
	Any other item required for Satisfactory operation of complete system is to be provided.	
	<ul style="list-style-type: none"> All IEDs shall be IEC 61850 Compliant and should have Medium size HMI. The BCU must be capable to control and Monitor all the parameters connected to 220kV BUS Bars. All the IEDs should have sufficient No. of I/Os to accommodate interlocks, status and anything required for satisfactory operation of Substations. 	

BILL OF MATERIALS

132/33 kV TRANSFORMER HV/LV CONTROL PANEL

S.No.	Description of Items	Qty.
1	Bay Control Unit (BCU) for HV --- HV LBB --- Under Voltage --- Over Voltage --- Under Frequency --- CB Trouble Alarms & Trips --- Transformer Trouble Alarms & Trips --- Metering & Measurement --- Event Recorder	1 No.
2	Bay Control Unit (BCU) for LV --- CB Trouble Alarms & Trips --- Metering & Measurement --- Event Recorder	1 No.
3	DC Supervision Relay.	1 No.
4	Trip Coil Supervision Relay for HV and LV	4 Nos.
5	Emergency CB TNC Switches for HV and LV	2 Nos.
6	Closing Auxiliary Relays for CB and Isolator Operations for HV Side and LV side	4 Nos.
7	Opening Auxiliary relays for CB & Isolator Operations for HV and LV Side	4 Nos.
8	Metering (part of BCU)	
9	Electronic Trivector Meter with 0.2 Class of Accuracy with ABT feature and AMR compatible (with RS 485 and Front Optical port) to be provided on LV side with TTB (Main & Check)	2 Nos.
	Any other item required for Satisfactory operation of complete system is to be provided.	
<ul style="list-style-type: none">• All IEDs shall be IEC 61850 Compliant and should have Medium size HMI.• The BCU must be capable to control and Monitor all the parameters connected to Transformer Bay• All the IEDs should have sufficient No. of I/Os to accommodate interlocks, status and anything required for satisfactory operation of Substations.		

BILL OF MATERIALS

132/33 kV TRANSFORMER HV/LV RELAY PANEL

S.No.	Description of Items	Qty.
1.	Numerical Transformer Differential Relay with IEC 61850 compatible and shall communicate with SAS ---Over Flux --- Disturbance recorder, Fault Recorder	1 No.
2	Numerical Non Directional Over Current and Directional Earth Fault Relay with High Set Feature for HV with IEC 61850 compatible and shall communicate with SAS. (part of HV BCU is acceptable)	1 No.
3	Numerical Non Directional Over Current and Directional Earth Fault Relay with High Set Feature for LV with IEC 61850 compatible and shall communicate with SAS. (part of LV BCU is acceptable)	1 No.
4	Event Recorder (all Numerical relays Shall have this feature and shall communicate with SAS)	- -
5	DC Supervision Relay	1 No.
6	Master Trip Relay for HV, LV, LBB & Under frequency trip relay with adequate no of Contacts and associated inter tripping and Electrical resettable.	4 Nos.
7	Supervision relays for 86HV & LV, 96 and 86 U/F	4 Nos.
	Any other item required for Satisfactory operation of complete system is to be provided.	
<ul style="list-style-type: none">● All IEDs shall be IEC 61850 Compliant and should have Medium size HMI.● The BCU must be capable to control and Monitor all the parameters connected to Transformer Bay.● All the IEDs should have sufficient No. of I/Os to accommodate interlocks, status and anything required for satisfactory operation of Substations.		

BILL OF MATERIALS
132KV FEEDER CONTROL AND RELAY PANEL

S.No.	Description of Items	Qty.
1	Numerical Distance Protection Relay with IEC 61850 i. PSB ii. SOTF iii. FFR iv. LBB v. Fault Locator vi. Open conductor vii. Disturbance Recorder etc.	1 No.
2	Bay Control Unit / Bay Control & Protection Unit -- Control, Metering & Measurement -- Event Recorder.	1 Nos.
3	Numerical Directional Over Current and Earth Fault Relay with High Set Feature (part of BCU is acceptable)	1 No.
4	Disturbance recorder, Fault Recorder (part of Distance Relay is acceptable)	1 No.
5	Event Recorder (all Numerical relays Shall have this feature and shall communicate SAS)	- -
6	Master Trip Relay with adequate no of Contacts and Electrical resettable.(Master trip + LBB trip)	2 Nos.
7	Emergency CB TNC Switches	1 Nos.
8	DC Supervision Relay	1 Nos.
9	Trip Coil Supervision Relay	2 Nos.
10	CB Troubles and Alarms (Part of BCU is acceptable)	1 Set
11	Closing Auxiliary Relays for CB and Isolator Operations	3 Nos.
12	Opening Auxiliary relays for CB & Isolator Operations	3 Nos.
13	Metering (part of BCU)	- -
14	Electronic Trivector Meter with 0.2 Class of Accuracy with ABT feature and AMR compatible (with RS 485 and Front Optical port) to be provided with TTB.	1 No.
	Any other item required for Satisfactory operation of complete system is to be provided.	
	<ul style="list-style-type: none"> All IEDs shall be IEC 61850 Compliant and should have Medium size HMI. The BCU must be capable to control and Monitor all the parameters connected to 132KV Bay All the IEDs should have sufficient No. of I/Os to accommodate interlocks, status and anything required for satisfactory operation of Substations. 	

BILL OF MATERIALS

132KV FEEDER CONTROL AND RELAY PANEL without Distance relay / With Differential relay

S.No.	Description of Items	Qty.
1	Transformer Differential Relay with IEC 61850 and communicate with SAS. --Disturbance Recorder, Fault Recorder etc.	1 No.
2	Bay Control Unit / Bay Control & Protection Unit -- CB Troubles & Alarms -- Metering & Measurement -- Event Recorder.	1 Nos.
3	Numerical Directional Over Current and Earth Fault Relay with High Set Feature (part of BCU is acceptable)	1 No.
4	Disturbance recorder, Fault Recorder (part of Numerical Directional Over Current and Earth Fault Relay is acceptable)	1 No.
5	Event Recorder (all Numerical relays Shall have this feature and shall communicate SAS)	- -
6	Master Trip Relay with adequate no of Contacts and Electrical resettable.(Master trip + LBB trip)	2 Nos.
7	Emergency CB TNC Switches	1 Nos.
8	DC Supervision Relay	1 Nos.
9	Trip Coil Supervision Relay	2 Nos.
10	CB Troubles and Alarms (Part of BCU is acceptable)	1 Set
11	Closing Auxiliary Relays for CB and Isolator Operations	3 Nos.
12	Opening Auxiliary relays for CB & Isolator Operations	3 Nos.
13	Metering (part of BCU)	- -
14	Electronic Trivector Meter with 0.2 Class of Accuracy with ABT feature and AMR compatible (with RS 485 and Front Optical port) to be provided with TTB.	1 No.
	Any other item required for Satisfactory operation of complete system is to be provided.	
	<ul style="list-style-type: none"> All IEDs shall be IEC 61850 Compliant and should have Medium size HMI. The BCU must be capable to control and Monitor all the parameters connected to 132KV Bay All the IEDs should have sufficient No. of I/Os to accommodate interlocks, status and anything required for satisfactory operation of Substations. 	

BILL OF MATERIALS

33KV TWIN FEEDER CONTROL AND RELAY PANEL

S.No.	Description of Items	Qty.
1	Numerical Non Directional Over Current and Earth Fault Relay with High Set Feature (part of BCU is acceptable)	2 Nos.
2	Bay Control Unit / Bay Control & Protection Unit	2 Nos.
3	Master Trip Relay with adequate no of Contacts and Electrical resettable	2 Nos.
4	Trip Coil Supervision Relay	4 Nos.
5	Emergency CB TNC Switches	2 Nos.
6	DC Supervision Relay	2 Nos.
7	CB Troubles and Alarms (Part of BCU)	1 Set
8	Closing Auxiliary Relays for CB.	2 Nos.
9	Opening Auxiliary relays for CB.	2 Nos.
10	Metering (part of BCU)	
11	Electronic Trivector Meter with 0.2 Class of Accuracy with ABT feature and AMR compatible (with RS 485 and Front Optical port) to be provided with TTB.	2 Nos.
	Any other item required for Satisfactory operation of complete system is to be provided.	
<ul style="list-style-type: none">• All IEDs shall be IEC 61850 Compliant and should have Medium size HMI.• The BCU must be capable to control and Monitor all the parameters connected to 33KV Bay• All the IEDs should have sufficient No. of I/Os to accommodate interlocks, status and anything required for satisfactory operation of Substations.		

GUARANTEED TECHNICAL PARTICULARS FOR DISTANCE PROTECTION NUMERICAL RELAY

1. Make & Type :
2. Rated voltage, current and frequency :
3. Short time current rating :
4. No. of independent loop measurement for phase fault and earth fault :
5. No. of zones :
6. Characteristic of relay for phase and Earth fault :
7. Range of ohmic setting :
8. Maximum operating time:
 - System impedance ratio :
 - Relay setting (Ohms) :
 -) Fault locations (as % of relay setting) :
 -) Fault resistance (Ohms) :
 - Maximum operating time (milli seconds) :
9. Resetting time :
10. Zone time setting range :
11. Facility for Zero sequence Compensation for earth fault for zone 1, zone 2 & zone. :
12. Method adopted for achieving 100% direction sensitivity in case of balanced/unbalanced faults and frequency range for detecting the same. :
13. Whether suitable for single phase and three phase tripping. :
14. Facility for switch on to fault feature. :
15. Facility for carrier aided tripping. :
16. Facility for weak end in feed logic and current reversal logic. :
17. VT fuse failure detection:
 - a) Whether detects single phase two phase, three phase PT fuse failure at Control room and yard. :
 - b) Method of detection.
 - c) Whether block distance protection in case of condition (a).

- d) Whether distance protection is allowed for tripping in case of fault when there is PT fuse failure. :
- 18. Power swing blocking: :
- a) Detection method :
 - b) Blocking time :
 - c) Details of combination of Zones that can be blocked :
- 19.
 - a) Details of trip contracts :
 - b) Details of additional contracts provided :
- 20. Details of Auto reclose relay:
 - a) Dead time setting :
 - b) Reclaim time setting :
 - c) Synchro check facility :
 - d) Facility to initiate from main-2 :
- 21. Details of IDMT directional earth fault relay:
 - a) Setting range :
 - b) Characteristic curve at 10 times of set value :
- 22. Characteristic angle range of distance relay. :
- 23. Details of Disturbance recorder:
 - a) No. of Analog input :
 - b) No. of Digital input :
 - c) Memory capacity to store records :
 - d) Facility to down load and analyse the recording :
- 24. Details of fault locator:
 - a) Whether in built :
 - b) Whether accurate for all operating conditions :
- 25. Communication port details :
- 26. Details of software needed for setting, programmable logic control. :
- 27. Whether self diagnostic feature is proved. :
- 28. Whether time Synchronizing facility is available. :
- 29. Have relevant IEC standards for relays and communication ports. :

GUARANTEED TECHNICAL PARTICULARS

1. Transformer Biased Differential Relay:

Make & Type	:
Numerical	:
Rated DC Voltage	:
Current Rated	:
Continuous	:
For 1 Sec.	:
Two Wind Relay	:
Operating time at 3 times normal current	:
Operating time for instantaneous operation	:
Bias setting range with steps	:
Availability of faulty phase identification	:
Availability of instantaneous High set feature with current setting range	:
Range of second harmonic restrain feature available	:
Availability of continuous self monitoring and diagnostic features	:
Transformer vector group and CT ratio selection/corrections through software	:

Disturbance recorder:

- | | |
|---|---|
| a) No. of external digital signal that can be recorded. | : |
| b) Facility to record currents in HV & LV Winding. | : |

Memory Capacity of D.R:

Fault records	:
No. of fault records that can be stored	:
Details of ports available with protocol	:

GUARANTEED TECHNICAL PARTICULARS FOR DIRECTIONAL AND NON-DIRECTIONAL OVERCURRENT AND EARTH FAULT RELAYS

- | | | | |
|-----|---|---|--|
| 1. | Description | : | |
| 2. | Model No. & Make DC Operating Voltage & its Range | : | |
| 3. | Selectability between definite time & IDMT O/C function | : | |
| 4. | Over current setting range: | : | |
| | Phase fault | : | |
| | Earth fault | : | |
| | Time setting range and steps | : | |
| 5. | High set Over current setting range | : | (Not applicable for non directional over current relays on LV side of transformer) |
| | Phase fault | : | |
| | Earth fault | : | |
| | Time setting range and steps | : | |
| 6. | IDMT characteristics | : | |
| 7. | P.T. Voltage | : | |
| 8. | Relay characteristic angle settable for Phase fault and Earth fault | : | |
| 9. | Operating time for instantaneous element | : | |
| 10. | Indications provided | : | |
| 11. | Communication ports provided | : | |
| 12. | Protocols supported | : | |
| 13. | Disturbance Recorder Details | : | |
| | a) No. of analog input | | |
| | b) No. of digital input | | |
| | c) Sampling rate | | |
| | d) Maximum storage capacity | | |
| 14. | Event Recorder Details | : | |
| | a) Maximum no. of events | | |
| | Resolution | | |
| 15. | Sampling rate & frequency | : | |
| 16. | Self diagnostic feature provided | : | |
| 17. | Availability of Time Synchronization facility | : | |
| 18. | Reset ratio | : | |
| 19. | Resetting time | : | |
| 20. | Other features available | : | |

GUARANTEED TECHNICAL PARTICULARS

BAY CONTROL UNIT

1. Make & Model No. :
2. Maximum Input/Output Capabilities
 - a. Max. Single Status indications :
 - b. Max. Double Status indications :
3. Data transmission speeds supported by BCU :
4. Availability of communication ports for communication with
 - i. Master Station. :
 - ii. Energy meters :
 - iii. Relays :
 - iv. Configuration & Maintenance tool. :
 - v. Local SCADA Systems :
5. Whether necessary H/W & S/W provided to operate with the above media :
6. Ability to communicate with multiple master with common or different protocols. :
7. Whether communication port can be expanded. If so, How many Communication ports in one card. :
8. Facility to modify and down load BCU configuration from Remote control center. :
9. Whether STNP interface provided in the BCU for synchronization with external clock. :
10. Whether provision available to down Load Analog & Accumulator data, Disturbance and event data from Numerical relays. :
11. Whether BCU can support Ethernet LAN connection. :
12. Resolution of time stamping of SOEs. :
13. Available control outputs. :
14. Whether security & safety features provided for control O/P. :

15. Provision of Electrical isolation between all the functional boards and field connections. :
16. Provision of sufficient provision in the BCU to protect from natural hazards viz lightning & thunder systems. :
17. Whether self diagnostics provided :
18. Input DC power supply to BCU :
19. Environmental requirements
 - i. Operation temperature :
 - ii. Relative humidity :
 - iii. Whether type tested for Continuous operation at 55 C for 48 hours followed by continuous operation at normal ambient temperature for 240 hours. :
20. Software requirements :
21. Operating System :
22. Automatic restart of the BCU upon power restoration, memory parity errors, hardware failures and upon manual request. :
23. Diagnostic software for checking the hardware errors and other functions of the BCU. :
24. Whether diagnostic software is user interactive. :
25. Whether configuration and maintenance tool with all required hardware (other than Laptop PC) and software. :

GUARANTEED TECHNICAL PARTICULARS
BUR BAR

1. Manufacturer's Name, Type and Designation of Bus bar :
protection relay.
2. Is it complete numerical protection? :
3. Operating Principle. :
4. Rated Current Voltage. :
5. Operating time at 5 times setting (up to trip impulses to :
trip relays)
6. Resetting Value. :
7. No. of contacts (NO/NC). :
8. Does the relay give 100% security and reliability under all :
operating conditions and up to 40 kA fault level.
9. CT secondary supervision and protection against CT :
secondary open provided.
10. Whether tripping for the differential current below the :
load current of the heaviest loaded feeder will take place.
11. Does it require external CT switching relays. :
12. Whether each scheme will operate selectively for each :
busbar.
13. Whether during normal load flow in busbars false :
operation will take place.
14. Whether clear Zone indication available. :
15. Whether protection IN/OUT switch provided for each :
zone?
16. Whether continuous DC supply supervision provided? :
17. Communication :
18. PHASE FAULT ELEMENTS (CU) :
Phase current slope adjustment :
Phase differential current threshold :
Check Zone slope adjustment :
Check Zone differential current Threshold :
Circuitry fault slope adjustment :
Circuitry fault threshold :
Circuitry fault alarm timer :

19.	SENSITIVE EARTH FAULT	:
	Residual current slope adjustment	:
	Residual different current threshold	:
	Residual Check Zone current slope adjustment	:
	Residual Check Zone differential current threshold:	:
	Circuitry fault slope adjustment	:
	Circuitry fault threshold	:
	Circuitry fault alarm timer	:
20.	BREAKER FAILURE PROTECTION (PU)	:
	1 ST phase O/C threshold (dead pole detection for 50BF)	:
	2nd phase O/C threshold	:
	2nd residual O/C threshold	:
	CB fail 1 timer	:
	CB fail 2 timer	:
21.	DEAD ZONE PROTECTION	:
	Accuracy	:
	Pick-up:	:
	Drop-off:	:
22.	Details of Disturbance recorder:	:
	a) No. of Analog input	:
	b) No. of Digital input	:
	c) Memory capacity to store records	:
	d) Facility to down load and analyze the recording	:

SUBSTATION AUTOMATION SYSTEM

1.0 GENERAL

- 1.0 This Specification provides for complete design, engineering, manufacture, assembly, shop testing, inspection and testing at manufacturer's works before despatch, packing, forwarding, insurance, transport and unloading, delivery at site, site testing, commissioning and training of complete Substation Automation System (SAS) for satisfactory operation of the 220/132kV, 132/33kV, 220/33kV, 220/11kV Substations of APTRANSCO as described in the following sections.

Part-I – Sub-Station Automation System

Part-II – Relay & Protection Panels

Part-III – Furniture

Part-IV – BOMs

Part-V – Annexures & Drawings

- 1.1 The SAS Supplier shall be a manufacturer, should have minimum of three years experience in Design, Manufacture, Supply, Testing & commissioning of numerical protection relays, BCUs for 132 kV & above Substations and should have experience in Design, supply, testing & commissioning of substation automation system with IEC 61850 protocol for 132 KV Substations and above by integrating numerical relays, BCUs & Energy Meters in any SEB/ Public undertaking/ Power utility in India. In case of SAS Supplier having experience as specified above and offer the relays by collaboration / Trade tie-up with well experienced manufacturer, the experience of manufacturer should be at least three years. And the offered relays are to be in service with IEC 61850 protocol (with SAS) having satisfactory performance certificate for one year in 132 KV Substations & above in any SEB/ Public undertaking/ Power utility in India.
- The SAS Supplier shall furnish end user satisfactory performance certificate for protection and SAS with IEC 61850 protocol of 132 KV SS and above by integrating relays, Energy meters and BCUs, executed by them in any SEB/ Public undertaking/ Power utility in India, at least for one substation for one year as on the date of tender opening.
 - In case if the SAS Supplier offered modified version in the proven class of relays with automation features having short of required Performance, then the SAS Supplier has to furnish extended warranty of 12 months in addition to the standard performance guarantee clause mentioned in the specification.
 - The SAS Supplier shall furnish the details of various purchase orders placed on them for Substation protection and automation of 132 kV SS and above offered by SEB/Public undertaking/ power utility in India during last 3 years. Necessary documentary evidence shall be produced for the same.
 - The SAS Supplier shall furnish along with the bid type test certificates and IEC 61850 conformance test certificates by KEMA / equivalent accredited laboratory for the offered relays. The date of above certificates shall not be earlier than Five years period from the date of bid opening Proof should be enclosed.
 - KEMA certificate/ equivalent certificate from development center authorized by UCA working group for having products including all IEDs and Ethernet switches conforming to IEC 61850 is to be furnished.

- The SAS Supplier shall be an ISO certified company to ensure the quality of system standard. The Bidder / SAS Supplier should furnish Performance certificates in support of the qualifying requirements and the Performance certificates shall be issued by an officer not below the rank of Executive Engineer or equivalent cadre of State Power utility/Government Organizations/ PSU only otherwise the bid will become non-responsive.

The above qualification requirements for SAS supplier are applicable for both the direct SAS tenders of APTRANSCO and also for Bulk load and evacuation and other turnkey contracts where SAS system is a part of Turnkey works. However the detailed Qualification Requirements for direct SAS tenders of APTRANSCO are given in Volume-I of this specification.

1.2 The Substation Automation System (SAS) shall be installed to control and monitor all the sub-station equipment from local control center and to support remote control center.

1.3 The SAS shall be of decentralized architecture and shall contain the following main functional parts:

- a) Bay control Intelligence Electronic Devices (IED s) for control and monitoring.
- b) Bay Protection Intelligent Electronic device (IEDs) for Protection.
- c) Station Human Machine Interface (HMI)
- d) Gateway for remote control via industrial grade hardware (to RCC) through IEC60870-5-101 and IEC60870-5-104 protocols.
- e) Gateway for State Load Dispatch Center (**SLDC**), the gateway should be able to communicate with SLDC on IEC 60870-5-101 & 104 protocols.
- f) Redundant managed switched Ethernet Local Area Network communication infrastructure with hot standby.
- g) Peripheral equipment like printers, display units, key boards, Mouse etc.

The Bay Control and Protection IEDs shall communicate on the IEC61850 standard for Communication Networks and shall comply with the

- IEC61850-5 for communication data modeling,
- IEC61850-6 for Sub-station Configuration Description Language for communication &
- IEC61850-7-1 to 7-4 for Data Model and Services.

1.4 It shall enable local station control via a PC by means of human machine interface (HMI) and control software package, which shall contain an extensive range of supervisory control and data acquisition (SCADA) function **and dedicated SCADA license shall be issued for each substation separately.**

1.5 It shall include communication gateway, intelligent electronic devices (IED) for bay control and inter IED communication infrastructure. An architecture drawing for SAS is enclosed. However the offered SAS architecture drawing shall be furnished along with the offer.

1.6 The bay level intelligent electronic devices (IED) for protection and monitor shall provide direct connection to the switchgear **without the need of interposing components** and perform protection and monitoring functions. Further, the protection and control IEDs shall

be connected to the Ethernet switches independently and both shall support horizontal communication (GOOSE messages) with IEC 61850 compatible.

1.7 The communication gateway shall facilitate the information flow with remote control centers.

1.8 The interposing relays shall be provided in control and relay panels for the control of isolators and circuit breakers.

1.9 Being the turnkey work/direct order, if any petty/ minor items required for erection/installation & commissioning of the substation automation system, even though they have not been specifically included in this specification but are necessary for successful erection/installation, commissioning and operation of the substation automation system are deemed to be included in the specification. It is the responsibility of the successful bidder to complete the SAS works in full shape and handover to APTRANSCO in fully operational condition within the time specified in the contract. No additional costs will be paid for minor components provided / required at a later stage.

2.0 System design

2.1 General system design

The Substation Automation System (SAS) design shall be function based concept independent of the technical solution scalable from basic until advanced system concept valid for actual solution based on today's technology.

The Substation Automation System (SAS) shall be suitable for operation and monitoring of the complete substation including future extensions.

The systems shall be of the state-of-the art suitable for operation under electrical environment present in extra high voltage substations, follow the latest engineering practice, and ensure long-term compatibility requirements and continuity of equipment supply and the safety of the operating staff.

The offered SAS shall have facility to support remote control and monitoring from Remote Control Centers via gate-way with communication compatible with IEC 60870-5-101 and IEC 60870-5-104 protocols (at least 3 Nos. IEC 60870-5-101 and 3 Nos. IEC 60870-5-104 ports are to be made available).

The system shall be designed such that personnel without any background knowledge in Microprocessor-based technology are able to operate the system. The operator interface shall be intuitive such that operating personnel shall be able to operate the system easily after having received some basic training. The offered software shall be user friendly.

The system shall incorporate the control, monitoring and protection functions specified, self-monitoring, signaling and testing facilities, measuring as well as memory functions, event recording and evaluation of disturbance records.

Maintenance, modification or extension of components may not cause a shutdown of the whole substation automation system. Self-monitoring of components, modules and communication shall be incorporated to increase the availability and the reliability of the equipment and minimize maintenance.

The SAS supplier shall publish and furnish all the information pertaining to their offered SCADA system to allow to interface by a third party SCADA system.

2.2 Supervisory Function: Data Acquisition, Processing, Monitoring, Analysis and Diagnostics.

The position of each switchgear, e.g., circuit breaker, isolator, transformer tap changer etc., shall permanently be supervised. Every detected change of position shall be immediately visible on the screen in the single line diagram, recorded in the event list. Alarms shall be initiated in cases when spontaneous position changes have taken place.

Each position of an apparatus shall be indicated by two binary auxiliary switches, which are opposite each other in normally closed (NC) and normally open (NO) position. An alarm shall be initiated if these position indications are inconsistent or indicate an excessive running time of the operating mechanism to change position.

Data Acquisition, Processing and Monitoring:

The SA system shall acquire data (analog and digital inputs) from Numerical relays and Electronic Energy meters (available in all the feeders, transformers). All other required data for the system shall be acquired as hard wired inputs from various field points

Double status inputs (i.e.) 1NO+1NC shall be provided for each circuit breaker.

The following are the minimum Data to be acquired:

Measurements – (U & F) for each Bus PT, I, P, Q from BCUs.

KWH, HVARH & KVAH from energy meters through serial communication port for all line feeders. All energy meters are looped as MODBUS SLAVES on an RS485 MODBUS link connected to the HMI through a Gateway acting as MODBUS MASTER on one side and as a IEC 61850 server on the other side. The measured values shall be displayed locally, on the HMI, Threshold limit values shall be selectable for alarm indications.

Basic Monitoring Functions are:

- Switchgear status indication
- Measurements (V, I, P, Q, F)
- Event list
- Alarm list
- Status and display of 220V DC system
- Status of display of Fire protection system
- Acquisition of alarm and fault record from protection relays
- Disturbance records.
- Trend curves.

The detailed I/O list shall be prepared by the successful bidder and get it approved by APTRANSCO.

2.2 System architecture

The SAS shall be based on a decentralized architecture and on a concept of bay-oriented, distributed intelligence.

Functions shall be decentralized, object-oriented and located as close as possible to the process.

The main process information of the station shall be stored in distributed databases. The typical SAS architecture shall be structured in two levels, i.e. in a Station level and in a Bay level. The data base sizing shall be sufficient to accommodate future expansions.

At bay level, the IEDs shall provide all bay level functions regarding control, monitoring and protection, inputs for status indication, and outputs for commands. The IEDs should be directly connected to the switchgear without any need for additional interposition or transducers. However, all the commands extending for control of switchgear shall be routed through suitable trip/ aux. relays.

The Switch gear Operating Mechanism pressures i.e., Circuit Breaker SF6 Gas Pressure, Operating Mechanism Pressure (Pneumatic, Hydraulic and Nitrogen Pressures), Pressure of SF6 Gas in case of SF6 CTs shall be interfaced with BCU through Transducers for monitoring these parameters in Local and RCC.

All the data (analog & digital) pertaining to ACDC panel, Distribution Transformers etc, shall be taken into SAS through Auxiliary BCUs and they all shall be mapped to SLDs (Pictorial View). Station auxiliary analog data, meter data shall be taken through RS485 to station BCU. Digital data to BCU shall be taken from potential free contacts.

Transformer Parameters i.e., Oil / Winding temperatures, On Line Monitor Hydran or any Other equipment like Transformer management Relay and OLTC Tap Position & Operation (not AVR) shall be interfaced with BCU through Transducers for monitoring & Control these parameters in Local and RCC.

Each bay control IED shall be independent from each other and its functioning shall not be affected by any fault occurring in any of the other bay control units of the station. It shall have sufficient spare DI/DO/AI points.

The data exchange between the electronic devices on bay and station level shall take place via the communication infrastructure. This shall be realized using fiber optic cables, thereby guaranteeing disturbance free communication. The fiber optic cables shall be run in G.I conduit pipes. Data exchange is to be realized using IEC 61850 protocol with a redundant managed switched Ethernet communication infrastructure.

The communication shall be made in fault tolerant ring in redundant mode, excluding the links between individual bay IEDs to switch wherein the redundant connections are not envisaged, such that failure of one set of fiber shall not affect the normal operation of the SAS. However failure of fiber, it shall be alarmed in SAS. **SNMP software for Ethernet switches and FO cables healthiness is to be provided. Fibre Optic LAN should be of dual redundant type only (Each ring with separate FO cable and each fiber optic cable shall have four (4) spare fibers).**

At station level, the entire station shall be controlled and supervised from the station HMI. It shall also be possible to control and monitor the bay from the bay level equipment at all times.

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

The station level contains the station-oriented functions, which cannot be realised at bay level, e.g. alarm list or event list related to the entire substation, gateway for the communication with remote control centers.

The GPS time synchronizing signal for the synchronization of the entire system shall be provided with display unit and necessary auxiliaries.

The SAS shall contain the functional parts as described in Para 1.3 above.

2.3 FUNCTIONAL REQUIREMENTS

2.3.1 Operation Philosophy

The high-voltage apparatus within the station shall be operated from the following places:

- Local Bay controller IEDs (in the bays)
- Station HMI.
- Remote control centers

Operation shall be possible by only one operator at a time.

The operation shall depend on the conditions of other functions, such as interlocking, synchrocheck, etc.

2.3.2 Select-before-execute

For security reasons the command is always to be given in two stages: selection of the object and command for operation under all mode of operation except emergency operation. Final execution shall take place only when selection and command are actuated.

2.3.3 Command supervision

2.3.3.1 Bay/station interlocking and blocking

Software Interlocking is to be provided to ensure that inadvertent incorrect operation of switchgear causing damage and accidents in case of false operation does not take place.

In addition to software interlocking hardwired interlocking are to be provided wherever necessary.

It shall be a simple layout, easy to test and simple to handle when upgrading the station with future bays. For software interlocking the bidder shall describe the scenario while an IED of another bay is switched off or fails.

A software interlock override function shall be provided which can be enabled to bypass the interlocking function.

2.3.3.2 Run Time Command cancellation

Command execution timer (configurable) must be available for each control level connection. If the control action is not completed within a specified time, the command should get cancelled.

2.3.3.3 Self-supervision

Continuous self-supervision function with self-diagnostic feature shall be included.

2.3.3.4 User configuration

The monitoring, controlling and configuration of all input and output logical signals and binary inputs and relay outputs for all built-in functions and signals shall be possible both locally and remotely.

It shall also be possible to interconnect and derive input and output signals, logic functions, using built-In functions, complex voltage and currents, additional logics (AND-gates, OR gates and timers). (Multi-activation of these additional functions should be possible).

The Functional requirement shall be divided into following levels:

- a. Bay (a bay comprises of one circuit breaker and associated disconnecter, earth switches and instrument transformer) Level Functions
- b. System Level Functions

3.0 Basic Functions

The following are the basic functions of the Substation Automation system

- (i) Control of all the equipment in the substation
- (ii) To execute commands from operator work station (HMI) at control room.
- (iii) Select-before execute commands.
- (iv) Operations of all 220kV and 132kV / 132kV and 33kV circuit breakers (depends on the applicability) through separate BCUs.
- (v) Operation of on-load-tap changer of the Power Transformer and all other FCC signals of PTR.
- (vi) Provision of interlocking of different switchgear isolators for their correct and safe operation.
- (vii) Monitoring and controlling of circuit breakers, isolators and earth switches for their correct and safe operation.

3.1 Bay level functions

In a decentralized architecture the functionality shall be as close to the process as possible. In this respect, the following functions can be allocated at bay level:

- ✓ Bay control functions **including data collection & process functionality in Bay Control / Protection Units.**

- ✓ Bay Protection functions

Separate IEDs shall be provided for Bay Control function (BCU) and Bay Protection function (BPU). The 220kV Main-1 & Main-2 protection, 132kV Main protection and Bus-Bar protection Central Unit shall have separate IEDs. However for 132kV backup and 33kV O/L & E/F protections are acceptable as part of BCU.

3.1.1. Bay control functions

3.1.1.1. Overview

Functions

- ❖ Control mode selection
- ❖ Select-before-execute principle
- ❖ Command supervision:

- Interlocking and blocking
- Double command
- ❖ Synchro-check, voltage selection
- ❖ Run Time Command cancellation
- ❖ Transformer Tap Changer control (for Power Transformer bays)
- ❖ Operation counters for Circuit Breakers and Pumps.
- ❖ Operating pressure Monitoring & Supervision (CB SF6 Gas Pressure, CB Operating Pressure i.e. Pneumatic / Hydraulic).
 - ❖ Hydraulic pump/ Air compressor control and runtime supervision
 - ❖ Display of interlocking and blocking
 - ❖ Breaker position indication per phase
 - ❖ Alarm annunciation
- ❖ Measurement display. (Electrical Parameters of Line, Transformer Parameters)
 - ❖ Local HMI (local guided, emergency mode)
 - ❖ Interface to the station HMI.
 - ❖ Data storage for at least 300 events
- ❖ Extension possibilities with additional I/O's inside the unit or via fiber optic communication and process bus

3.1.1.2. Control mode selection

Bay level Operation:

As soon as the operator receives the operation access at bay level the operation is normally performed via bay control IED. During normal operation Bay Control Unit allows the safe operation of all switching devices via the bay control IED.

EMERGENCY Operation

It shall be possible to close or open the selected Circuit Breaker with ON or OFF switch even during the outage of bay IED.

REMOTE mode

Control authority in this mode is given to a higher level (Remote Control Centre) and the installation can be controlled only remotely. Control operation from lower levels shall not be possible in this operating mode.

3.1.1.3. Synchronism and energizing check

The synchronism and energizing check functions shall be bay-oriented and distributed to the bay control and/or protection devices. These features are:

- Settable voltage, phase angle, and frequency difference.
- Energizing for dead line - live bus, live line - dead bus or dead line – dead bus with no Synchro-check function.
- Synchronizing between live line and live bus with Synchro-check function

Voltage selection

The voltages relevant for the Synchro-check functions are dependent on the station topology, i.e. on the positions of the circuit breakers and/or the isolators. The correct voltage for synchronizing and energizing is derived from the auxiliary switches of the circuit breakers, the isolator, and earthing switch and shall be selected automatically by the Bay Control and Protection IEDs.

3.1.1.4. Transformer Tap Changer control

Raise and lower operation of OLTC taps of Transformer shall be facilitated through Bay controller IED.

3.1.2. Bay Protection functions

3.1.2.1. General

The Protection functions are independent of Bay Control function. The Protection shall be provided by separate Protection IEDs (Numerical Relays) and other Protection devices as per section Relay & Protection.

IEDs, shall be connected to the communication infrastructure for data sharing and meet the real-time communication requirements for automatic functions. The data presentation and the configuration of the various IEDs shall be compatible with the overall system communication and data exchange requirements.

Event and disturbance recording function

Each IED should contain an event recorder capable of storing at least 200 time-tagged events. This shall give alarm if 70% memory is full. The disturbance recorder function shall be as per detailed in section C&R.

Bay Monitoring Function:

Analogue inputs for voltage and current measurements shall be connected directly to the voltage transformers (VT) and the current transformers (CT) without intermediate transducers. The values of active power (W), reactive power (VAR), frequency (Hz), and the rms, Max/Min values for voltage (U) and current (I) shall be calculated in the Bay control/protection unit.

3.2. System level functions

3.2.1. Status supervision

The position of each switchgear, e.g. Circuit Breaker, Isolator, Earth-Switch, Transformer tap changer etc., shall be supervised continuously. Every detected change of position shall be immediately displayed in the single-line diagram on the station HMI screen, recorded in the event list and a hard copy printout shall be produced. Alarms shall be initiated in the case of spontaneous position changes.

The switchgear positions shall be indicated by two auxiliary switches, normally closed (NC) and normally open (NO), which shall give ambivalent signals. An alarm shall be initiated if these position indications are inconsistent or if the time required for operating mechanism to change position exceeds a predefined limit.

The SAS shall also monitor the status of sub-station auxiliaries. The status and control of auxiliaries shall be done through separate one or more IED and all alarm and analogue values shall be monitored and recoded through this IED.

3.2.2. Measurements

The measured values shall be displayed locally on the station HMI in the control centre. The abnormal values must be discarded. The analogue values shall be updated *every 2 seconds*.

Threshold limit values shall be selectable for alarm indications.

3.2.3. Sequence of Events (SOE) and alarm handling feature

To analyze the chronological or sequence of events occurring in the power system network, time tagging of data is required which should be achieved through SOE feature of SA. The server should have an internal clock with adequate stability. The server time should be set from time synchronization messages received from GPS equipment to be supplied by the SAS supplier under the scope of this specification.

The processor should maintain a clock and should time stamp the digital status data. Any digital status input data point in the server should be assignable as an SOE point. Each time a SOE status indication point changes the state, the server should time tag the change and store in SOE buffer with in it. The time resolution for SOE should be 1 ms at point of acquisition.

Events and alarms are generated either by the switchgear, by the control IEDs, or by the station level unit. They shall be recorded in an event list in the station HMI. Alarms shall be recorded in a separate alarm list and appear on the screen. All, or a freely selectable group of events and alarms shall also be printed out on an event printer. The alarms and events shall be time-tagged with a time resolution of 1 m sec.

3.2.4. Station HMI

3.2.4.1. Substation HMI Operation:

On the HMI the object has to be selected first. In case of a blocking or interlocking conditions are not met, the selection shall not be possible and an appropriate alarm annunciation shall occur. If a selection is valid the position indication will show the possible direction, and the appropriate control execution button shall be pressed in order to close or open the corresponding object.

Control operation from other places (e.g. REMOTE) shall not be possible in this operating mode.

3.2.4.2. Presentation and dialogues

General

The operator station HMI shall be a redundant with hot standby and shall provide basic functions for supervision and control of the substation. The operator shall give commands to the switchgear on the screen via mouse clicks or keyboard commands.

The HMI shall give the operator access to alarms and events displayed on the screen. Device monitoring function shall be displayed on the HMI for all the devices. Aside from these lists on the screen, there shall be a printout of alarms or events in an event log.

An acoustic alarm shall indicate abnormalities, and all unacknowledged alarms shall be accessible from any screen selected by the operator.

The following standard pictures shall be available from the HMI:

- Single-line diagram showing the Switchgear Status, measured values, Switchgear Pressure values (wherever required) and Transformer / Reactor Parameters like OLTC Tap Position, WTI, OTI, Hydran DGA & information from Transformer Management Relay.

- Control dialogues with interlocking and blocking **information** details. **This control dialogue shall tell the operator whether the device operation is permitted or blocked and Tap changer operation & Select before Execute.**
- Measurement dialogues, Statistics & Trends
- Energy Meter data related to P& Q of Station / Bay and station Losses.
- Protection Coupler data of send & receive counters information
- Alarm list, station / bay-oriented
- Event list, station / bay-oriented
- Substation Auxiliaries
- System status

3.2.4.3. HMI design principles

Consistent design principles shall be adopted with the HMI concerning labels, colours, dialogues and fonts. Non-valid selections shall be dimmed out.

The object status shall be indicated using different status colours for:

- Selected object under command
- Selected on the screen
- Not updated, obsolete values, not in use or not sampled
- Alarm or faulty state
- Warning or blocked
- Update blocked or manually updated
- Control blocked
- Normal state

3.2.4.4. Process status displays and command procedures

The process status of the substation in terms of actual values of currents, voltages, frequency, active and reactive powers as well as the positions of circuit breakers, isolators and transformer tap-changers shall be displayed in the station single-line diagram.

In addition to above for Transformer , WTIs, OTI, Online Monitor Hydran Value, status of cooling fans, pumps etc and SF6 gas Pressures of Circuit breakers & SF6 CTs and CB Operating mechanism Pressures shall also be displayed. Controlling of OLTC and operation of conventional RTCC shall be able to carried from HMI.

In order to ensure a high degree of security against undesired operation, a "select-before-execute" command procedure shall be provided. After the "selection" of a switch, the operator shall be able to recognize the selected device on the screen, and all other switchgear shall be blocked. As communication between control centre and device to be controlled is established, the operator shall be prompted to confirm the control action and only then final execute command shall be accepted. After the "execution" of the command the operated switching symbol shall flash until the switch has reached its new position.

The operator shall be in a position to execute a command only, if the switch is not blocked and if no interlocking condition is going to be violated. The interlocking statements shall be checked by the interlocking scheme implemented at bay and station level.

After command execution the operator shall receive a confirmation that the new switching position has been reached or an indication that the switching procedure was unsuccessful with the indication of the reason for non-functioning.

3.2.4.5. System supervision & display

The SAS system shall be comprehensively self-monitored such that faults are immediately indicated to the operator, possibly before they develop into serious situations. Such faults are recorded as a faulty status in a system supervision display. This display shall cover the status of the entire substation including all switchgear, IEDs, communication infrastructure and remote communication links, and printers at the station level, etc. Dynamic coloring of single line diagram with load, power factor voltage. Bay view to zoom all parameters

3.2.4.6. Event list

The event list shall contain events that are important for the control and monitoring of the substation with proper time stamping.

The event and associated time (with 1 ms resolution) of its occurrence has to be displayed for each event.

The operator shall be able to call up the chronological event list on the monitor at any time for the whole substation or sections of it.

A printout of each display shall be possible on the hard copy printer of Dot matrix Printer or Line Printer of 132 Column.

The events shall be registered in a chronological event list in which the type of event and its time of occurrence are specified. It shall be possible to store all events in the computer on date wise (from 00Hrs to 24 Hrs), Month wise and Year wise and shall be obtainable. The information shall be obtainable also from a printed event log.

The chronological event list shall contain:

- Position changes of Circuit Breakers, Isolators and Earthing Devices
- Indication of Protective Relay operations
- Fault signals from the Switchgear
- Indication when analogue measured values exceed upper and lower limits. Suitable provision shall be made in the system to define two level of alarm on either side of the value or which shall be user defined for each measured.
- Loss of communication.
- Hourly time Stamping

Filters for selection of a certain type or group of events shall be available. The filters shall be designed to enable viewing of events grouped per:

- Date and time
- Bay
- Device
- Function e.g. trips, protection operations etc.
- Alarm class

3.2.4.7. Alarm list

Faults and errors occurring in the substation shall be listed in an alarm list and shall be immediately transmitted to the control centre. The alarm list shall substitute a conventional alarm tableau, and shall constitute an evaluation of all station alarms. It shall contain unacknowledged alarms and persisting faults. The date and time of occurrence shall be indicated.

The alarm list shall consist of a summary display of the present alarm situation. Each alarm shall be reported on one line that contains:

- The date and time of the alarm
- The name of the alarming object
- A descriptive text
- The acknowledgement state.

Whenever an alarm condition occurs, the alarm condition must be shown on the alarm list and must be displayed in a flashing state along with an audible alarm. After acknowledgement of the alarm, it should appear in a steady (i.e. not flashing) state and the audible alarm shall stop. The alarm should disappear only if the alarm condition has physically cleared and the operator has reset the alarm with a reset command. The state of the alarms shall be shown in the alarm list (Unacknowledged and persistent, Unacknowledged and cleared, Acknowledged and persistent).

Filters for selection of a certain type or group of alarms shall be available as for events.

3.2.4.8. Object picture

When selecting an object such as a circuit breaker or isolator in the single line diagram, the associated bay picture shall be presented first. In the selected object picture, all attributes like

- Type of blocking
- Authority
- Local / remote control
- ALDC / SLDC / SAS control
- Errors etc., shall be displayed.

3.2.4.9. Control dialogues

The operator shall give commands to the system by means of mouse click located on the single-line diagram. It shall also be possible to use the keyboard for command activation. Data entry is performed with the keyboard. Dedicated control dialogues for controlling at least the following devices shall be available:

- Breaker and Disconnecter
- Transformer tap-changer

The information of control Command given from SLDC / ALDC / RCC / LCC / BCU / Emergency TNC Switch / at particular Equipment should be clearly appear in Event recorder along with any bypass arrangements made.

3.2.5. User-authority levels

It shall be possible to restrict activation of the process pictures of each object (bays, apparatus...) within a certain user authorization group. Each user shall then be given access rights to each group of objects, e.g.:

- Display only

- Normal operation (e.g. open/close of switchgear)
- Restricted operation (e.g. by-passed interlocking)
- System administrator

For maintenance and engineering purposes of the station HMI, the following authorization levels shall be available:

- No engineering allowed
- Engineering/configuration allowed
- Entire system management allowed

The access rights shall be defined by passwords assigned during the login procedure. Only the system administrator shall be able to add/remove users and change access rights.

3.2.6. Reports

Substation Automation System shall record all activities, switching, changes etc., made in a substation.

Following shall be automatically monitored:

- Status
- Events, alarms
- Limit values.

The SAS shall support various report generation automatically in the user defined formats

These reports shall be generated

- a. Periodically
- b. Event oriented basis
- c. On demand by operator at any time

The reports shall provide time-related follow-ups of measured and calculated values. The data displayed shall comprise:

- Trend reports: (V, A, F, MW, MVA, MVAR ... etc.)
 - ✓ Day (mean, peak)
 - ✓ Month (mean, peak)
 - ✓ Semi-annual (mean, peak)
 - ✓ Year (mean, peak)
- Historical reports of selected analogue Values:
 - ✓ Day (at 15 minutes interval)
 - ✓ Week
 - ✓ Month
 - ✓ Year
- Historical reports of Energy Meter Values P(2 Quadrant) & Q(4 Quadrant) :
 - ✓ Day (at 15 minutes interval)
 - ✓ Week
 - ✓ Month
 - ✓ Year

➤ Protection Coupler counters:

- ✓ Day
- ✓ Month
- ✓ Semi-annual
- ✓ Year

It shall be possible to select displayed values from the database in the process display on-line. Scrolling between e.g. days shall be possible. Unsure values shall be indicated. It shall be possible to select the time period for which the specific data are kept in the memory.

Following printouts shall be available from the printer and shall be printed on demand:

- i. Daily voltages, currents, MW, MVA, MVAR and frequency curves depicting time on X-axis and the appropriate parameters on the Y-axis. The time duration of the curve is 24 hours.
- ii. Weekly trend curves for real and derived analogue values.
- iii. Printouts of the maximum and minimum values and frequency of occurrence and duration of maximum and minimum values for each analogue parameter for each circuit in 24 hr period.
- iv. Provision shall be made for logging information about breaker status like number of operation with date and time indications.
- v. Equipment operation details shift wise and during 24 hours.
- vi. Printout on adjustable time period as well as on demand for MW, MVAR, Current, Voltage on each feeder and transformer as well as Tap Positions, temperatures (WTIs, OTI) and status of pumps, fans and OLTC oil filters for transformers.
- vii. Printout on adjustable time period as well as on demand system frequency and average frequency.
- viii. Daily Station Losses with energy received to energy delivered.
- ix. Reports in specified formats which shall be handed over to successful bidder. **The Bidder has to develop these reports. The reports are limited to the formats for which data is available in the SAS database.**

3.2.7. Trend display (historical data)

It shall be possible to illustrate all types of process data as trends – input and output data, binary and analogue data. The trends shall be displayed in graphical form as column or curve diagrams with a maximum of 10 trends per screen. Adjustable time span and scaling ranges must be provided.

It shall be possible to change the type of value logging (direct, mean, sum, or difference) on-line in the window. It shall also be possible to change the update intervals on-line in the picture as well as the selection of threshold values for alarming purposes.

3.2.8. Automatic disturbance file transfer

All recorded data from the IEDs with integrated disturbance recorder shall be automatically uploaded (event triggered or once per day) to a dedicated computer and be stored on the hard disc.

3.2.9. Disturbance analysis

The PC-based work station shall have necessary software to evaluate all the required information for proper fault analysis.

3.2.10. IED parameter setting

It shall be possible to access all protection and control IEDs for reading the parameters (settings) from the station HMI or from a dedicated monitoring computer. The setting of parameters or the activation of parameter sets shall only be allowed after entering a password.

3.2.11. Automatic sequences

The available automatic sequences in the system should be listed and described, (e.g. sequences related to the bus transfer). It must be possible to initiate pre-defined automatic sequences by the operator and also define new automatic sequences.

3.2.12 Other Functions

- i) Switching sequences
- ii) Time synchronization through GPS.
- iii) Monitoring of DC system.
- iv) Changing of relay settings of all numerical relays from Engg. / DR work station with suitable software.
- v) Storage of data.
- vi) Collection of disturbance record files from various relay and analysis of the same from Engg. / DR work station with suitable software.

3.3. Gateway

Dedicated Gateway server should be provided for transmission of data to the SLDC.

The gateway server should be suitable for integration to the existing control centre at SLDC APTRANSCO which is having GE Harris XA21 SCADA server. Present protocol implemented at SLDC is IEC 60870-5-101.

The IEC 60870-5-101 protocol implementation document for present SCADA system in SLDC is enclosed with this document. SAS system should be in line interoperability profile.

The Gateway server should be enabled for IEC 870 – 5 – 104 & 101 protocol for integration with Main and Backup SLDCs in future.

The Gateway server should be capable of reporting to two control centres simultaneously on IEC 870 – 5 – 104 protocol.

The Gateway server should be enabled for communication to any Front End Processor of any vendor and should be capable of being integrated to any SCADA system of any vendor over IEC 104 protocol & 101 protocol.

The uptime of the Gateway server after integration to the SLDC should be 99%.

Suitable communication ports for transmission of data may be provided keeping in view of the data transmission over IEC 870 – 5 – 104 protocol & 101 protocol.

Refresh rate of the Gateway server shall not be more than 4 seconds.

The data exchanges shall be via purchaser provided redundant wide band/PLCC communication network.

All the necessary interface compatible equipments to meet the above requirements shall be in bidders scope

3.3.1 Communication Interface

The Substation Automation System shall have the capability to support simultaneous communications with multiple independent remote master stations,

The Substation Automation System shall have communication ports as follows:

- (a) Two ports for Remote Control Centre
- (b) Two ports for Area Load Dispatch Center / State Load Dispatch Centre (ALDC/SLDC)
- (c) Two spare ports.

The communication interface to the SAS shall allow scanning and control of defined points within the substation automation system independently for each control centre. The substation automation system shall simultaneously respond to independent scans and commands from employer's control centers (RCC & ALDC/SLDC). The substation automation system shall support the use of a different communication data exchange rate (bits per second), scanning cycle, and/or communication protocol to each remote control centre. Also, each control centre's data scan and control commands may be different for different data points within the substation automation system's database.

3.3.2 Communication Protocol

The communication protocol for gateway to control centre must be open protocol and shall support IEC 60870-5-101 & 104 and IEC 61850 for all levels of communication for substation automation such as Bay to station HMI etc.

4.0 System hardware:

4.1 Redundant Station HMI and Disturbance Recorder Work station:

The SAS shall provide redundant station HMI in hot standby mode. **The Systems used in these work stations shall be of industrial grade with latest processors and highest configuration.**

It shall be capable to perform all functions for entire substation including future requirements as indicated in the SLD. It shall use industrial grade components. Processor and RAM shall be selected in such a manner that during normal operation not more than 30% capacity of processing and memory are used. Supplier shall demonstrate these features. As such the RAM, Hard Disk and Bus should be latest and with maximum Values.

The capacity of hard disk shall be selected such that the following requirement should occupy less than 50% of disk space:

1. Storage of all analogue data (at 15 Minutes interval) and digital data including alarm, event and trend data for thirty (90) days,

2. Storage of all necessary software,
3. 1TB OR MORE space as per the market trends for OWNER'S use.

Supplier shall demonstrate that the capacity of hard disk is sufficient to meet the above requirement.

4.1.1 HMI (Human Machine Interface)

The VDU shall show overview diagrams (Single Line Diagrams) and complete details of the switchgear with a colour display. All event and alarm annunciation shall be selectable in the form of lists. Operation shall be by a user friendly function keyboard and a cursor positioning device. The user interface shall be based on WINDOWS concepts with graphics & facility for panning, scrolling, zooming, decluttering etc.

4.1.2 Visual Display Units/TFT's (Thin Film Technology)

The contractor shall provide three display units, one for station HMI, one for redundant HMI and one for DR work station. These shall have high resolution and reflection protected picture screen. High stability of the picture geometry shall be ensured. The screen shall be at least 24" diagonally in size or more and capable of colour graphic displays.

The display shall accommodate resolution of 1280 X 1024 pixels.

The HMI shall be able to switch the key board and cursor positioning device, as unit among all the monitors at a consol via push button or other controls.

4.1.3 Printer

One laser printer and one dot matrix printer is in the scope of this specification. It shall be robust & suitable for operation with a minimum of 132 characters per line for Dot Matrix Printer. The printing operation shall be quiet with a noise level of less than 45 dB suitable for location in the control room. Printer shall accept and print all ASCII characters via master control computer unit interface.

The printer shall have in built testing facility. Failure of the printer shall be indicated in the Station HMI. The printer shall have an off line mode selector switch to enable safe maintenance. The maintenance should be simple with provisions for ease of change of print head, ribbon changing, paper insertion etc.

All reports and graphics prints shall be printed on laser printer. One Line/ Dot Matrix printer shall be used for Events and Alarms Printing. All printers shall be continuously online through directly or printer server.

4.1.4 Mass Storage Unit

The mass storage unit shall be built-in to the Station HMI. All operational measured values and indications shall be stored in a mass-storage unit in form of DVD RW. The unit should support at least Read (48X), Write (24X), and Re-Write (10X) operations, with Multi-Session capability. It should support ISO9660, Rockridge and Joliet File systems. It should support formatting and use under the operating system provided for Station HMI. The monthly back up of data shall be taken on disc. The facility of back up of data shall be inherent in the software.

All the data pertaining to Substation is to stored in a system year/ month / day wise. The daily data is stored in a day file of Particular Month and Year automatically from 00.00Hrs to 24.00Hrs.

4.1.5 Switched Ethernet Communication Infrastructure:

The bidder shall provide the redundant switched optical Ethernet communication infrastructure for SAS.

The Ethernet switch compliant with IEC 61850 standard shall have dual power supply and of managed type. The supplier shall keep provision for 50% spare capacity for employers use

- ✓ One switch shall be provided to connect all IEDs in one bay of 220 kV/ 132kV yard.
- ✓ One switch shall be provided to connect all IEDs for 33 kV Twin feeder panel.
- ✓ One switch shall be provided to connect all IEDs for Bus coupler, Transfer Bus Coupler and Bus bar for 220 kV Switch yard which are accommodated in one Kiosk.

Each switch shall have at least 50% spare ports. (For connecting station Bus, one spare port shall be made available).

4.1.6 List of Equipments:

Quantity of equipments shall be decided by bidder in order to achieve guaranteed reliability and availability as declared by bidder.

- i. Station HMI
- ii. Redundant Station HMI (in Hot-stand by mode)
- iii. Bay level units with bay mimic
- iv. Disturbance Recorder Work Station (Maintenance HMI)
- v. Colour Laser Printer (For Reports & Disturbance records)
- vi. Dot matrix printer
- vii. Communication infrastructures between Bay level units, Station HMI, printers, redundant Lan etc. as required
- viii. All interconnecting cables, switches, power supply cables
- ix. Any other equipment as necessary.
- x. Redundant 230 V inverters with 100 % capacity.
- xi. Aux. BCU shall be accommodated in SAS panel.
- xii. All the servers for main& Redundant HMI and DR shall be arranged in the desk top table with lock& key arrangements.
- xiii. All the required transducers such as D.C. supply i.e. Battery& Charger voltages and currents, D.C. earth leakages, A.C. currents & voltages, winding temperature, oil temperature, tap changers etc. are to be supplied by the bidders.

4.2 Bay level unit/Bay Control Unit

The bay unit shall use industrial grade components. The bay level unit, based on microprocessor technology, shall use numerical techniques for the calculation and evaluation of externally input analogue signals. They shall incorporate select-before-operate control principles as safety measures for operation via the HMI. They shall perform all bay related functions, such as control commands, bay interlocking, data acquisition, data storage, event recording and shall provide inputs for status indication and outputs for commands. They shall be directly connected to the switchgear. The bay unit shall acquire and process all data for the bay (Equipment status, fault indications, measured values, alarms etc.) and transmit these to the other devices in sub-station automation system. In addition, this shall receive the operation commands from station HMI and control centre. The bay unit shall have the capability to store all the data for at least 24 hours.

One no. Bay level unit shall be provided for supervision and control of each 220 kV, 132 kV and 33 kV bay (a bay comprises of one circuit breaker and associated disconnectors, earth

switches and instrument transformer). The Bay level unit shall be equipped with analogue and binary inputs/outputs for handling the control, status monitoring and analogue measurement functions. All bay level interlocks are to be incorporated in the Bay level unit so as to permit control from the Bay level unit/ local bay mimic panel, with all bay interlocks in place, during maintenance and commissioning or in case of contingencies when the Station HMI is out of service.

The Bay level unit shall meet the requirements for withstanding electromagnetic interference according to relevant parts of IEC 61850. Failure of any single component within the equipment shall neither cause unwanted operation nor lead to a complete system breakdown.

The Bay Level Unit should have a redundant Power Supply unit **or** have a automatic change over facility one of the power supply fails and have to alarmed and event in SAS. All the BCUs provided in the substation shall be similar and shall be interchangeable.

4.2.1 Input/Output (I/O) modules

The I/O modules shall form a part of the bay level unit (BCU) and shall provide coupling to the substation equipment. The I/O modules shall acquire all switchgear information (i.e. data coming directly from the switchgear or from switchgear interlocking devices) and transmit commands for operation of the switchgear.

The measured values of voltage and current shall be from the secondaries of instrument transformers.

The measured values of SF6 Gas Pressures, Operating Mechanism Pressures, WTIs, OTI, on line monitor Hydran Value shall also be received through transducers to Bay Level Unit.

The digital inputs shall be acquired by exception with 1 ms resolution. Contact bouncing in digital inputs shall not be assumed as change of state. Sufficient spare Input & Outputs shall be available in every BCU.

4.3 Extendibility in future

Offered substation automation system shall be suitable for extension in future for additional bays. During such requirement, all the drawings and configurations, alarm/event list etc. displayed shall be designed in such a manner that its extension shall be easily performed by the employer. During such event, normal operation of the existing substation shall be unaffected and system shall not require a shutdown. The contractor shall provide all necessary software tools along with source codes to perform addition of bays in future and complete integration with SAS by the user. These software tools shall be able to configure IED, add additional analogue variable, alarm list, event list, modify interlocking logics etc. for additional bays/equipment which shall be added in future.

The SAS shall be designed such that it will cater for the present and future about 40 BCUs with total 2000 I/O Points.

5.0 TIME SYNCHRONISATION

- i) The Time synchronization equipment shall receive the coordinated Universal Time (UTC) transmitted through Geo Positioning Satellite System (GPS) and synchronize equipments to the Indian Standard Time in a substation. The time synchronization shall be realized using the SNTP protocol at inter bay bus. An accuracy of +/- 1 mSec with in the station is required.
- ii) Time synchronization equipment shall include antenna & its mounting facility, all special cables and processing equipment etc.

The GPS antenna shall have adequate protection from wind, lightning etc. and shall be mounted anywhere in the substation roof at a place preferable by the purchaser.

- iii) It shall be compatible for synchronisation of Event Loggers, Disturbance recorders and SCADA at a substation through individual port or through Ethernet realised through optic fibre bus.
- iv) Equipment shall operate up to the ambient temperature of 50 degree centigrade and 100% humidity.
- v) The synchronisation equipment shall have 2 micro second accuracy. Equipment shall give real time corresponding to IST (taking into consideration all factors like voltage, & temperature variations, propagation & processing delays etc). including communication time for satellite link to achieve real time signal.
- vi) Equipment shall meet the requirement of IEC 60255 for storage & operation.
- vii) The system shall be able to track the satellites to ensure no interruption of synchronisation signal.
- viii) The output signal from each port shall be programmable at site for either one hour, half hour, minute or second pulse, as per requirement.
- xi) The equipment offered shall have six (6) output ports. Various combinations of output ports shall be selected by the customer, during detailed engineering, from the following :
 - a) Voltage signal : Normally 0-5V with 50 milli Seconds minimum pulse duration. In case any other voltage signal required, it shall be decided during detailed engineering.
 - b) Potential free contact (Minimum pulse duration of 50 milli Seconds.)
 - c) IRIG-B
 - d) RS232C
 - e) SNTP Port
- x) The equipment shall have a periodic time correction facility of one second periodicity.
- xi) Time synchronisation equipment shall be suitable to operate from 220V DC supply available at the sub-station with voltage variation of + 10% and -15%.
- xii) The cable connecting Antenna and Time Synchronizing unit should be run through HDPE pipe or GI pipe from the location of Antenna fixing to Time Synchronizing panel with suitable fixtures and no provision to enter rain water and should not be affected by atmospheric conditions.
- xiii) The equipment shall also have real time digital display in hour, minute, second, milli seconds. (24 hours mode) and shall have a separate time display unit to be mounted on the top of control panels having display size of approximately 144 mm height. The equipment shall have periodic time correction facility of one second periodicity.

6.0 Software structure

The software package shall be structured according to the SAS architecture and strictly divided in various levels. Necessary firewall shall be provided at suitable points in software to protect the system. An extension of the station shall be possible with lowest possible efforts. Maintenance, modification or an extension of components of any feeder may not force a shut-down of the parts of the system which are not affected by the system adaptation.

6.1.1 Station level software

6.1.1.2 Human-machine interface (HMI)

The base HMI software package for the operator station shall include the main SAS functions and it shall be independent of project specific hardware version and operating system. It shall further include tools for picture editing, engineering and system configuration. The system shall be easy to use, to maintain, and to adapt according to specific user requirements. Systems shall contain a library with standard functions and applications.

6.1.2 Bay level software

6.1.2.1 System software

The system software shall be structured in various levels. This software shall be placed in a non-volatile memory. The lowest level shall assure system performance and contain basic functions, which shall not be accessible by the application and maintenance engineer for modifications. The system shall support the generation of typical control macros and a process database for user specific data storage. In case of restoration of links after failure, the software along with hardware shall be capable of automatically synchronizing with the remaining system without any manual interface. This shall be demonstrated by contractor during integrated system test.

6.1.2.2 Application software

In order to ensure robust quality and reliable software functions, the main part of the application software shall consist of standard software modules built as functional block elements. The functional blocks shall be documented and thoroughly tested. They form part of a library.

The application software within the control / protection devices shall be programmed in a functional block language.

6.1.2.3 Network Management System:

The contractor shall provide network management system software for following management functions:

- a. Configuration Management
- b. Fault Management
- c. Performance Monitoring

This system shall be used for management of communication devices and other IEDs in the system. This NMS can be loaded in DR work-station and shall be easy to use, user friendly and menu based. The NMS shall monitor all the devices in the SAS and report if there is any fault in the monitored devices. The NMS shall

- (a) Maintain performance, resource usage, and error statistics for all managed links and devices and present this information via displays, periodic reports and on demand reports.
- (b) Maintain a graphical display of SAS connectivity and device status.
- (c) Issue alarms when error conditions occurs
- (d) Provide facility to add and delete addresses and links

6.1.2.4 The contractor shall provide each software in two copies in CD to load into the system in case of any problem related with Hardware/Communication etc.

7.0 TESTS

The substation automation system offered by the bidder shall be subjected to following tests to establish compliance with IEC 61850 for EHV substation equipment installed in sheltered area in the outdoor switchyard and specified ambient conditions:

7.1 Type Tests:

7.1.1 Control IEDs and Communication Equipment:

a. Power Input:

- i. Auxiliary Voltage
- ii. Current Circuits
- iii. Voltage Circuits
- iv. Indications

b. Accuracy Tests:

- i. Operational Measured Values
- ii. Currents
- iii. Voltages
- iv. Time resolution

c. Insulation Tests:

- i. Dielectric Tests
- ii. Impulse Voltage withstand Test

d. Influencing Quantities

- i. Limits of operation
- ii. Permissible ripples
- iii. 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 (Radio interference level) Test.
- viii. Conducted Interference Test

f. Function Tests:

- i. Indication

- ii. Commands
- iii. Measured value Acquisition
- iv. Display Indications

g. Environmental tests:

- i. Cold Temperature
- ii. Dry Heat
- iii. Wet heat
- iv. Humidity (Damp heat Cycle)
- v. Vibration
- vi. Bump
- vii. Shock

7.2 Factory Acceptance Tests:

The SAS supplier shall conduct Pre-FAT themselves and FAT in witness with the purchaser for all the supplied equipment in their works on fully integrated mode.

The supplier shall submit a test specification for factory acceptance test (FAT) and commissioning tests of the station automation system for approval. For the individual bay level IED's applicable type test certificates shall be submitted.

The manufacturing and configuration phase of the SAS shall be concluded by the factory acceptance test (FAT). The purpose is to ensure that the Contractor has interpreted the specified requirements correctly and that the FAT includes checking to the degree required by the user. The general philosophy shall be to deliver a system to site only after it has been thoroughly tested and its specified performance has been verified, as far as site conditions can be simulated in a test lab. During FAT the entire Sub-station Automation System including complete control and protection system to be supplied under present scope shall be tested for complete functionality and configuration in factory it self. The Extensive testing shall be carried out during FAT. The Purpose of factory Acceptance testing is to ensure trouble free installation at site. No major configuration setting of system is envisaged at site.

If the complete system consists of parts from various suppliers or some parts are already installed on site, the FAT shall be limited to sub-system tests. In such a case, the complete system test shall be performed on site together with the site acceptance test (SAT).

7.2.1 Hardware Integration Tests:

The hardware integration test shall be performed on the specified systems to be used for Factory tests when the hardware has been installed in the factory. The operation of each item shall be verified as an integral part of system. Applicable hardware diagnostics shall be used to verify that each hardware component is completely operational and assembled into a configuration capable of supporting software integration and factory testing of the system. The equipment expansion capability shall also be verified during the hardware integration tests. **The vendor specifically demonstrates how to add a device in future in SAS during FAT, SAT and under Training.** The device shall be from different manufacturer than SAS supplier.

7.2.2 Integrated System Tests:

Integrated system tests shall verify the stability of the hardware and the software. During the tests all functions shall run concurrently and all equipment shall operate a continuous 100

Hours period. The integrated system test shall ensure the SAS is free of improper interactions between software and hardware while the system is operating as a whole.

7.3 Site Acceptance Tests:

The Site acceptance tests (SAT) shall completely verify all the features of SAS hardware and software. The bidder shall submit the detailed SAT procedure and SAT procedure shall be read in conjunction with specification.

8.0 SYSTEM OPERATION

8.1 Substation Operation

8.1.1 NORMAL OPERATION

Operation of the system by the operator from the control room shall take place via industry standard HMI (Human Machine interface) subsystem consisting of graphic colour VDU, a standard keyboard and a cursor positioning device (mouse).

The coloured screen shall be divided into 3 fields:

- i) Message field with display of present time and date
- ii) Display field for single line diagrams
- iii) Navigation bar with alarm/condition indication

For display of alarm annunciation, lists of events etc a separate HMI View node shall be provided.

All operations shall be performed with mouse and/or a minimum number of function keys and cursor keys. The function keys shall have different meanings depending on the operation. The operator shall see the relevant meanings as function tests displayed in the command field (i.e. operator prompting). For control actions, the switchgear (i.e. circuit breaker etc.) requested shall be selectable on the display by means of the cursor keys. The switching element selected shall then appear on the background that shall be flashing in a different color. The operator prompting shall distinguish between:-

- Prompting of indications e.g. fault indications in the switchgear, and
- Prompting of operational sequences e.g. execution of switching operations

The summary information displayed in the message field shall give a rapid display of alarm/message of the system in which a fault has occurred and alarm annunciation lists in which the fault is described more fully.

Each operational sequence shall be divided into single operation steps which are initiated by means of the function keys/WINDOW command by mouse. Operator prompting shall be designed in such a manner that only the permissible keys are available in the command field related to the specific operation step. Only those switching elements shall be accessed for which control actions are possible. If the operation step is rejected by the system, the operator prompting shall be supported by additional comments in the message field. The operation status shall be reset to the corresponding preceding step in the operation sequence by pressing one of the function keys. All operations shall be verified. Incorrect operations shall be indicated by comments in the message field and must not be executed.

The offer shall include a comprehensive description of the system. The above operation shall also be possible via WINDOWS based system by mouse.

9.0 POWER SUPPLY

Power for the substation automation system shall be derived from substation 220V DC system.

2 Nos. Inverters of 3 kVA capacity each shall be provided for station HMI, Disturbance recorder evaluation unit and its peripheral devices e.g. printer etc. In the event of Power failure, necessary safeguard software shall be built for proper shutdown and restart.

All power system cabling from station D.C. system to inverter and inverter to individual units under the scope of supplier.

10.0 DOCUMENTATION

The following documents shall be submitted for employer's approval during detailed engineering:

- (a) System Architecture Drawing
- (b) Hardware Specification
- (c) Functional Design specification Document
- (d) Clear procedure describing how to add an IED / Bay / Diameter in future covering all major suppliers.
- (e) Sizing Calculations of various components.
- (f) Response Time Calculation.

The following documentation to be provided for the system in the course of the project shall be consistent, CAD supported, and of similar look / feel. All CAD drawings to be provide in "dxf" format and also in acrobat format.

- ❖ List of Drawings
- ❖ Substation Automation System Architecture
- ❖ Block Diagram
- ❖ Guaranteed Technical parameters, Functional Design Specification and Guaranteed availability and reliability
- ❖ Calculation for power supply dimensioning
- ❖ I/O Signal lists
- ❖ Schematic diagrams
- ❖ List of Apparatus
- ❖ List of Labels
- ❖ Logic Diagram (hardware & software)
- ❖ Test Specification for Factory Acceptance Test (FAT)
- ❖ Product Technical Manuals
- ❖ Application Manuals
- ❖ Assembly Drawing
- ❖ Operator's Manual
- ❖ Testing and Commissioning Manuals
- ❖ Complete documentation of implemented protocols between various elements
- ❖ Listing of software and loadable in CD ROM



Other documents as may be required during detailed engineering

Two sets of hard copy and four sets of CD ROM containing all the as built documents/drawings shall be provided.

11.0 TRAINING, SUPPORT SERVICES, MAINTENANCE AND SPARES

11.1 Training

Contractor personnel who are experienced instructors and who speak understandable English shall conduct training. The contractor shall arrange on its own cost all hardware training platform required for successful training and understanding in India. The Contractor shall provide all necessary training material. Each trainee shall receive individual copies of all technical manuals and all other documents used for training. These materials shall be sent to Employer at least two months before the scheduled commencement of the particular training course. Class materials, including the documents sent before the training courses as well as class handouts, shall become the property of Employer. Employer reserves the right to copy such materials, but for in-house training and use only. Hands-on training shall utilize equipment identical to that being supplied to Employer. In addition three sets of additional Training document with 2 sets CDs shall be provided after the training and before handing over the system per each substation.

The supplier shall give training in the field of philosophy of Control & Protection, substation automation and design aspects PLCC in the form of tutorial to owner's personnel.

The following are the minimum required for each substation:

- a) At the works 4 Engineers for one week duration with lecture & hands on and complete SAS including BCUs and BPU's at free of cost. Lodging, boarding charges and local transport to the place of training to the trainees shall be borne by the bidder/SAS supplier. The travel expenses are borne by the purchaser.
- b) The supplier shall also impart Operation and maintenance training at substation site in the field of erection, testing, operation and maintenance of Protection & Automation for engineers for 5 days after installation of complete SAS including BCUs and BPUS at free of cost.

The bid price offered is deemed to have included this. Training offered

Shall be free of cost to the owner.

The schedule and detailed contents of each course will be finalized during Employer and Contractor discussions.

11.2 Maintenance

Maintenance Responsibility during the Guaranteed Availability Period.

During Guaranteed Availability Period, the Contractor shall take continual actions to ensure the guaranteed availability and shall make available all the necessary resources such as specialist personnel, spare parts, tools, test devices etc. for replacement or repair of all defective parts and shall have prime responsibility for keeping the system operational. During Guarantee period as specified in tender document, contractor shall arrange bi-

monthly visit of their representative to site to review the performance of system and incase any defects / short comings etc. is observed during the period, the same shall be set right by the contractor with in 15 days.

11.3 Consumables:

All consumables such as paper, cartridges shall be supplied by the contractor till the SAS is taken over by the owner. .

11.4 Availability Spares:

In addition to mandatory spares as listed in Annexure 26, the bidder is required to supply the spares for SAS, which may be required for ensuring the guaranteed availability during the guaranteed availability period. The final list of spares shall form part of scope of supply and accordingly the price thereof shall be quoted by the bidder and shall be considered in the evaluation of the bids. During the guaranteed availability period, the spare parts supplied by the Contractor shall be made available to the Contractor for usage subject to replenishment at the earliest. Thus, at the end of availability period the inventory of spares with the Employer shall be fully replenished by the Contractor. However, any additional spares required to meet the availability of the system (which are not a part of the above spares supplied by the Contractor) would have to be supplied immediately by the Contractor free of cost to the Employer.

12.1 RELIABILITY AND AVAILABILITY

The SAS shall be designed so that the failure of any single component, processor, or device shall not render the system unavailable. The SAS shall be designed to satisfy the very high demands for reliability and availability concerning:

- ❖ Mechanical and electrical design
- ❖ Security against electrical interference (EMI)
- ❖ High quality components and boards
- ❖ Modular, well-tested hardware
- ❖ Thoroughly developed and tested modular software
- ❖ Easy-to-understand programming language for application programming
- ❖ Detailed graphical documentation and application software
- ❖ Built-in supervision and diagnostic functions
- ❖ Security
 - ~ Experience of security requirements
 - ~ Process know-how
 - ~ Select before execute at operation
 - ~ Process status representation as double indications
- ❖ Distributed solution
- ❖ Independent units connected to the local area network
- ❖ Back-up functions
- ❖ Panel design appropriate to the harsh electrical environment and ambient conditions
- ❖ Panel grounding immune against transient ground potential rise

Outage terms

1) Outage

The state in which substation automation system or a unit of SAS is unavailable for Normal Operation due to an event directly related to the SAS or unit of SAS. In the event, the owner has taken any equipment / systems other than Sub-station Automation System for schedule/forced maintenance, the consequent outage to SAS shall not be considered as outage for the purpose of availability.

2) Actual outage duration (AOD)

The time elapsed in hours between the start and the end of an outage. The time shall be counted to the nearest 1/4th of an hour. Time less than 1/4th of an hour shall be counted as having duration of 1/4th of an hour.

3) Period Hours (PH)

The number of hours in the reporting period. In a full year the period hour are 8760h (8784h for a leap year).

4) Actual Outage hours (AOH)

The sum of actual outage duration within the reporting period $AOH = \sum AOD$

5) Availability:

Each SAS shall have a total availability of 99.98 % i.e. the ratio of total time duration minus the actual outage duration to total time duration.

12.2 Guarantees Required

The availability for the complete SAS shall be guaranteed by the Contractor. Bidder shall include in their offer the detailed calculation for the availability. The contractor shall demonstrate their availability guaranteed by conducting the availability test on the total sub-station automation system as a whole after commissioning of total Sub-station Automation system. The test shall verify the reliability and integrity of all sub-systems. Under these conditions the test shall establish an overall availability of 99.98%. After the lapse of 1000 Hours of cumulative test time, test records shall be examined to determine the conformance with availability criterion. In case of any outage during the availability test, the contractor shall rectify the problem. The 1000 Hours period shall again start after such rectification. The test shall be continued until the specified availability is achieved.

The contractor has to establish the availability in a maximum period of three months from the date of commencement of the availability test.

After the satisfactory conclusion of test both contractor and employer shall mutually agree to the test results and if these results satisfy the availability criterion, the test is considered to be completed successfully. After that the system shall be taken over by the employer and then the guarantee period shall start.

12.3 Update Time:

1. Graphical Displays within 1 sec
2. Alarm points 4 alarms per second
3. SOE points within 5 m sec
4. Analog values in every 2 sec

12.4 Response time:

1. Logs & Reports within 2 sec
2. Alarm summaries within 1 sec
3. SLDs within 2 sec

Annexure: LIST OF ANALOGUE AND DIGITAL INPUTS

BASIC MONITORING REQUIREMENTS are:

- 1 Switchgear status indication
- 2 Switchgear SF6 Gas Pressures and Operating Mechanism Pressures.
- 3 Measurements (V, I, P, Q, f)
- 4 Event
- 5 Alarm
- 6 Winding & Oil Temperatures of Transformers.
- 7 Ambient temperature.
- 8 Status and display of 415V LT system, 220V & 48V DC system
- 9 Status of display of Fire protection system, Fire & Smoke Detector System, Air conditioning system & Generator System including auto change over System.
- 10 Acquisition of all counters in PLCC panels through potential free contacts from PLCC or independently by counting the receive/send commands.
- 11 Acquisition of alarm and fault record from protection relays.
- 12 Disturbance records
- 13 Monitoring the state of batteries by displaying DC voltage, charging current and load current etc.
- 14 Tap-position of Transformer
- 15 Transformer Management Relay or online Hydran Monitoring etc
- 16 Transformer Parameters & Cooling System Monitoring

List of Inputs

The list of input for typical bays is as below:-

Analogue inputs

- | | | | | | |
|------|-----------------|---------|--|--------------|-------------|
| i) | For line | Current | R phase | Y phase | & B phase |
| | | Voltage | R-Y phase | Y-B phase | & B-R phase |
| | | | R-N phase | Y-N phase | & B-N phase |
| ii) | For Transformer | Current | R phase | Y phase | B phase |
| | | | WTI&OTI | Tap position | |
| iii) | For BUS COUPLER | Current | R phase | Y phase | B phase |
| iv) | Common | | | | |
| | a) Voltage | | Bus-I, Bus-II and Transfer Bus wherever applicable | | |
| | | | R-Y phase Y-B phase & B-R phase | | |
| | | | R-N phase Y-N phase & B-N phase | | |
| | b) Frequency | | for Bus-I and Bus-II | | |

- c) Ambient temperature (switchyard).
- d) Kiosk / PRR Temperature
- e) LT system
- i) Voltage R-Y, Y-B, B-R of Main Switch Board section
- ii) Voltage R-Y, Y-B, B-R of Diesel Generator
- iii) Current from LT transformer
- iv) Current from Diesel Generator
- v) Voltage of 220V DCDB
- vi) Current from 220V Battery set
- vii) Current from 220V Battery charger
- viii) Voltage of 48V DCDB
- ix) Current from 48V Battery set
- x) Current from 48V Battery charger

Digital Inputs

The list of input for various bays/SYSTEM is as follows: all parameters shall be individual and separately display and do not mix 2 to 3 parameters in one item.

I. Line Bays

- 1) Status of each pole of CB,
- 2) Status of Isolator, Earth switch
- 3) CB troubles individually
- 4) CB operation/closing lockout
- 5) Pole discrepancy operated
- 6) Trip coils faulty (Individually)
- 7) LBB Bay wise operated
- 8) Bus bar protection trip relay operated (bay wise)
- 9) Auto Re-closer operated (Breaker / Bay Wise)
- 10) A/R lockout (Breaker / Bay wise)
- 11) Direct trip-I and II sent (individually)
- 12) Direct trip-I & II received (individually)
- 13) Main I& II blocking (individually)
- 14) Main I/II-Inter trip send (individually)
- 15) Main I/II-Inter trip received (individually)
- 16) O/V STAGE – I operated
- 17) O/V STAGE – II operated
- 18) FAULT LOCATOR FAULTY
- 19) MAIN-I/II CVT FUSE FAIL
- 20) 21L1 MAIN-I PROTN TRIP
- 21) 21L2 MAIN-II PROTN TRIP
- 22) 67N Main-I & Main-2 Operated (Individually)
- 23) 21M1 MAIN-I PSB ALARM
- 24) 21M1 MAIN-I SOTF TRIP
- 25) 21M1 MAIN-I R-PH TRIP
- 26) 21M1 MAIN-I Y-PH TRIP

- 27) 21M1 MAIN-I B-PH TRIP
- 28) 21M1 MAIN-I START
- 29) 21 MAIN-I/II Carrier aided trip
- 30) 21 MAIN-I/II fault in reverse direction
- 31) 21 MAIN-I/II ZONE-2 TRIP
- 32) 21 MAIN-I/II ZONE-3 TRIP
- 33) 21 MAIN-I/II weak end in feed operated
- 34) 21M2 MAIN-II PSB alarm
- 35) 21M2 MAIN-II SOTF TRIP
- 36) 21M2 MAIN-II R-PH TRIP
- 37) 21M2 MAIN-II Y-PH TRIP
- 38) 21M2 MAIN-II B-PH TRIP
- 39) 21M2 MAIN-II start
- 40) 21M2 MAIN-II aided trip
- 41) 21 MAIN-I/II fault in reverse direction
- 42) 67 Back-up O/C operated
- 43) 67 Back-up E/F operated
- 44) 220V DC-I/II source fail
- 45) SPEECH CHANNEL FAIL
- 46) PLCC Protection Channel - I FAIL
- 47) PLCC Protection Channel-II FAIL
- 48) High Speed / Master Trip Relays Gr - A & Gr - B Operated
- 49) Single Phase Trip Relays Operated
- 50) Any other required

II. Transformer bays

- 1) Status of each pole of CB, Isolator, Earth switch
- 2) CB troubles
- 3) CB operation/closing lockout
- 4) Pole discrepancy operated
- 5) Trip coil-1/2 faulty
- 6) LBB operated
- 7) Bus bar Protection trip relay operated
- 8) 87T1 Differential Relay operated
- 9) 87T2 Differential Relay OPTD
- 10) 99HV OVERFLUX ALARM (HV)
- 11) 99HV OVERFLUX TRIP (HV)
- 12) 99LV OVERFLUX ALARM (LV)
- 13) 99LV OVERFLUX TRIP (LV)
- 14) OTI ALARM/TRIP
- 15) WTI HV / LV Alarm / trip
- 16) PRD OPTD
- 17) BUCHOLZ TRIP
- 18) BUCHOLZ ALARM

- 19) OLTC BUCHOLZ / OSR ALARM
- 20) OLTC/ OSR BUCHOLZ TRIP
- 21) OIL LOW / MOG ALARM
- 22) 67PHV back-up O/C (HV) operated
- 23) 220V DC-I/II source fail
- 24) TAP MISMATCH
- 25) 86 GR-A PROTN OPTD HV /LV
- 26) 86 GR-B PROTN OPTD HV/ LV
- 27) 67PLV back-up O/C (LV) operated
- 28) 67NLV back-up E/F (LV) operated
- 29) All Latch Relays Operation
- 30) HV Bus Voltage selection
- 31) All Protective Relays operation
- 32) All inter trip relay Operation, Cooling System Operation
- 33) Any Other required

III. Bus bar Protection

1. Bus bar Main-I trip
2. Bus bar Main-II trip
3. Bus bar zone-I CT open
4. Bus bar zone-II CT open
5. Bus Transfer CT sup. operated
6. Bus Transfer bus bar protection operated
7. Bus protection relay fail

IV. Auxiliary system

- 1) Incomer On/Off
- 2) 415V Bus U/V
- 3) DG set Breaker on/off
- 4) Alarm/trip *signals as listed in Section: DG set*
- 5) LT Transformer-I Buchholz Alarm & trip
- 6) LT Transformer-II Buchholz Alarm & trip
- 7) LT Transformer-I WTI Alarm & trip
- 8) LT Transformer-II WTI Alarm & trip
- 9) LT Transformer-I OTI Alarm & trip
- 10) LT Transformer-II OTI Alarm & trip
- 11) PLCC exchange fail
- 12) Time sync. Signal absent
- 13) Alarm/trip signals as listed in Section: *Battery and Battery charger*
- 14) 220v DC-I earth fault
- 15) 220v DC-II earth fault
- 16) Alarm/trip signals as listed in Section: *Fire protection system*
- 17) Alarm signals of *Fire & Smoke detector System*

V. KIOSK system

- 1) AC Compressor 1 On/Off

- 2) AC Compressor 2 On/Off
- 3) Fire Detection 1 On/Off
- 4) Fire Detection 2 On/Off
- 5) Kiosk/PRR Temperature High

The exact number and description of digital inputs shall be as per detailed engineering requirement Apart from the above mentioned digital inputs, minimum of 200 inputs shall be kept for APTRANSCO use in future.

Annexure: IEC 60870-5-101 and 60870-5-104 PROTOCOL for APTRANSCO ALDC / SLDC

1. Tele-metered Data and ASDU mapping

The following table explains the type of the tele metered data and corresponding ASDUs used to transmit this data as per IEC 60870-5-101 protocol.

Type of Power System Data	Data Unit Type as per IEC	Description as per IEC	Data Polling Method	Interrogation group	Transmitted after Class X request	Info object address range
Analog Inputs (P,Q,V,F)	ASDU - 9	Measured Value Float Value	By Periodic Group Scan	Group-2	Class-2	This will finalized during Detailed Engg.
Digital Inputs – Single status (circuit Breakers, Isolators, Protection Signals)	ASDU - 1	Single Point Information	By exception (spontaneous) and on periodic Group Scan	Group-1	Class 1 after exception, class 2 after Group 1 Scan	
	ASDU – 2 (for SOE)	Single Point Information with Time tag	By exception (spontaneous)		Class 1 after exception,	
Pulse Accumulators	ASDU - 15	Integrated Totals	By periodic counter interrogation	Group 1 (Counter Interrogation)	Class 2	
Analog Outputs (Set Point)	ASDU - 48	Set Point command Normalized Value				
Digital Control Command (CB Trip / Close)	ASDU - 45	Single command				

2. DATA POLLING METHOD

1. The RTU shall respond to the Master stations request for the at least the following commands as per the protocol:
 - Status of Link
 - Reset of Link
 - Delay acquisition command *
 - Clock synchronization command *
 - General interrogation command
 - Interrogation of Scan group 1 command (all status data)
 - Interrogation of Scan group 2 command (all analog data)
 - Class 1/2 data pollingIf supervisory control commands are envisaged, then SBO procedure is to be used.
2. Normal data polling is by Scan groups
3. All digital inputs are assigned to Scan group-1 and all Analog values are assigned to Scan group-2
4. Analog values are acquired periodically by using the Scan group-2 polling. This periodicity is ranging from 10-15 seconds based on the quantity of analogs and the communication channel bandwidth.
5. Digital input state changes are reported spontaneously by RTU as class 1 data and an integrity scan is performed for all the digital inputs using Scan group-1 at every 10 minutes interval.
6. Double bit digital status data are to be sent as two single-point information from the RTU.

** These features may not be required*

List of IO Points to be transmitted to ALDC/SLDC

- | | |
|-----------|--|
| A. | MW and MVAR for all Lines, Transformers, Reactors and Capacitors. |
| B. | Voltage of all buses |
| C. | Frequency of all 400Kv and 220kV Buses |
| D. | Frequency of one 132Kv Bus |
| E. | All Breakers |
| F. | All isolators |
| G. | Tap Position for all Transformers |
| H. | Master Protection Relay signal for all Feeders, Transformers Units, Reactors and |
| Bus Bar | |
| I. | Loss of Voltage signal for Bus bar |
| J. | All the points identified in point (e),(h) and (i) above as GPS Time stamped. |

- K.** Temperature value per substation.
- L.** Any other point decided during detailed engineering

Further provision shall be made in the system to work for as per IEC 60870-5-104 protocol.

BILL OF MATERIALS

SUBSTATION AUTOMATION SYSTEM for each Substation

1.	Station HMI Computers: Industrial grade desktop PC 1TB Hard disk, 4 GB RAM expandable up to 8 GB with i7 or i5 processor, Keyboard and Mouse with software. HP/HCL/equivalent. (1 No. for Station HMI, 1 No. for Redundant HMI)	2 Nos.
2.	DR/ER Work Station: Industrial grade desktop PC 1TB Hard disk, 4 GB RAM expandable up to 8 GB with i7 or i5 processor, Keyboard and Mouse with software. HP/HCL/equivalent.	1 No.
3.	24" VDU (TFT) Monitors.	3 Nos.
4.	A4 Color Laser Printer with furniture. Resolution in Dpi: Color 600X600, Speed PPM: 8 B/W & color, USB Port. HPCP1515N/equivalent.	1 No.
5.	132 Column Dot Matrix Printer: USB Port with furniture. 24 Pin MSP455 XL/equivalent.	1 No.
6.	GPS Clock, antenna and associated equipment for time synchronization.*	1 No.
7.	Data concentrator for Energy Meters interface. *	1 No.
8.	Gateway consists of chassis, mother board, power supply, processor with communication ports (3 Nos. ports each): (a) IEC 870-5-101 and (b) IEC 870-5-104. *	1 No.
9.	Installation, cabling & 2 KVA Invertors as per Appendix-II. *	2 Nos.
10.	Armoured 6 core Fiber Optic cables in double length along with accessories. *	As required
11.	Dual Power and of managed type Industrial grade Ethernet switches & Accessories. *	As required

* Reputed make.

Note: - 1) The furniture required for the above is appended.

2) Inverter specification is appended.

QUALITY ASSURANCE PLAN

The bidder shall invariably furnish the following information along with his offer failing which the offer shall be liable for rejection. Information shall be separately given for individual type of material offered.

- (i) The structure of organization.
- (ii) The duties and responsibilities assigned to staff ensuring quality of work.
- (iii) The system of purchasing, taking delivery and verification of material.
- (iv) The system for ensuring quality of workmanship.
- (v) The quality assurance arrangements shall conform to the relevant requirement of ISO-9000, 9002 or 9003 as applicable.
- (vi) Statement giving list of important raw materials, names of sub-supplies for the raw materials, list of standards according to which the raw material are tested, list of tests normally carried out on raw material in the presence of contractors representative, copies of test certificates.
- (vii) Information and copies of test certificates in respect of bought out items.
- (viii) List of manufacturing facilities available.
- (ix) Level of automation achieved and lists of areas where manual processing exists.
- (x) List of areas in manufacturing process, where stage inspections are normally carried out for quality control and details of such tests and inspections.
- (xi) List of testing equipment available with the bidder for final testing of material specified and test plant limitation, if any vis-à-vis the type. Special acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in a Schedule of Deviations from the specified test requirements.

The Contractor shall within 15 days of placement of order submit the following information to the Purchaser.

- (i) List of the raw material as well as bought out accessories and the names of sub-suppliers selected from those furnished along with the offer.
- (ii) Type test certificates of the raw material and bought out accessories if required by the Purchaser/Engineer.
- (iii) Quality Assurance Plan (QAP) with hold points for purchasers inspection. QAP and purchasers hold points shall be discussed between the purchaser and contractor before the QAP is finalized.

The Contractor shall submit the routine test certificates of bought out accessories and central excise passes for raw material at the time of routine testing if required by the Purchaser and ensure that the quality assurance requirements of specification are followed by the sub-contractor.

The Quality Assurance Programme shall give a description of the Quality System and Quality Plans with the following details.

(i) Quality System:

- The structure of the organization.
- The duties and responsibilities assigned to staff ensuring quality of work.
- The system of purchasing, taking delivery & verification of materials.
- The system of ensuring of quality workmanship.

- The system of control of documentation.
- The system of retention of records.
- The arrangement of contractor internal auditing.
- A list of administrative and work procedures required to achieve contractors quality requirements. These procedures shall be made readily available to the Purchaser for inspection on request.

(ii) Quality Plans:

- An outline of the proposed work and programme sequence.
- The structure of contractors' organizations for the contract.
- The duties and responsibilities ensuring quality of work.
- Hold and notification points.
- Submission of engineering documents required by this specification.
- The inspection of the materials and components on request.
- Reference to contractors' work procedures appropriate to each activity.
- Inspection during fabrication/construction.
- Final inspection and test.

APPENDIX-I

Supply of furniture includes Transport to site for each Sub station.

All furniture should be of Godrej make only.

Sl.No.	Description	Unit	Qty.
1	Necessary furniture to house Industrial grade desktop with 25" (TFT) Monitor for Station HMI & Redundant HMI.	Nos.	2
2	Necessary furniture to house Industrial grade desktop with 25" (TFT) Monitor for station Engg. W/S (DR work station).	Nos.	1
3	Necessary furniture to housing 132 Column Dot Matrix Printer.	Nos.	1
4	Necessary furniture to housing A4 Laser color printer.	Nos.	1
5	Suitable revolving computer compatible chairs for the operators & system Engineers.	Nos.	3
6	Adequate Storage rack with locking facility for storing Drawings and O&M Manuals.	Nos.	2

APPENDIX-II

GENERAL TECHNICAL SPECIFICATIONS OF INVERTER

STAND ALONE UNIT	
Make	Reputed make.
Type of inverter	On Line μ P controlled IGBT based Static inverter
Rating @ 50 °c	2 KVA @ 0.8PF
Type of power switching	Pulse width modulation
No. of inverters	2
Input Voltage	220V DC \pm 10%
Output voltage	230V AC \pm 1%
Voltage adjustment range	+/- 5%
Accuracy (Steady State)	+/- 1%
Transient voltage regulation for	
Nominal frequency	50 Hz
Frequency regulation	0.01 Hz
i) Free running	
Total harmonic distortion	Less than 2.5% for linear load & Less than 5% for non-linear load
Single harmonic	Less than 2%
Overload capability	
125% of full load	10 Mins.
150% of full load	60 Secs.
Power factor range	Rated 0.8(0.6 to Unity, within KVA & KW)
Branch fuse clearing capability	30% rated (HRC) type fuse) 10% rated (Slow Blow type fuse)
Operating Temperature	50 °c
Relative Humidity for Operation	< 95% - non condensing
Acoustic noise	< 60 dB above ambient noise
Protection class	IP – 41
Method of cooling	Forced air cooling
Exterior color	RAL7032

Annexure

Project: APTRANSCO PROJECT

Sl. No.	Product Description	Unit	Qty	
1	<p>Pyrotech make Control desk for made in Welded Construction system, duly powder coated & gasketed with all necessary fixed hardware.</p> <p>Specifications-</p> <p>1) Overall Dim:- 650+100+15(H) X 650*3(W) X 1100(D) mm</p> <p>2) Construction detail – Welded (03 SECTION'S+ 02 PRINTER'S)</p> <p>3) Material-</p> <p>a) Side sheet – 1.6mm thk.CRCA</p> <p>b) Desktop –1.6mm thk. CRCA</p> <p>c) Front Door – 1.6mm thk. CRCA</p> <p>d) Rear Door – 1.6mm thk.CRCA</p> <p>e) Base frame – 3mm thk.CRCA</p> <p>f) C.G. Plate – 3mm thk. RCA</p> <p>4) Cable Entry – Bottom</p> <p>5) Lock – Single point IP Lock</p> <p>6) Gasket – PU Foam</p> <p>7) Antivibration Pad – 15mm thk.</p> <p>8) Finishing- Powder Coating- Min thk. 60Micron</p> <p>a) External - RAL -7035, Soft Grey (Structure finish)</p> <p>b) Internal – RAL -7035, Soft Grey (Structure finish)</p> <p>c) Base frame – RAL7022</p> <p>d) Keyboard Drawer – Dark Grey</p> <p>9) Access- Front & Rear</p> <p>10) Electrical items –As per Annexure-1 only</p> <p>11) Other detail as per our GA drawing,drawing no.033739 rev 01 (03 Sheet).</p> <p>12) Any change in Bill of material, specification & drawing will effect price accordingly.</p>	Set	1	
2	<p>Pyrotech make Storage Cabinet made in welded construction system, duly powder coated & gasketed with all necessary hardwares & channels.</p> <p>Dim: 1500+50(H) X 1000(W) X 350(D)mm</p> <p>Construction Features:</p> <p>1) side sheet will be made of 2mm thk. CRCA sheet.</p> <p>2) Front door will be made of 2mm thk. CRCA sheet.</p> <p>3) Base frame & C.G. Plate will be made of 3mm thk. CRCA sheet.</p> <p>4) Trays will be made of 2mm thk. CRCA sheet.</p> <p>5) Rear sheet will be made of 2mm thk. CRCA sheet.</p> <p>6)Top sheet will be made of 2mm thk. CRCA sheet.</p> <p>7) Powder coating- Min 60 micron</p> <p>External & Internal :-RAL7035 Soft grey (Structure finish)</p> <p>Base frame- Black</p> <p>8) All hardwares will be MS Zn plated & yellow pass.</p> <p>We have not considered any electrical items in our scope of supply.</p> <p>Other details as per our drawing no. 033736 Rev00 (01 sheet)</p>	No.	2	
3	<p>OPERATOR CHAIR: -</p> <p>Specifications-</p> <p>a) Model No.- IFS-7010 With met. base</p> <p>b) Fabric colour - Blue</p> <p>c) Pedestal: - 5MM THK MS</p> <p>d) Plate Covered with poly -Propylene</p> <p>e) Cladding, PU ARM REST</p> <p>f) Glass Filled</p> <p>g) Nylon twin wheel</p>	No.	3	

BILL OF MATERIAL

CONTROL DESK - Annexure-1

S.NO.	Item Description	Make	Unit	Qty.
1	MCB DP 10A	Siemens	No.	5
2	Spike Booster 4 Way	Reputed	No.	5
3	Door Switch 2A	Reputed	No.	5
4	CFL 11W, 230V AC	Philips	No.	5
5	Exhaust Fan 4" , 230V AC	Rexnord	No.	5
6	Toggle switch	Reputed	No.	5
7	Cu Bus Bar 25x3	Reputed	No.	5
8	Power Socket 5/15A	Anchor	No.	5
9	Terminal 2.5sq with wiring material	Phoneix	No.	A/R

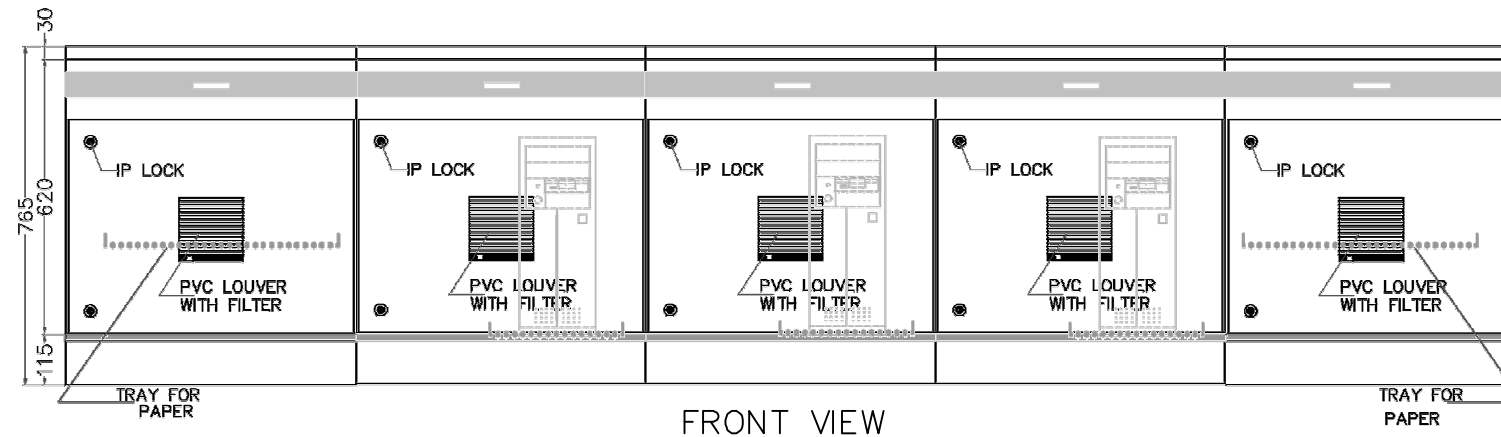
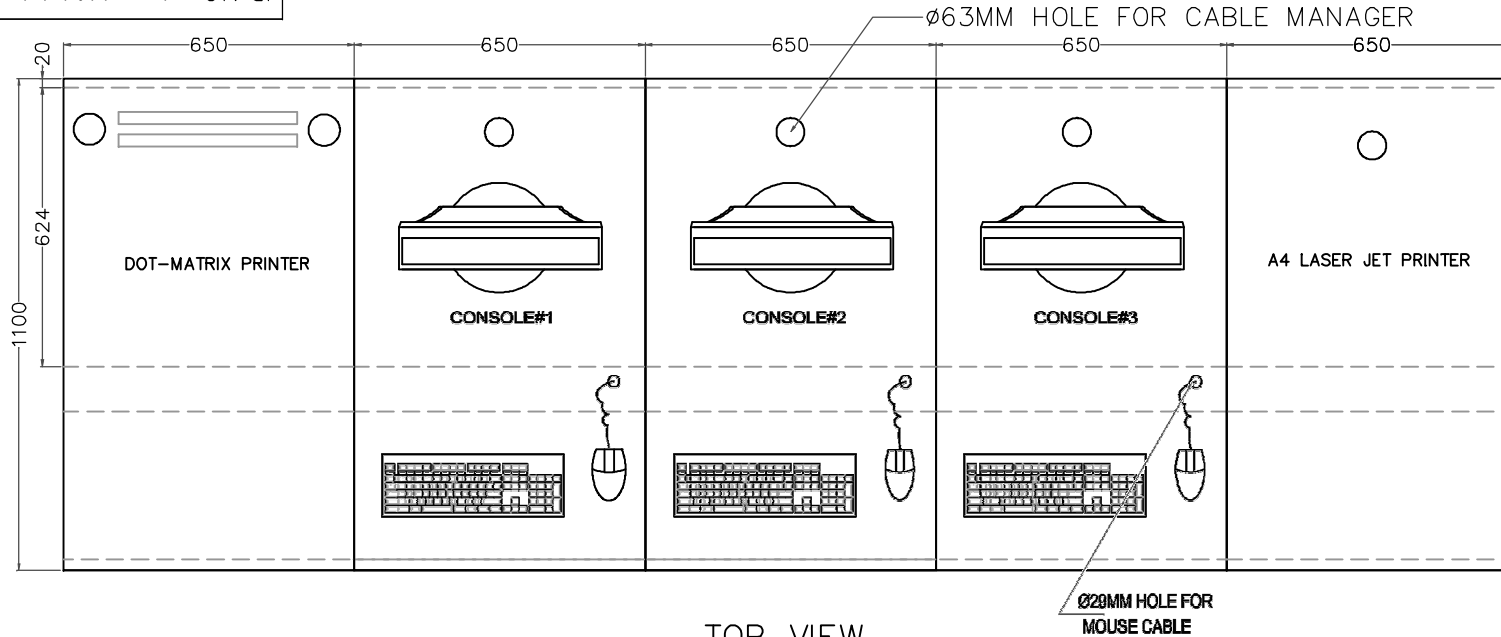
THIS DRAWING AND DESIGN IS THE PROPERTY OF PYROTECH
ELECTRONICS PVT.LTD.UNIT#2, UDAIPUR 313 003 AND MUST NOT
BE COPIED OR LENT WITHOUT THEIR PERMISSION IN WRITING



PATH:IT/OFFER/OFFER 2011/SIEMENS
FILE NAME: M21510

NOTE: ALL DIMENSIONS ARE INmm
OVERALL TOLERANCE ± 2 mm

ID.NO. 05 4 033735 3 M21510



CONSULTANT: -----					PROJECT: -----					END USER: -----				
REV	DRN.BY:	CHD.BY:	DATE:	APP.BY:	REMARKS	DRN.BY:	HEMENDRA	PO No.	PROJECTION	PYROTECH ELECTRONICS PVT.LTD. UNIT#2, UDAIPUR 313003				
01	AJAY		17.10.11		AS PER CUSTOMER COMMENTS	CHD.BY:		PROJ.No: M21510		DRAWING No. 033735 01				
						APP.BY:		DEPT: DESIGN		TITLE: - G.A. DRAWING OF CONTROL DESK FOR CCR				
						DATE:	06.09.11	SCALE: NTS		CUSTOMER: - SIEMENS LTD.				

8

7

6

5

4

3

2

1

A

NOTE: ALL DIMENSIONS ARE IN mm
OVERALL TOLERANCE ± 2 mm

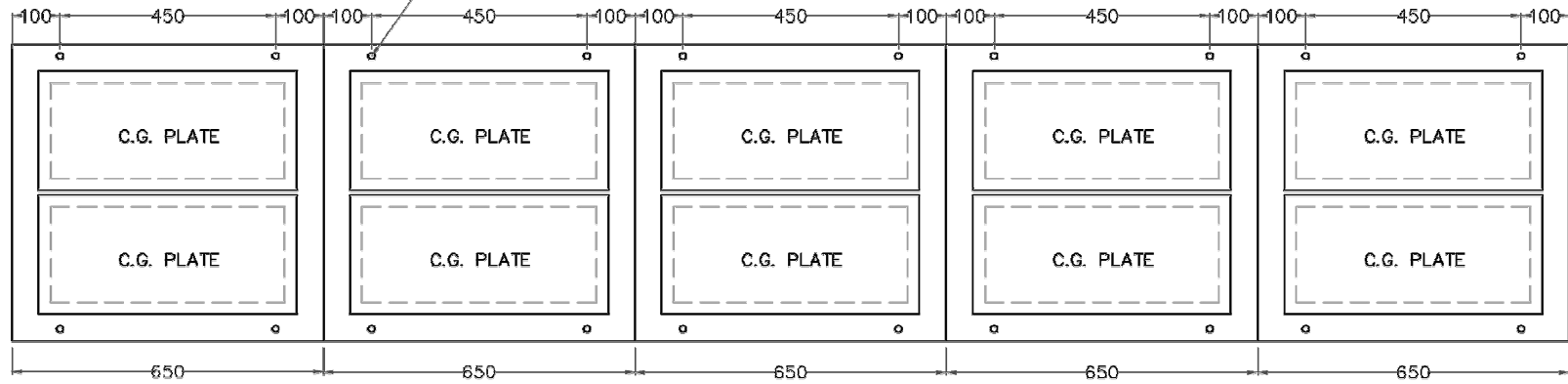
PATH: IT/OFFER/OFFER 2011/SIEMENS
FILE NAME: M21510

THIS DRAWING AND DESIGN IS THE PROPERTY OF PYROTECH
ELECTRONICS PVT.LTD. UNIT#2, UDAIPUR 313 003 AND MUST NOT
BE COPIED OR LENT WITHOUT THEIR PERMISSION IN WRITING

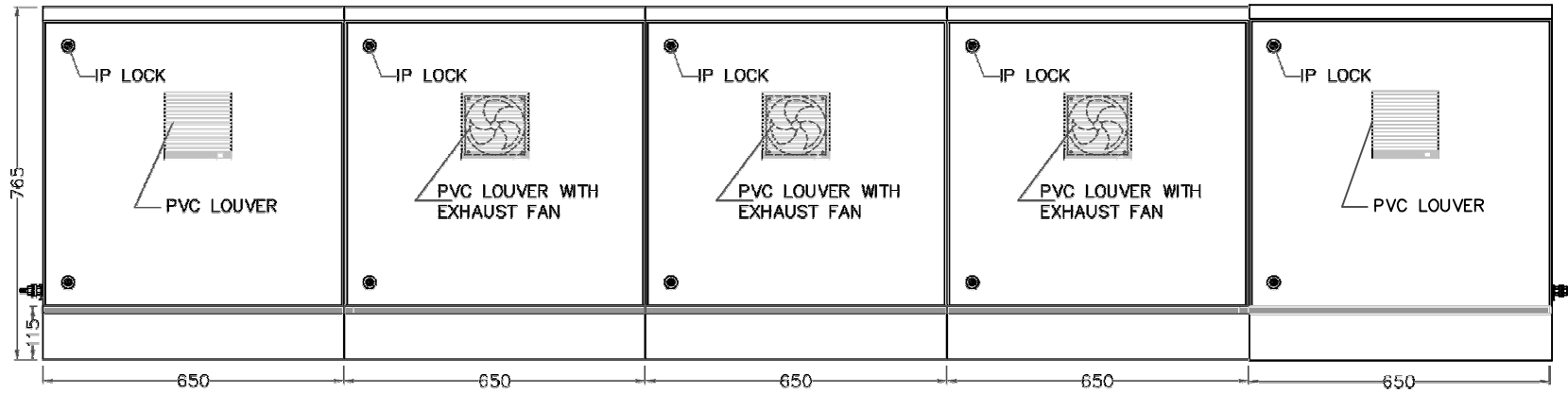


ID. NO. 05 4 033735 3 M21510

Ø14mm HOLE FOR GROUTING



BASE FRAME



REAR VIEW

CONSULTANT: -----					PROJECT: -----					END USER: -----				
REV	DRN.BY:	CHD.BY:	DATE:	APP.BY:	REMARKS	DRN.BY:	HEMENDRA	PO No.	PROJECTION	PYROTECH ELECTRONICS PVT.LTD. UNIT#2, UDAIPUR 313003				DRAWING No.
01	AJAY		17.10.11		AS PER CUSTOMER COMMENTS	CHD.BY:		PROJ.No: M21510		TITLE: - G.A. DRAWING OF CONTROL DESK FOR CCR				033735
						APP.BY:		DEPT: DESIGN		-				01
						DATE:	06.09.11	SCALE: NTS		CUSTOMER: - SIEMENS LTD.				REV.

8

7

6

5

4

3

2

1

THIS DRAWING AND DESIGN IS THE PROPERTY OF PYROTECH
ELECTRONICS PVT.LTD. UNIT#2, UDAIPUR 313 003 AND MUST NOT
BE COPIED OR LENT WITHOUT THEIR PERMISSION IN WRITING



PATH: IT/OFFER/OFFER 2011/SIEMENS
FILE NAME: M21510

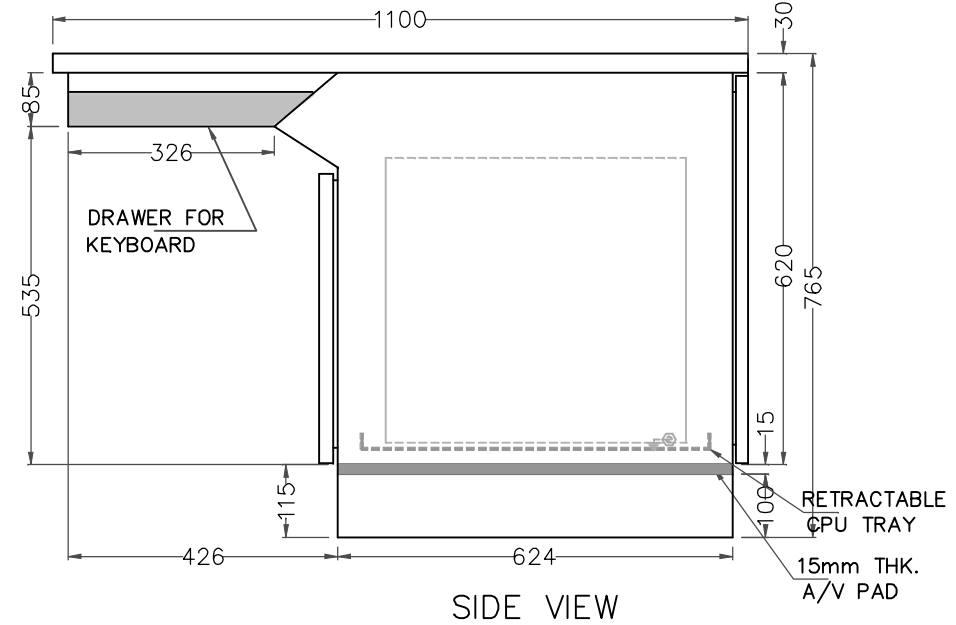
NOTE: ALL DIMENSIONS ARE IN mm
OVERALL TOLERANCE ± 2 mm

8 7 6 5 4 3 2 1

ID.NO. 05 4 033735 3 M21510

NOTES:

1. DESK MADE OF WELDED CONSTRUCTION SYSTEM.
2. ALL SHEETS WILL BE MADE OF 1.6mm THK. CRCA SHEET.
3. DESK TOP SHEET WILL BE MADE OF 1.6mm THICK CRCA.
5. C.G. PLATE & BASE FRAME WILL BE MADE OF 3mm THICK CRCA.
6. POWDER COATING: —
EXTERNAL :— RAL-7035, SOFT GREY (STRUCTURE FINISH)
INTERNAL :— RAL-7035, SOFT GREY (STRUCTURE FINISH)
BASE FRAME: BLACK
7. QTY:— 01 SET (03 SECTION+02 PRINTERS)



CONSULTANT: -----

PROJECT: -----

END USER: -----

REV	DRN.BY:	CHD.BY:	DATE:	APP.BY:	REMARKS	DRN.BY:	HEMENDRA	PO No.	PROJECTION	PYROTECH ELECTRONICS PVT.LTD. UNIT#2, UDAIPUR 313003	DRAWING No.	01
01	AJAY		17.10.11		AS PER CUSTOMER COMMENTS	CHD.BY:		PROJ.No: M21510		TITLE: — G.A. DRAWING OF CONTROL DESK FOR CCR	033735	
						APP.BY:		DEPT: DESIGN		CUSTOMER: — SIEMENS LTD.	SHEET 3 OF 3	REV.
						DATE:	06.09.11	SCALE: NTS				

8 7 6 5 4 3 2 1

NOTE: ALL DIMENSIONS ARE INmm
OVERALL TOLERANCE $\pm 2\text{mm}$

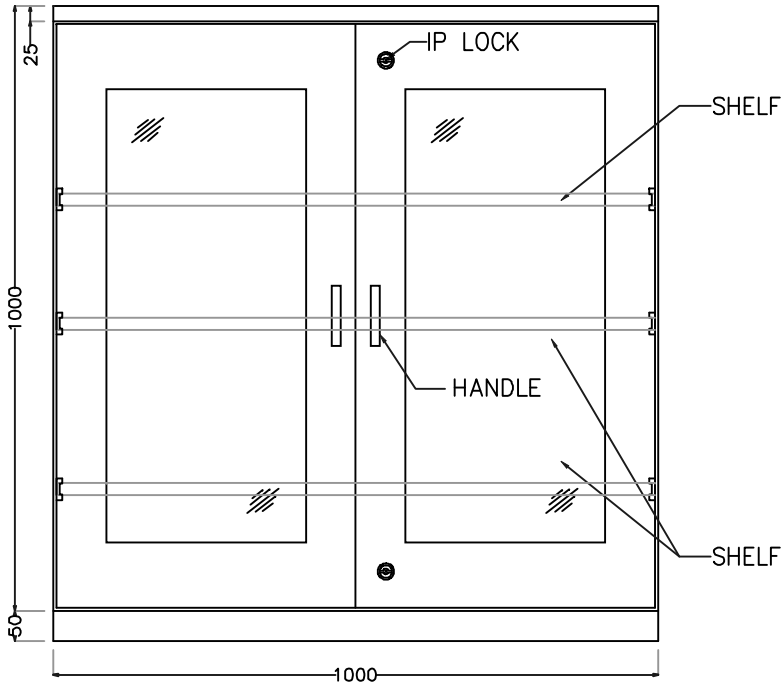
PATH:IT/OFFER/OFFER 2011/SIEMENS
FILE NAME: M21510

THIS DRAWING AND DESIGN IS THE PROPERTY OF PYROTECH
ELECTRONICS PVT.LTD.UNIT#2, UDAIPUR, 313 003 AND MUST NOT
BE COPIED OR LENT WITHOUT THEIR PERMISSION IN WRITING



8 7 6 5 4 3

ID.NO. 05 4 033736 1 M21510



FRONT VIEW

- NOTES: –
1. STORAGE CABINET WILL BE MADE OF WELDED CONSTRUCTION SYSTEM.
 2. ALL SHEETS WILL BE MADE OF 2MM THK. CRCA SHEET.
 3. CABINET TOP WILL BE MADE OF 2MM THK. CRCA SHEET.
 4. POWEDER COATING :– MIN. THICKNESS 60–80 MICRONS.
EXTERNAL & INTERNAL :– RAL–7035, SOFT GREY.
 5. QTY. :– 02 No.

CONSULTANT: –-----					PROJECT: –-----				END USER: –-----	
REV	DRN.BY:	CHD.BY:	DATE:	APP.BY:	REMARKS	DRN.BY:	HEMENDRA	PO No.	PROJECTION	PYROTECH ELECTRONICS PV
						CHD.BY:		PROJ.No: M21510		TITLE: – G.A. DRAWING OF STORA
						APP.BY:		DEPT: DESIGN		–
						DATE:	06.09.11	SCALE: NTS		CUSTOMER: – SIEMENS LTD.

8 7 6 5 4 3