

KARNATAKA POWER TRANSMISSION CORPORATION LIMITED

SECTION – Relay & Protection Panel

TECHNICAL SPECIFICATION

RELAY & PROTECTION PANELS WITH SUB-STATION AUTOMATION SYSTEM AND IEC 61850 BASED ANNUNCIATOR SYSTEM FOR 400/220KV SUB-STATIONS

SECTION-1

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SECTION – RELAY & PROTECTION PANEL

1.00 SCOPE:

- 1.01 This Technical specification covers design, manufacture, inspection, testing at works and supply, erection, testing & commissioning of relay and protection panels, with sub-station automation system AND IEC 61850 BASED ANNUNCIATOR SYSTEM for 400/220 KV Sub-Stations of KPTCL grid.
- 1.02 The interface requirement between protection relay panel/equipments and substation automation system is the complete responsibility of the bidder. The vendor should arrange all necessary testing instruments required for testing & commissioning of Protection & Substation Automation System.
- 1.03 A dedicated vendor's representative shall be available at site from the date of erection till the complete course of commissioning and handover.
- 1.04 Vendor shall estimate lump sum cost of complete job based on tender purpose specifications & drawings. Tender specification and drawings will be submitted as reference purpose only and vendor shall prepare control & relay panel scheme drawings as per specification. The Bill of Material mentioned is of minimum requirement and bidder to review the specification and shall include all necessary relays/timers/MCB etc. for satisfactory operation of Protection & Substation Automation System.
- 1.05 Bidder to propose the essential spares tools & tackles along with bid for satisfactory Operation & Maintenance of protection system and SAS.
- 1.06 Supply of license of the SAS, necessary relay software & communication cables etc required for the project is in the scope of bidder. (Like Relay, BCU, Fault disturbance recorder configuration, programming, parameterization tool and other software as required).

- 1.07 The equipment should conform in all respects to the relating standards and shall be manufactured to the highest quality of Engineering, design and workmanship. The equipment manufactured shall ensure satisfactory and reliable performance throughout the service life.
- 1.08 The equipments offered shall be complete in all respects. Any material / component / accessories/software not specifically stated in this specification but which is otherwise necessary for trouble free operation of the equipment specified in this specification shall be deemed to be included unless excluded expressly in writing by owner. All such components/ accessories / software shall be supplied and no extra cost shall be payable.
- 1.09 The design and manufacturing shall be such that the equipment / components/ accessories/software of the same type and of identical rating shall be interchangeable. Likewise similar or corresponding parts/ components or accessories thereof shall also be interchangeable.
- 1.10 Wherever and whenever a material or article or component is specified or described by the name of a particular brand or manufacturer or vendor, the specific item mentioned shall be understood as establishing type, function and quality and not as limiting competition. However, tenderers are invited to offer other similar equipments/components/accessories provided they meet with the required standards, design, duties and performance.
- 1.11 All equipments offered shall confirm to type tests and shall also be subjected to acceptance and routine tests in accordance with the requirements stipulated herein. The purchaser reserves the right for conducting any or all of the type tests in accordance with the relevant standards. Such type tests shall be done free of cost. Where type tests have already been conducted the tenderer shall submit copies of the same along with tender. The type tests certificates should however be not older than TEN (10) years as on the **last date of submission of bid**.

a) For equipments manufactured in India:

- i). The type tests on indigenous equipment for which testing facility is available in India, should have been conducted in any independent laboratories approved by the Government or the laboratories accredited by the National accreditation body of the country like Central Power Research Institute (CPRI), Electrical Research and Development Association (ERDA), etc.
- ii). The type tests on indigenous equipment, for which testing facility is not available in India, should have been conducted in a laboratory of foreign country accredited by National accreditation body of that country.
- iii). The type tests conducted in-house by a manufacturer shall also be acceptable provided the laboratory is accredited by National accreditation body of the country and the tests has been conducted in the presence of a representative of NABL accredited laboratory or any of the purchasing utilities or CEA in that order. Such type test reports shall record the details

of such witness including the signature/authentication in the type test report.

b) For equipments manufactured Abroad:

- i). Type tests on imported equipment should have been conducted in an Indian Laboratory or foreign laboratory accredited by National accreditation body of the country where the Type test has been conducted.
- ii). The type tests conducted in-house by a manufacturer shall also be acceptable provided the laboratory is accredited by National accreditation body of the country and the tests has been conducted in the presence of a representative of accredited laboratory or any of the purchasing utilities or CEA in that order. Such type test reports shall record the details of such witness including the signature/authentication in the type test report.

In case of in-house type tested imported equipment of foreign OEM, the term “Purchasing Utility” covers the foreign Utility who has purchased that equipment.

2.00 BRIEF DESCRIPTION OF PROJECT:

2.01 The details of the project are as per Annexure enclosed.

2.02 The protection to be provided for various lines, Transformers etc., shall be as Follows:

- i. Main protection i.e. distance scheme and differential scheme shall be of fast acting numerical type.
- ii. Back up protection shall be of numerical type.

2.03 The supply of panels shall conform to the approved drawings.

3.00 STANDARDS:

Unless specified otherwise, equipment covered by this specification shall conform to the Indian Electricity Rules and to the latest editions of relevant Indian Standards, British or American IEC or other equivalent standard as well as latest CEA regulations & guidelines. In the event of supplies conforming to other equivalent international standards, the salient features of comparison shall be brought out in the tender. One copy of such standard specification in English language shall be enclosed with the tender. A general reference list of standards is furnished as follows:

| Sl. No. | Particulars | IS | BS | IEC |
|---------|-------------|----|----|-----|
|---------|-------------|----|----|-----|

| | | | | |
|----|---|-----------------------------|-------|-------|
| 1 | Application guide for electrical relays for protection and other relays | 3842 | 142 | 50 |
| 2 | Electrical relays for power system | 3231 | ---- | 50255 |
| 3 | Current transformers | 2705 | ---- | ---- |
| 4 | Voltage transformers | 3156 | ---- | ---- |
| 5 | Push buttons and control switches (LV switching devices for control and auxiliary circuits) | 6875 | ---- | ---- |
| 6 | AC electricity meter | 722 | ---- | ---- |
| 7 | Static protective relay | 8686 | ---- | ---- |
| 8 | Indicating instruments & recorders | ---- | 89/90 | ---- |
| 9 | Fuses | 2203 | 88 | 66 |
| 10 | AC static watt hour meter for active energy | ---- | --- | 686 |
| 11 | Colours for ready mixed paints and enamels | 5 | ---- | --- |
| 12 | Ready mixed paints, brushing, finishing exterior and semi glass for general purpose white | 127 | ---- | ---- |
| 13 | Paints, finishing interior white | 641 | ---- | ---- |
| 14 | Direct acting indicating analog electrical measuring instruments and their accessories | 1258 part: 1-5 7-9 | ---- | ---- |
| 15 | Degree of protection provided by enclosures for low voltage switch gear and control gear. | 2147 | ---- | ----- |

| Sl. No. | Particulars | IS | BS | IEC |
|---------|---|------|------|-----------------------------------|
| 16 | Performance tests for protective scheme used in protection of light gauge steel against corrosion | 4177 | ---- | ---- |
| 17 | Sub-Station Automation System | ---- | ---- | 61850 ed1 & ed2 (Site selectable) |
| 18 | Communication Protocol | ---- | ---- | 60870-5-104 |
| 19 | Numerical relays | ---- | ---- | 61000 |
| 20 | Environmental testing | ---- | ---- | 68 |
| 21 | Insulation co-ordination for equipment with low-voltage system | ---- | ---- | 664 |

4.00 CLIMATIC AND GEOGRAPHICAL CONDITIONS:

4.01

| Sl. No. | Particulars | |
|---------|--|--------------------------|
| 1. | Altitude | Not exceeding 1000 Mtrs. |
| 2. | a) Max. ambient air temperature | 50 deg.C |
| | b) Average daily ambient air temperature | 35 deg.C |
| 3. | Minimum ambient temperature | 5 deg. C |
| 4. | Relative humidity | 10-100% |
| 5. | Average annual rainfall | 1000 to 3000mm / 5000mm |
| 6. | Average period of rainfall in a year | 5 months |
| 7. | Maximum wind pressure in Kg/Sq. mt. | 150 |
| 8. | Isoceraunic level | 46 |

4.02 The climate is moderately hot, tropical climate conducive to rust and fungus growth.

4.03 The climatic conditions are given to indicate wide range of variation in ambient conditions.

4.04 All electrical devices shall be tropicalised and given fungicidal treatment. They shall also be capable of satisfactory operation under the hot and humid climatic conditions that would prevail at the site.

4.05 All the equipments, contacts, etc., shall be designed to withstand seismic acceleration equivalent 0.3 g. Air conditioning is not available in the control room.

5.00 SYSTEM DETAILS:

5.01 Following is salient particulars of the system.

| Sl. No. | Particulars | 400kV | 220kV |
|---------|-----------------------------|---------------------|---------------------|
| 1 | Nominal system voltage (KV) | 400 | 220 |
| 2 | Highest system voltage (KV) | 420 | 245 |
| 3 | No. of phases | 3 | 3 |
| 4 | Frequency (Hz) | 50 | 50 |
| 5 | Method of grounding | Effectively earthed | Effectively earthed |

5.02 The relays and meters shall be suitable for operation at 1 Amp Current Transformer secondary and 110V phase to phase and 63.5 volts phase to neutral, secondary voltage of the Voltage Transformer.

6.0 AUXILIARY SUPPLY:

6.01 The Purchaser shall make separate arrangement for providing low tension AC & DC power supply for control and auxiliary use. The tenderer shall give in his tender the estimate for AC & DC power required for the equipment covered by this specification.

6.02 The auxiliary supply voltage available is as follows:

| Sl. No. | Particulars | Details |
|---------|--|--|
| 1 | Power devices (like drive motors etc) | 415V, 3 phase, 4 wire, 50Hz AC supply with one point grounded |
| 2 | AC control and protective devices | 240V, 1 phase, 2 wire, 50 Hz AC supply with one point grounded |
| 3 | DC for alarm, control and protection devices | a) 220VDC for 400/220KV Stations. - 2 wire ungrounded DC supply from batteries and battery charger. The ripple content in the DC supply from the charger will be less than 2% |
| 4 | PLCC | 48V DC ungrounded. |

The above supply voltage may vary as follows:

| | | |
|---|-----------|--|
| 1 | AC supply | Voltage variation +10% to -30% Frequency variation $\pm 5\%$ Both variations may occur simultaneously or independently |
| 2 | DC supply | +10% to -20% |

DC distribution grouping between source-1 and source -2 DC shall be considered as follows.

| DC-1 distribution: | DC-2 distribution: |
|--|--|
| Group-A trip ckt. | Group-B trip ckt. |
| CB trip coil-1 ckt. | CB trip coil-2 ckt. |
| Main -1 relay, AR, BCU, BU BB-1 protection | Main -2, Back-up protection relay, BU BB-2 protection, |

- 6.03 Each of the foregoing supplies will be made available by purchaser at one terminal point for each equipment for operation of accessories and auxiliary equipments. In case of 110V, AC supply is required, the tenderer shall include adequately rated 415/110V control transformers for each equipment. Bidders scope of supply shall include distribution beyond the points of supply, including supply of interconnecting cables between instruments and terminal blocks.

7.0 TYPE OF PANEL:

7.01 VOID

7.02 VOID

- 7.03 Simplex Panel: Simplex Panel shall consist of vertical front panel with equipments mounted there on and wiring occurs from front of relay panels. In case of panels having width of more than 800 mm, double leaf doors shall be provided, the door shall have handles with either built in locking facility or shall be provided with pad lock. Panel shall have hinged type openable glass door in front. Relay/devices shall be visible from front glass door with front door opening. All equipments shall be mounted on a 19" rack swing door inside the front glass frame. The panel shall have padlock arrangement for locking.

8.0 CONSTRUCTIONAL FEATURES:

- 8.01 Relay Panels shall be of simplex type design as indicated. It is the responsibility of the bidder to ensure that the equipments specified and such unspecified complementary equipment required for completeness of the protective/ control schemes be properly accommodated in the panels without congestion and if necessary, provide panels with larger dimensions / Additional panels to be provided. No price increase at a later date on this account shall be allowed. However the width of the panels that are being offered to be placed in Outdoor Bay RCC-KIOSK should be in conformity with space availability in the KIOSK.
- 8.02 Panels shall be completely metal enclosed and shall be dust, moisture and vermin proof. The enclosure shall provide a degree of protection not less than IP-31 in accordance with IS : 2147.
- 8.03 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 3mm for weight bearing members of the panels such as base frame, front sheet and door frames, and 2.0mm for sides, door, top and bottom portions. There shall be sufficient reinforcement to provide level surfaces, and resistance to vibration and rigidity during transportation and installation. Anti vibration pad of 15mm thickness shall be provided. Panel base frame shall be of 100mm height

The dimensions of the panels shall be as given below:

| | |
|----------------------|---|
| <u>Height</u> | - 2312 mm including base channel height of 102mm. |
| <u>Depth</u> | - 610mm |
| <u>Width</u> | - 800/ 1000 mm. |

- 8.04 All doors, removable covers and panels shall be gasketed all around with synthetic rubber gaskets. Neoprene/EPDM generally conforming with provision of IS 11149. However, XLPE gasket can also be used for fixing protective glass doors. Ventilating louvers, if provided shall have screens and filters. The screens shall be made of either brass or GI wire mesh.
- 8.05 Design, materials selection and workmanship shall be such as to result in neat appearance, inside and outside with no welds, rivets or bolt heads appearing from outside, with all exterior surfaces true and smooth.
- 8.06 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 bidder, shall be placed between panel & base frame.
- 8.07 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.
- 8.08 Relay panels of modern modular construction would also be acceptable.
- 8.09 The purchaser reserves the right to order the panels in full or part of the quantity indicated in the annexure. However, the breakup will be station – wise.
- 8.10 The offer shall include dummy panels and filler plates wherever necessary to have continuous formation. However the purchaser reserves the right to order the dummy panels and filler plates.

9.0 MOUNTING:

- 9.01 All equipment on and in panels shall be mounted and completely wired to the terminal blocks ready for external connections. The equipments on front of panel shall be mounted flush with only their bezels projection.
- 9.02 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.

- 9.03 The centre lines of switches, push buttons and indicating lamps shall be not less than 750mm from the bottom of the panel. The center lines of relays, meters and recorders shall be not less than 450 mm from the bottom of the panel.
- 9.04 The centre lines of switches, push buttons and indicating lamps shall be matched to give a neat and uniform appearance. Likewise the top lines of all meters, relays and recorders etc., shall be matched.
- 9.05 Final arrangement of control instruments & relays shall be as per the drawing approved by the purchaser.
- 9.06 No equipment shall be mounted on the doors.
- 9.07 At existing station, panels shall be matched with other panels in the control room in respect of dimensions, colour, appearance and arrangement of equipment (center lines of switches, push buttons and other equipment) on the front of the panel.
- 9.08 All the equipment connections and cabling shall be designed and arranged to minimize the risk of fire and damage which may be caused by fire.
- 9.09 The contractor shall carry out cut out, mounting & wiring of free issue items supplied by other which are to be mounted in this panel in accordance with corresponding equipment manufacturers drawing.
If any cutouts are left blank for mounting of future equipment, it shall be properly blanked off with metal plates, and wires left shall be properly insulated or terminated to a terminal block.

10.0 PAINTING:

- 10.01 All sheet steel work shall be phosphated in accordance with the IS: 6005 "Code of practice for phosphating iron and steel".
- 10.02 Sheet steel shall be sand blasted to remove rust and scale, oil grease, dirt and swarf shall be thoroughly removed by emulsion cleaning.
- 10.03 Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.
- 10.04 After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying.
- 10.05 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.

10.06 After application of Primer, the panel exterior shall finally be painted with two coats of synthetic enamel paint, each coat applied by stoving. The colour of the finishing paint shall generally be "Siemens grey" corresponding to shade No. RAL 7032 of IS-5 for panel exterior. All cubicle interiors shall be painted brilliant white, so as to give a contrasting effect with cubicle wiring

10.07 Each coat of primer and finished paint shall be of slightly different shade to enable inspection of painting. The final finished thickness of paint film shall not be less than 60 microns and shall not be more than 100 microns.

10.08 The finished paint appearance shall be aesthetically pleasing and shall be free from scratches, dents or unevenness. A small quantity of paint shall be supplied free of cost for minor touching up, if any that may be required at site.

10.09 In case the tenderer proposes to follow any other established painting procedure like electrostatic painting, the procedure shall be submitted along with offer/bid for purchaser's review and approval.

11.00 PANEL INTERNAL WIRING:

11.01 All wiring shall be of switch board type super flexible multi-stranded **PVC (70°C) insulated 1100V grade cables & shall be of FRLS type, C2 category, conforming to IS: 1554 (Part-1) and its amendments and shall be suitable for a steady conductor temperature of 70°C**, which has proved its utility in tropical regions against hot and moist climate and vermin (mice, white ants and cockroaches, etc.) and of **FRLS** type.

11.02 The size of wiring in different circuits shall not be less than those specified below:

| Sl. No. | Circuits | Area of cross-section of conductor (minimum permissible size of wire) |
|---------|---|--|
| 1 | Metering and relaying circuits connected to CTs and PTs | 2.5 sq. mm |
| 2 | Audio visual annunciation, signaling and control circuits | 1.5 sq. mm |
| 3 | AC/DC Auxiliary control supply circuits | 1.5 sq. mm |

11.03 Following colour scheme shall be used for the wiring.

| Colour of the wire | Circuit where used | Colour of the ferrule |
|--------------------|---|-----------------------|
| Red | Red phase of instrument transformer circuits | Red |
| Yellow | Yellow phase of instrument transformer circuits | Yellow |
| Blue | Blue phase of instrument | Blue |

| | | |
|-------|---|---|
| | transformer circuits | |
| Green | Neutral connections earthed or not earthed in the instrument transformer circuits | Green |
| White | AC control wiring circuits using 415/ 240V auxiliary supply and cubicle lighting | Respective phase: Red, Yellow and blue Neutral : green |
| Grey | DC control wiring circuits | Red : Trip circuit Blue : indicating circuit Yellow: alarm circuit Green : relay, auxiliary and other interconnections |
| | Lower voltage DC supply (from DC to DC converter) | - “ - |

11.04 All cubicle wiring shall be of the grouped type and laid out in flat formation on the framework, in the interior of the panel cubicles and secured to it by means of cleats. Wiring shall be run straight and given right angle bends wherever necessary. Wiring round the hinges shall be of extra flexible conductors twisted around the axis of the wires.

Longitudinal troughs extending throughout the full length of the panel shall be preferred for inter panel wiring. Interconnection to adjacent panel shall be brought out to a separate set of terminal blocks located near the slots of holes meant for taking the interconnecting wires. All potential bus wiring, audible alarm, bus wiring, AC & DC control supply bus wiring, wiring for cubicle lighting and such other wiring which runs from cubicle to cubicle within the switchboard shall be laid down in gutters and shall be carefully screened.

Wiring connected to the space heaters in the cubicle shall have porcelain headed insulation over a safe length from the heater terminals.

Each wire shall be continuous from end to end and shall not have any joints within itself. Individual wires shall be connected only at the connection terminal or studs of the terminal blocks, meters, relays, instruments and other switch board devices.

Terminal ends of the wires shall be provided with numbered self-locking ferrules suitably coloured for phase identification. At points of intersection where a change of number is necessary, duplicate ferrule shall be provided with the appropriate numbers on the changing end.

Wire ends shall be elegantly hooked with Ross - Courtney solder less Terminals. At the terminal connection, washers shall be interposed between wire terminals

and the holding nuts. All holding nuts shall be secured with locking nuts. The connection stud shall project at least 3 mm from the lock nut surface,

Wiring shall be so connected at the terminal studs that no wire terminal number ferrule gets masked due to succeeding connections. All wire shall be suitable for bending and shall meet the terminal studs at right angles with the stud axis and they shall not be skewed.

All studs, nuts, bolts, screws etc., shall be threaded according to the IS practice unless purchaser's approval to any other practice of threading is obtained. Spare quantity of nuts, lock nuts and washers of all varieties used on the switchboard shall be supplied to the extent of 10% of the used quantities. The supplier should note that there would be no mezzanine floor for the control room building for cable spreading and the method of taking the cables directly into panel from the duct shall be clearly indicated.

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

12.0 TERMINAL BLOCKS AND TERMINAL CONNECTORS:

12.01 Terminal blocks shall be of the projecting stud type with check nuts and washers. The insulation housing of the terminal connector along with barriers shall be moulded form thermosetting resin dielectric and shall be of AC 1100V grade. The stubs shall be fully threaded and shall be of tin plated brass. The size of the stubs shall be suitable for a continuous rating of not less than 35 Amps and shall accommodate the conductor terminal with a close fit, check nuts and washers shall also be of tin plated brass. Check nuts shall be hexagonal and shall be suitable for being tightened with tubular box type spanners. The end termination facility shall be suitable for tightening with screw driver. Tin plated brass inserts shall be provided between the terminal connector studs for effective resistance free, electrical contact between the incoming and outgoing terminations.

12.02 Terminal connectors shall be preferably of bolt and nut type for being assembled on to standard mounting channels for multi-way grouping to form terminal blocks. These terminal blocks shall be mounted vertically in columns inside the panel in a pillar type formation and shall be so located that the incoming tail ends of the control cables can be terminated to these terminal blocks easily.

12.03 All terminal blocks shall be provided with removable shrouds made of transparent dielectric material rated for 1100V grade. Each shroud shall be etched or provided with a plastic marker strip to identify the circuits that are terminated.

- 12.04 Each terminal block shall be provided with at least 30% spare terminals on each panel and these spare terminals shall be uniformly distributed on all terminal blocks.
- 12.05 All studs, nuts, screws etc., shall be threaded according to IS:7684. Sufficient spare quantities of all varieties and size of bolts, studs, nuts, washers and screws used in the cubicle shall be supplied along with cubicle free of cost.
- 12.06 Where terminal blocks are arranged in different columns or rows then minimum clearance of 150 mm shall be provided between the terminal block. A minimum clearance of 250 mm shall be kept between Terminal blocks and associated cable gland plates.
- 12.07 Terminal blocks containing CT secondary leads shall be provided with test, isolating, short circuiting & earthing facilities / sliding link type and VT's secondary leads shall be provided with isolating features.
- 12.08 Arrangement of terminal block assemblies & wiring channel within the enclosure shall be such that a row of terminal blocks is run in parallel & close proximity along each side of the wiring duct to provide for convenient attachment of internal panel wiring. The side of terminal block opposite to wiring duct shall be reserved for the owner's external cable connections. All the adjacent terminal blocks shall also share the field wiring corridor. All wiring shall be provided with adequate support inside the panels to hold them firmly & to enable free & flexible termination without causing strain on terminals.

13.0 SPACE FOR CONTROL CABLES AND CABLE GLANDS:

All control and supply cable will be conducted at the bottom of the cubicles. The bottom plates of panels shall be fitted with removable gland plates (in two equal halves) and fixed with the cable glands, the size of which shall suit the owner's external cables. Cable glands shall be screened type and made of brass or nickel plated steel and shall be suitable for PVC armoured cable. Necessary drawing showing the cable entry position and foundation bolt location shall be supplied by the bidder. The required quantities of cable glands suitable for the cable sizes as described below shall be provided in each panel.

- 19 C x 2.5 Sq. mm for Power Transformer.
- 19 C x 2.5 Sq. mm for Circuit Breaker.
- 10 C x 2.5 Sq. mm for Circuit Breaker.
- 4 C x 6.0 Sq. mm for CT Circuits.
- 2 C x 6 Sq. mm for NCT Circuits.
- 4 C x 6 Sq. mm for PT Circuits and D.C.
- 19 C x 2.5 sq.mm & 10 C x 2.5 Sq. mm for Isolator.
- 2 C x 2.5 Sq. mm. for coupling capacitor.

14.0 MIMIC DIAGRAM: VOID

15.0 NAME PLATE & MARKINGS

15.01 Each unit panel shall be provided with a circuit label of size 40mm x 200mm (min) located prominently at the top on the front and rear face of the panel. Circuit labels shall be located inside the cubicle also for easy identification on both halves of the panel. These name plates and labels shall bear the name of the circuit or equipment etc., to which the panel is associated with. The letter shall have a minimum height of 20mm.

15.02 The name plate shall be 50mm width plates made of brass or black plastic and shall be etched with 3mm sized letters of the name of the associated circuit / equipment. The etched letters shall be duly filled in with white enamel paint, if the plate is of black plastic or with black enamel if the plate is of brass.

15.03 All instruments, relays and such other electrical devices and accessories mounted in the control panel shall be provided with name plate bearing the name of the manufacturer, serial number, type and technical rating data. These name plates shall be installed at the rear of the device inside the cubicle.

15.04 VOID

15.05 Each panel shall be provided with a label located at the bottom corner on the front and shall contain the following details:

- i. Manufacturer's name.
- ii. P.O. No. & date.
- iii. Drawings reference No. that pertains to that panel.
- iv. Serial No. of the panel.

The letters on name plates shall have minimum height 4 mm and the gap between lines / words shall be more than 2 mm.

16.0 INTERNALLY MOUNTED EQUIPMENTS:

16.01 SPACE HEATERS:

Each control and relay panel shall be provided with a strip type or coil type tubular enclosed space heaters to prevent condensation of moisture within the panel. It shall be installed at the base of the cubicle and operated on 240V AC single phase supply. The surface temperature shall be well below visible heat. Space heaters shall be provided with an independent switch control, fuse and an adjustable thermostat to regulate the temperature.

16.02 PANEL LIGHTING:

The interior of the cubicles shall be illuminated by fluorescent lamps. The illumination shall be free from hard shadows and shall be planned to avoid any strain or fatigue to a wire man working inside the cubicle due to any abnormal or non-uniform illumination. These lamps shall be operated through switches or door push buttons. It shall operate on 240V, AC single phase supply.

16.03 POWER SOCKETS:

At least 3 nos. of 5 Amps three pin multiple plug points and 2 nos. of 15 Amps, 3 pin power plug outlets shall be provided at convenient points in each set of the 220KV, 110KV, 66KV and 33KV control panels. The plug points shall be provided with electrical and mechanical cover with chain. For simplex panels, a single phase 5A plug and socket and a 15 Amp. 3 Pin power plug & socket with switch is to be provided with security cover

17.0 FUSES:

17.01 H.R.C. fuses of adequate current and voltage rating shall be provided inside the cubicle for the various protection, control and incoming auxiliary AC & DC supply circuits.

The fuse bases and carriers shall be mounted inside the cubicle in an easily accessible location. They shall conform to relevant standard and shall be designed to carry HRC cartridge fuse links. The fuse bases and carriers shall be moulded from the thermosetting resin dielectric or moulded standard grades phonolic Bakelite or equivalent thereof and shall be black in colour. The selection of the main and sub-circuit fuse ratings shall be such as to ensure selective clearance of sub-circuit faults. All accessible live connections to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carriers and bases shall have imprints of the fuse rating and voltages.

The short time fuse rating of Fuses shall be not less than 9kA.

There shall be individual fuse units for each of the following circuits:

- i) Signaling and Annunciation circuits.
- ii) V.T. secondary instrument circuits.
- iii) V.T. secondary, relay circuits.
- iv) AC & DC control circuits (shall be separate for CB & Isolators).
- v) AC auxiliary circuits.
- vi) AC Power socket, cubicle space heater and lighting.
- vii) Others if any.

18.0 EARTHING:

18.01 All panels shall be provided with a bare copper tinned earthing bus extended throughout the length of the panel. Location of earth bus shall ensure no

radiation interference for earth system under various switching conditions of isolators and breakers. The material and the size of the earthing bus shall not be less than 25 mm x 6 mm, perforated Copper with threaded holes at a gap of 50mm with provision of bolts and nuts for connection with cable armours and mounted equipments etc for effective earthing. When several panels are mounted adjoining each other, the earth bus shall be made continuous and necessary connection and clamps for this purpose shall be included in the scope of supply. Provision shall be made for extending the earth bus bars at a future date into new adjacent panels to be installed if any. Provision shall be made at the end panels for connecting the same to the system earth ground mat.

18.02 All metallic cases of instruments, relays, accessories installed within the cubicle shall be connected to the earth bus with 1100V grade standard multicore 2.5 sq. mm PVC insulated conductor of green colour. The run of the wires shall be continuous without any joints and shall be crimped at either end with open type solder less lugs.

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

18.04 VT & 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.

18.05 An electrostatic discharge arrangement shall be provided in each panel so as to discharge human body before handles the equipment inside the panels.

19.0 INDICATING LAMPS: VOID

20.0 TEST TERMINAL BLOCKS:

20.01 Each panel where metering is involved shall be installed with instrument test terminal blocks. These test terminal blocks shall be designed for use on panels with poly-phase meters to facilitate their in-situ testing. The test terminal blocks shall be mounted at the bottom end of the front face of the panel. They shall be of the projecting type semi-flush mounted with wire connected at the back. All wiring to indicating, integrating and recording instruments shall be done through the Test Terminal Block. The test terminal block shall be provided with screw type front cover such that the removal of this cover shall grant access to the terminals in the front for connecting check meters or for injection of external supply to the panel instruments.

20.02 The test terminal blocks shall facilitate in-situ testing of instruments without interrupting the primary load circuit. The current terminals shall therefore be provided with shorting arrangement through links before interrupting the normal circuit for insertion of external check meters or for injection of an external supply into the panel instruments without causing an open circuit in the current transformer secondaries. The potential terminal shall be provided with sliding links for isolation of the normal supply voltage to the panel instruments from the secondaries of voltage transformer.

20.03 The test terminal block shall have its insulation housing made of a moulded dielectric materials such as phonolic Bakelite or equivalent thereof with adequate insulation between current and potential terminals of different phases. The potential testing studs shall preferably be housed in narrow recesses of the block moulded insulation to prevent accidental short circuit between potential studs themselves or between potential and current terminals. The cover studs to be provided shall be suitable for sealing with lead seals so as to prevent unauthorized access to the test studs.

20.04 The test terminal block rating shall be 1100 volts, 35 Amps, The terminals shall be nickel-plated brass and their contact resistance shall be less than 1 milli ohm. The test Terminal Block shall preferably be of IMP make or any other standard link type makes.

21.0 CONTROL SWITCHES:

21.01 Control and instrument switches shall be rotary operated type with escutcheon plates clearly marked to show operating position and circuit designation plates and suitable for flush mounting with only switch front plate and operating handle projecting out. Handles of different shapes and suitable inscriptions on switches shall be provided as an aid to switch identification.

21.02 The selection of operating handles for the different types of switches shall be as follows;

| | |
|---------------------------|------------------------------|
| a) Selector switches | Oval or knob, black |
| b) Trip transfer switches | Pistol grip, lockable, black |

21.03 VOID

21.04 VOID

21.05 Lockable type of switches, which can be locked in particular positions, shall be provided when specified. The key locks shall be fitted on the operating handles.

21.06 All control switches wires shall be connected at the back. The contact mechanism shall become operated. The contacts shall be silver plated and designed for liberal rating of the duty involved. The contacts shall be provided with a dust and vermin proof removable protection cover. The protection cover shall preferably be of transparent, inflammable material made of moulded dielectric materials. Springs to be provided in the switch shall not be used as current carrying parts.

The contacts provided in the switch shall not be used as continuous current carrying parts.

The contact combination and their operation shall be such as to give completeness to the interlock and function of the scheme. The contact rating of the switches shall be as follows :

| Description | Contact rating in Amps | |
|--|------------------------|----------|
| | 220V/110V DC | 240V AC |
| a) Make and carry continuously | 10 | 10 |
| b) Make and carry for 0.5 seconds | 30 | 30 |
| c) Break: 1. resistive load 2. inductive load with L/R = 40 ms | 3 0.2 | 7 --- |

21.07 VOID

22.0 SYNCHRONIZING SWITCHES: VOID

23.0 PUSH BUTTON SWITCHES-

- a) Push button switches provided, shall be of the momentary contact type wired back connected. They shall be semi-flush mounted and where required they shall be shrouded to prevent inadvertent or undesirable operation. They shall be provided with integral inscription plates engraved with their functions.
- b) All push buttons shall be with two sets of Normally Open (NO) and Normally Closed (NC) contacts. The contact faces shall be silver plated and shall be able to make/break and carry the rated current. The rated current shall be appropriate to the duty of the desired function, but not less than 5 Amps.

24.0 VOID

25.0 ANNUNCIATION SYSTEM: VOID

26.0 INDICATING & INTEGRATING INSTRUMENTS:

26.01 VOID

26.02 VOID

26.03 VOID

26.04 VOID

26.05 INTEGRATING METERS: -

- a) It shall of static type, 3 phase,4 wire, 2 element trivector meter suitable for 1 Amp, CT and 110 volts phase to phase VT secondaries. It must be flush mounted type and tropicalised. It shall have separate registers for recording KWh and KVARh consumption separately and also demands with automatic resetting at the end of the month and also to record EXPORT AND IMPORTS.
- b) The meter should be of 0.2S accuracy class.
- c) The meters shall have legible LED/LCD minimum 6 digits auto-cycle display. The meter shall have non-volatile memory requiring no battery back up.
- d) The meters shall conform to the detailed specification enclosed as Annexure.
- RPP-TVM

26.06VOID

26.07 VOID

27.0 RELAYS:

27.01 GENERAL:

- a) All relays shall conform to the requirements of IS3231/IEC 50255/IEC 61000 or other applicable standards. Relays shall be suitable for flush or semi flush mounting on the front with connections from the rear.

- b) All main protective relays shall be numerical type & communication protocol shall be as per IEC 61850 ed1 & ed2 (Site selectable). Further the test levels of EMI as indicated in IEC 61850 ed1 & ed2 (Site selectable) shall be applicable to these.
- c) A detailed note regarding the various quality control procedures adopted by the manufacturer should be given with special reference to static / numerical relay components on their quality assurance tests. Information should be furnished regarding various equipment used for quality assurance tests.
- d) The numerical relays offered must have proven performance. The bidder shall give a detailed account of the field experience of the relays offered, information regarding experience in designing etc.
- e) The protection scheme at the other end of the transmission line will be furnished to the successful bidder if required. The other particulars like distance of the lines, impedance, CT ratios, PT details will be furnished to the successful bidder and should provide the protection schemes suitable for parameters furnished.
- f) The relay codes mentioned in the wiring/ schematic diagram, for auxiliary relays etc., which are part of a composite relay, shall be marked on the name plate provided. This is required to facilitate the field staff, to identify the auxiliary relay provided in the composite unit at the time of trouble shooting.
- g) All relays, other components, wiring etc shall withstand a test voltage of 2.5kV RMS, AC, 50 Hz.
- h) The tenderer shall give a detailed account of the field experience of the relays offered. Information regarding experience within the country should be indicated, giving the approximate quantity of similar relays supplied in India. The bidder should also give an account of his experience in designing coordinating similar protective gear within the country.
- i) The tenderer shall indicate what facilities are available with him within the country for repair / recalibration of the relays offered by him. Whether such facilities are available for the repair of imported relays included in his offer shall also be stated in the tender.
- j) The tenderer shall indicate what facilities are available with him for commissioning these Relays. Such facilities shall cover indigenous and imported equipment. The bidder shall arrange to train at his cost the engineering staff of KPTCL for trouble- free operation and maintenance of these relays.

- 27.02 a) The protective and auxiliary relays offered shall be of proven design and based on sound principles and should conform to BS : 142 and IS : 3231 and IEC : 255 wherever applicable. The protection equipment shall be designed and applied to provide maximum discrimination between faulty and healthy circuits and its performance shall be in accordance with the BS standard 3950. The equipment shall remain in operation during transient phenomenon, which may arise during switching or other disturbances to the system. They shall be in standard cases and shall be provided with dust and vermin proof cases and covers, The covers shall be transparent and shall be removable from the front. The relay shall be suitable for semi-flush mounting only the flanges projecting in the front and with connection from the rear. The relays shall be rectangular in space and dull black or egg shell black enamel painted cases. All numerical IEDs shall be provided with Harsh Environmental coating as per relevant IEC
- b) All protective relays shall be in draw-out or plug-in type / modular cases with proper testing facilities. The testing facilities provided on the relays shall be specifically stated in the tender. Necessary test plugs shall be supplied loose and shall be included in bidder's scope of supply. Test block and switches shall be located immediately below each relay for testing. As an alternative to test block and test plug arrangements the bidder shall also quote alternative testing facility of protective relays by providing a push button which when pressed connects the testing equipment to the relay coils and injects current in the coil and automatically disconnects the trip circuits and on operation of relay gives a signal that the equipment and the circuits are correct. The above tests shall be carried out without short circuiting the CT secondary connections. The Purchaser reserves the right for accepting any one of the above two testing facilities. Unless otherwise specified all auxiliary relays and timers shall be supplied in non-draw out cases/ plug-in type modular cases.
- c) All AC relays shall be suitable for operation at 50 Hz AC Voltage operated relays shall be suitable for 110 Volts VT secondaries and current operated relays for 1 Amp CT secondaries as specified. DC auxiliary 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.
- d) All relays coils requiring a continuous voltage shall have adequate thermal capacity for continuous operation. The current and voltage coil shall be rated for the current and voltage rating specified under system details and auxiliary supply.
Opto Inputs: To avoid spurious pickup & mal operation of opto inputs they shall have programmable opto inputs thresholds. Which shall be

immune to capacitive discharge, spurious pick up for battery earth fault conditions, switching voltages and also ensure minimum chatters

All BI's & BO's of Numerical relays shall be independent & galvanically isolated. All numerical relays shall be suitable auxiliary supply voltage of 80 -250V DC and BI's shall be suitable for 80-250V DC supply.

- e) The power supply unit shall be fully rated with liberal design in capacity.
- f) The DC supply for solid state relay shall be from DC / DC converters and these shall be amply and fully rated for all operating conditions in service. Provision of DC stand by power supply will however not be acceptable.
- g) 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. and 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 spare contacts. Relay cases size shall be so chosen as not to introduce any limitations on the use of available contacts on the relay due to inadequacy of terminals. Paralleling of contacts, if any shall be done at the terminals on the casing of the relay.
- h) 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 subject to purchaser's approval. 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. Similar separate operating indicator (auxiliary relays) shall also be provided in the trip circuits of protections located outside the board such as buchholtz relays, oil and winding temperature protection, sudden pressure devices, fire protection etc.
- i) There shall be no relay in the protective circuits, which shall cause tripping of the circuit breaker when the relay is de-energized.

- j) Timers shall be of solid state type. Pneumatic timers are not acceptable. Time delay in terms of milliseconds obtained by the external capacitor/resistor combination is not preferred & shall be avoided.
- k) Provision shall be made for easy isolation of trip circuit of each relay for the purpose of testing & maintenance.
- l) All protective relays & alarm relays shall be provided with one extra isolated pair of contacts wired to terminals exclusively for further use.
- m) The setting range of relays offered, if different from ones specified shall also be acceptable if they meet the functional requirement.
- n) Any alternative/additional protection of relays considered necessary for providing complete effective & reliable protection shall also be offered separately. The acceptance of this alternative/additional equipment shall lie with KPTCL.
- o) 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.
 - i) The operating time of the series seal-in-units 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.
 - ii) Seal-in-units shall obtain adequate current for operation when one or more relays operate simultaneously.
 - iii) Impedance of the seal-in-units shall be small enough to permit satisfactory operation of the trip coil on trip relays when D.C supply voltage is minimum.
 - iv) 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 outputs 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.
 - v) 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).

- vi) 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 seal-in 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.
- vii) 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.
- p) For numerical relays the scope shall include the following:
 - i) Necessary software & hardware to up/down load the data to/from the relay from/to the personal computer provided in the station.
 - ii) The relay shall have suitable communication facility for connectivity to sub-station Automation system/SCADA. The relay shall be capable of supporting IEC 870-5-103 and 61850 ed1 & ed2 (Site selectable) protocol.
 - iii. The relay shall be provided with Parallel Redundant Protocol (PRP) as per relevant IEC in order to have zero recovery time and no loss of data and information due to failure of one communication link or hardware.
 - iv. Cyber security: The protection relays & control IED's shall be compliant to NERC standard to ensure security & availability of secured data at remote access.
- 27.03 a) The materials, the components of static/ numerical relays shall be designed to withstand the most severe tropical climatic conditions such as corrosive atmosphere, saline, fog, damp, heat and fungus prone environment. These devices as such shall be tropicalised in such a manner so as to meet with the IEC-68 standard.
- b) The components shall be loaded by less than half of their rated values. The resistor shall be of carbon composition or metal oxide type and the capacitors shall be plastic film or tantalum type. Stringent measures including shielding of long internal wiring should be taken to make relays immune to voltage spikes. As per IEC, the relays must meet the requirements of IEC-255-4, appendix 'E'. Class-III regarding HF disturbance tests, IEC-255-4 regarding impulse test at 5kV and fast transient test as per IEC-801-4. Insulation barriers shall be provided to

ensure that transients present in CT & VT connections due to extraneous source do not cause damage to static circuits.

- c) The cases, racks and sub-units shall preferably be of stainless steel. The screws used in cases, racks and sub-units shall be either of stainless steel or zinc plated steel.
- d) The material of connector terminal blocks shall be of dielectric moulded type resin. The connector plugs shall be corrosion resistive and the lugs shall be made of tinned brass with the contact face silver / gold plated. All connections with the connector plug shall be by wire wrapping.
- e) The static/ numerical components forming the electronic solid state circuitry shall be mounted on printed circuit board of adequate thickness and made of stratified glass epoxid. A protective lacquer shall be applied when all the components are soldered. Transformers in the circuitry shall also be impregnated with the same lacquer. All components shall be clearly marked and all wiring colour coded and tagged. Flat ribbon cable is exempted from being tagged.
- f) The relays shall be modular units assembled in fully tropicalised draw out cases with the modules or sub-units plugged into racks. They shall be electrically isolated on the measuring side through intensity or voltage input transformers with shield bonded (at the over voltage/fixed voltage) and on the operation side through on/off relays. The layout of measurement inputs, output relays, detection circuits and visual display such as to eliminate mutual interference of the circuits involved. Internal test points shall be provided on the printed circuit at typical points of the relay diagram. These test points, if possible shall be provided on the front of the relay to enable testing during operation without having to disconnect the relay.
- g) Insulation barriers shall be provided to ensure that transients present for CT and VT connections due to extraneous sources do not cause damage to static circuits. The static relays offered shall be tested to withstand both 5 kV impulse tests and high frequency disturbance stipulated by IEC. Details of the equipment used for tests shall be furnished.
- h) The relay shall be designed for designed for shock wave resistance, temperature resistance, humidity resistance, transportation resistance and storage resistance and to be insensitive to radio frequency interferences.
- i) The performance of static/numerical relay shall not be affected by transient, common mode and transient mode electromagnetic interference..

- j) The solid state relays shall be stable and suitably protected against transient/ induced over voltages and noise signals. The bidder shall state clearly in his bid, special requirements, if any, for DC input arrangement or cabling considered necessary for satisfactory operation of solid state relays quoted by him.
- h) The tripping/opening /closing (of Isolator and Breakers etc.) command directly from BCU contact is not acceptable. Separate auxiliary relays shall be provided for the same.

28.0 PROTECTION SCHEME:

TRANSMISSION LINE PROTECTION

- 28.1. All relays shall be suitable for series compensated line.
- 28.2. 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 main protections having equal performance requirement specially in respect of time called as Main-I and Main-II for 400KV lines, 220kV UG cables and 220kV Transmission lines. **Main 1 and Main 2 relays shall be provided with minimum 24BI's and 24BO's.**
- 28.3. The maximum fault current could be as high as 50kA 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.
- 28.4. The protective relays shall be suitable for use with capacitor voltage transformers having non-electronic damping and transient response as per IEC.
- 28.5. Fault Recorder, Distance to fault Locator and Over voltage relay (stage -1) functions if offered as an integral part of line protection relay, shall be acceptable provided these meet the technical requirements as specified in the respective clauses.
- 28.6. Auto reclosure relay function if offered as an integral part of BCU shall be acceptable for 400kV & 220kV lines, provided the auto reclosure relay features meets the technical requirements as specified in the respective clause
- 28.7. The following protections shall be provided for each of the Transmission lines:

For 400KV Long lines

Main-I: Numerical distance protection scheme with back-up OC / EF

Main-II: Numerical distance protection scheme of a make different from that of Main –I with back-up OC / EF

For 400KV Short lines/UG cables with OFC/ADSS cable/OPGW

Main-I: Numerical differential protection scheme with back-up distance protection

Main-II: Numerical differential protection scheme of a make different from that of Main –I with back-up distance protection

For 220KV lines

Main-I: Numerical distance protection scheme with back-up OC / EF

Main-II: Numerical distance protection scheme of a make different from that of Main –I with back-up OC / EF

For 220KV XLPE UG cables

Main-I: Numerical differential protection scheme with back-up distance protection

Main-II: Numerical differential protection scheme of a make different from that of Main –I with back-up distance protection

28.8. The detailed description of the above line protections is given here under.

28.8.1-A. Main-I and Main-II Numerical Distance Protection scheme for 400kV & 220 kV lines:

- (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
- (c) shall have stepped time-distance characteristics and three independent zones (zone 1, zone-2 and zone-3)
- (d) shall have mho or quadrilateral or other suitably shaped characteristics for zone-1 , zone-2 and zone- 3.

- (e) shall have following maximum operating time (including trip relay time , if any) under given set of conditions and with CVT being used on line (with all filters included) .

(i) for 400 KV & 220kV lines:

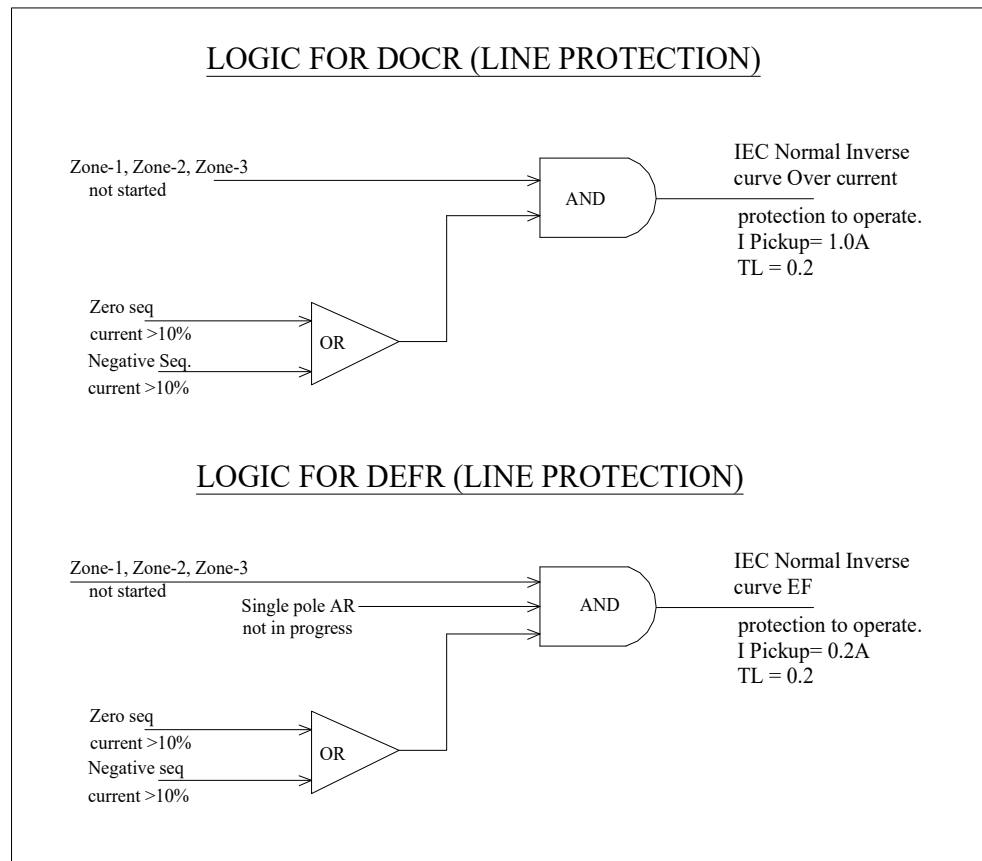
| | | |
|--|-------------------|--|
| Source to Impedance ratio | 4 | 15 |
| Relay setting (Ohms) | (10 or 20) and 2 | 2 |
| Fault Locations (as % of relay setting) | 50 | 50 |
| Fault resistance (Ohms) | 0 | 0 |
| Maximum operating time (Milliseconds) | 40 for all faults | 45 for 3 ph faults & 60 for all other 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 55 milli-seconds (including the resetting time of trip relays)
- (i) shall have facilities for offset features with adjustable 10-20% of Zone-3 setting.
- (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 be suitable for single & three phase tripping.
- (n) 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.
- (o) shall be provided with necessary self reset type trip duty contacts for completion of the scheme (Minimum number of these trip duty contacts

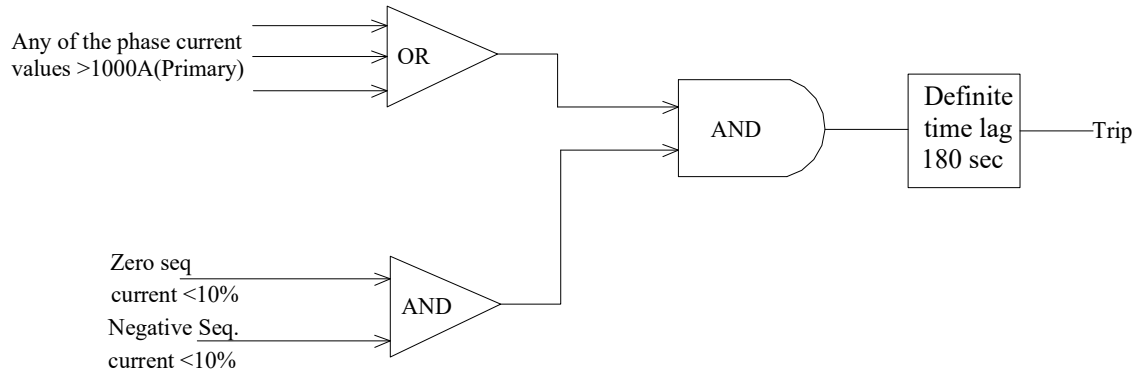
shall be four per phase) either through built in or through separate high speed trip relays . Making capacity of these trip contacts shall be 30 amp for 0.2 seconds with an inductive load of $L/R > 10$ mill seconds. If separate high speed trip relays are used, the operating time of the same shall not be more than 10 milliseconds

- (p) shall be suitable for use in permissive under reach / over reach /blocking communication mode.
- (q) shall have suitable number of potential free contacts for Carrier aided Tripping, Auto reclosing, CB failure, Disturbance recorder & Data acquisition system.
- (r) include power swing blocking protection which shall
 - have suitable setting range to encircle the distance protection described above.
 - block tripping during power swing conditions.
 - release blocking in the event of actual fault
- (s) include fuse failure protection which shall monitor all the three fuses of C.V.T. 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
- (t) 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 400 KV transmission lines
- (u) 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
- (v) Must have a current reversal guard feature.
- (w) The scheme shall not become inoperative even under severe system fault condition near the location of the relay when the potentials applied to the relay are very small. If characteristic of starting relays are such that it cannot pickup because of very low infeed, under- voltage relays may also be used as supplementary relays

LOGIC FOR DOCR (LINE PROTECTION)

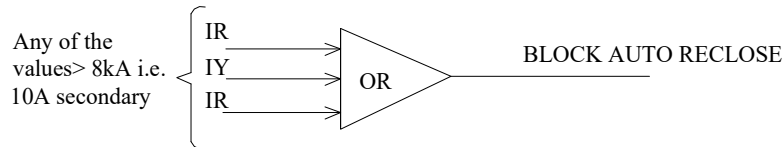


LOGIC FOR DIRECTIONAL OVER CURRENT PROTECTION (OVERLOAD)



ADDITIONAL LOGIC FOR AUTO RECLOSURE

(Along with the other inputs for AR Block, the following input is to be added)



Disturbance Recorder (DR) and Event Log (EL)

- The Pre-triggering and post triggering time for recording DR shall be 0.5 and 2.0 second respectively.
- The analog values to be indicated in the DR shall be V_a , V_b , V_c , V_n , I_b , I_c and I_n . The values indicated shall be primary values invariably.
- The DR shall be triggered for operation of MAIN-2 relay, operation of 86 OR 96 of the panel, operation of MAIN-1 relay in some cases.
- The binary status mapped to DR shall be CB status on each phase, Trip relays operated, zone1 start, zone2 start, zone3 start, zone4 start, zone1 trip, zone2 trip, zone3 trip, zone4 trip, carrier received, carrier sent, carrier faulty, CB not ready, Trip A phase, Trip B phase, Trip C phase, AR operated, TOR operated, AR block, SOFT operated, DEF start, DEF trip, DOC start, DOC trip, Fuse fail operated, OC operated, EF operated, PSB operated, Broken conductor operated, Pole Discrepancy operated,

LBB operated, any other external binary input given for triggering of DR like MAIN-1 in some cases.

- e. **Event Log (EL):** The Event Log of all the above binary status for pick up and drop out with timing shall be incorporated in the EL report.

1. Station name:

Object name – (Main-1 /Main-2)

Line Name:

Line length.

Triggering signal:

Triggering date and time:

Record No:

Fault locator: (Distance of the fault in kM)

2. Analog values of pre-fault voltages and currents with angle of the phasor.

3. Watch dog contact.

28.8.1B Main I / Main II Line Differential Protection (Applicable for 400kV & 220kV Short lines/ UG cables).

- The line Differential Protection IED (Intelligent Electronic Device) protection relay should be Numerical with full compliance to IEC 61850 ed1 & ed2 (Site selectable) standards in every respect and Interoperability with other manufacturers IEDs and tools should be verified.
- The IED shall be suitable for Protection, control and monitoring of overhead lines and cables for all Voltage levels in solidly grounded or impedance grounded networks.
- The protection unit should be based on Phase segregated Line differential Principle and use.
- Advanced and proven algorithms shall support user friendly Engineering tool and Disturbance handling tool.
- It should be possible to integrate Protection and control functionality for several objects in the IED. The IED shall have complete functionality for single and multi breaker arrangements with single or three phase tripping.
- At least Four/Five independent parameter setting groups shall be included.
- IED shall have extensive self supervision including analogue channels.
- At new installations or at extensions and replacements in existing installations it shall be possible to integrate the IED into a substation automation or monitoring system or use the IED as a stand-alone multifunction unit.
- It shall be possible to equip the IED with a HMI for local access of all information.
- A Restrained dual Bias operate characteristic shall be used and the highest phase current in any line shall be utilized as bias current.
- Charging current compensation for increased sensitivity for long lines and cables shall be included.
- The IED should be suitable for multiplexed, route switched or dedicated fibre networks.
- Two time synchronization methods shall be available, the echo-method when channels with stable and equal delays in both directions are used

and GPS to be used in switched networks with unequal channel delays in both directions.

- The communication channel shall be continuously monitored and an automatic switchover to a redundant channel shall be possible.
- IED shall be provided with programmable logic for tripping and indications as well as a high number of logic blocks and timers for user adaptation.
- For Line differential communication it shall be possible to select between a master-master system or master slave system depending on the functional or economical requirements. An automatic changeover to Master-slave communication should take place if an interruption occurs in communication channel in master-master communication system.
- A backup high speed full scheme distance protection with at least three zones should be possible to include in order to get fault clearance in case of communication failure, it shall be possible to have the distance protection continuously in operation or only released for operation at communication failure. The distance Protection shall have characteristics that will give load encroachment discrimination and load current compensation of the reactance line in the first zone to avoid over reach. It should be possible to set the distance Protection zone in forward, reverse or non directional mode. Each zone should have individual resistive and reactive reach settings. Separate phase selection logic and automatic switch onto fault logic should be included.
- Disturbance recording, event recording shall be built in features and included in the IED.
- IED shall be provided with a front mounted HMI and front port for connection to a Personal Computer.
- The IED shall be provided with communication interface for connection to Substation Automation system and substation monitoring system. IEC 61850 ed1 & ed2 (Site selectable)-8-1 & IEC 60870-5-103 communication protocol shall be available. The IED shall meet the IEC 61850 ed1 & ed2 (Site selectable) standard in every respect and interoperability with other manufactures IEDs and tools should be verified.
- Power supply modules from 48V to 250V AC/DC shall be available.
- It shall be possible to select different mounting alternatives such as rack, flush or wall mounting. Depending of the required numbers of I/O

modules in the IED 1/1 x 19", 3/4 x 19" and 1/2 x 19" cases shall be available.

- GPS time synchronization module with GPS receiver used for time synchronization shall be available.

28.8.2. Back-up Directional Over Current and Earth fault protection scheme

(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 VT fuse failure relays for alarm purposes.

(d) 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 LEDs.

(e) 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 LEDs
- include necessary separate interposing voltage transformers or have internal feature in the relay for open delta voltage to the relay.

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

29.0 CIRCUIT BREAKER PROTECTION :

This shall include following function:

29.1. AUTO RECLOSING function shall be separate from Main-I and Main-II protection in case of 400kV lines. **However, Auto-reclose as in built function of BCU is acceptable for 220kV lines.**

- (a) have single phase and three phase reclosing facilities.
- (b) have a continuously variable single phase dead time range of 0.1-2 seconds.
- (c) have a continuously variable three phase dead time range of 0.1-2 seconds.
- (d) have a continuously variable reclaim time range of 5-300 seconds.
- (e) incorporate a four-position selector switch/ from which single phase/three phase/single and three phase auto reclosure and non-auto reclosure mode can be selected. Alternatively, the mode of auto reclosing can be selected through programming.
- (f) have facilities for selecting check synchronising or dead line charging features. It shall be possible at any time to change the required feature by reconnection of links.
- (g) be of single shot type.
- (h) have priority circuit to closing of both circuit breakers in case one and half breaker arrangements to allow sequential closing of breakers
- (i) include check synchronising 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.

29.2. LOCAL BREAKER BACK-UP PROTECTION SCHEME shall be separate from Main-I and Main-II protection in case of 400kV lines. For 220kV lines in-built function of Main1/ Main 2 relay is acceptable.

- (a) be triple pole type
- (b) have an operating time of less than 15 milli seconds
- (c) have a resetting time of less than 15 milli seconds
- (d) have three over current elements
- (e) 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 /reactor equipment protections
- (f) have a setting range of 20-80% 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 0.1-1 seconds
- (i) have necessary auxiliary relays to make a comprehensive scheme.

29.3. TRIP CIRCUIT SUPERVISION RELAY

- (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 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.

30.0 LINE OVER VOLTAGE PROTECTION RELAY shall

- (a) monitor all three phases

- (b) have two independent stages and stage- 1 & II relay are acceptable as built in with line distance relays Main I & II respectively .
- (c) have an adjustable setting range of 100-170% of rated voltage with an adjustable time delay range of 1 to 60 seconds for the first stage.
- (d) have an adjustable setting range of 100-170% of rated voltage with a time delay of 100-200 mill seconds for the second stage.
- (e) be tuned to power frequency
- (f) provided with separate operation indicators (flag target) for each stage relays.
- (g) have a drop-off to pick-up ratio greater than 95%.
- (h) provide separate out-put contacts for each 'Phase' and stage for breaker trip relays, event logger and other scheme requirements.

31.0 REACTOR PROTECTION

31.1. Numerical Differential Protection shall

- (a) be triple pole type
- (b) have operation time less than 25 milli-seconds at 5 times setting.
- (c) be tuned to system frequency
- (d) have current setting range of 10 to 40% of 1 Amp. Or a suitable voltage setting range.
- (e) be high impedance / biased differential type .
- (f) be stable for all external faults

31.2. Restricted earth fault protection Relay shall

- (a) be single pole and numerical type
- (b) be of current/voltage operated high impedance type
- (c) have a current setting of 10-40% of 1 Amp./have a suitable voltage setting range.
- (d) be tuned to system frequency.

- (e) have a suitable non-linear resistor to limit the peak voltage to 1000 Volts.

31.3. Numerical Back up impedance protection Relay shall

- (a) be triple pole type, with faulty phase identification/ indication
- (b) be a single step polarised 'mho' distance/ impedance relay suitable for measuring phase to ground and phase to phase faults.
- (c) have adequate ohmic setting range to cover at least 60 % of the impedance of the reactor and shall be continuously variable.
- (d) have an adjustable characteristic angle of 30-80 degree.
- (e) have a definite time delay relay with a continuously adjustable setting range of 0.2-2.0 seconds.
- (f) include VT failure relay which shall block the tripping during VT fuse failure condition.

32. TRANSFORMER PROTECTION

32.1. Numerical Transformer differential protection 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. Magnetising 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) include necessary separate interposing current transformers for angle and ratio correction or have internal feature in the relay to take care of the angle & ratio correction

- (i) have a fault recording feature to record graphic form of instantaneous values of following analogue channels during faults and disturbances for the pre fault and post fault period:
- current in all three windings in nine analogue channels in case of 400kV class and above transformers or 6 analogue channels for lower voltage transformers and
 - Voltage in one channel

The disturbance recorder shall have the facility to record the following external digital channel signals apart from the digital signals pertaining to differential relay.

1. REF protection operated
2. HV breaker status (Main and tie)
3. IV breaker status
4. Bucholz /OLTC Bucholz alarm / trip
5. WTI/OTI/PRD alarm/trip of transformer

Necessary hardware and software for automatic up-loading the data captured by disturbance recorder to the personal computer (DR Work Station) available in the substation shall be included in the scope.

32.2. 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 0.1 to 6.0 seconds at values of 'v/f' between 100% to 130% 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 $\pm 10\%$.
- (g) have a resetting ratio of 95 % or better.
- (h) Be acceptable as a built in feature of protection IEDs provided for transformer protection

32.3. 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

32.4. Numerical Back-up 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 LEDs.
- (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 LEDs
- include necessary separate interposing voltage transformers or have internal feature in the relay for open delta voltage to the relay

32.5. Transformer Overload Protection Relay shall

Separate Numerical Transformer overload relay shall be provided with two stages. One stage as non-trip alarm & the second stage is to extend trip command to breakers to have required load relief. The Over Load relay operated contact shall be wired to auxiliary relay of minimum 8NO contacts.

32.6. Transformer Neutral Current relay for 400 KV transformer.

(a) 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

(b) have low transient, over reach high set instantaneous unit of continuously variable setting range 200-800 % of rated current

32.7. TERTIARY PROTECTION: Neutral displacement relay shall be provided for tertiary. The relay shall –

- Have IDMT characteristic with setting range of 5% - 50% of rated input voltage.
- Have input from open delta connected V.T. Secondary A.C. rating.
- Include operating indicators.
- Shall be IEC 61850 ed1 & ed2 (Site selectable) compliant

32.8. ADDITIONAL RELAYS FOR TRANSFORMER PROTECTION/SUPERVISION

a) Auxiliary relays for internal faults:

Transformer relay panel shall be provided with adequate number of auxiliary relays needed for main Buchholz trip, winding temp. Trip, Oil temp. Trip, pressure relief device trip and OLTC Buchholz trip. The contacts of these relays shall be used for annunciation for BCU (SAS system) and tripping

33. A) TEE PROTECTION DIFFERENTIAL RELAYS

33.1.1. TEE-1 differential protection relays shall

- (a) be triple pole type
- (b) have an operating time less than 30 milliseconds 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) have an operating current setting of 15% of 1 Amp or less

33.1.2. TEE-2 Differential relay shall

- (a) be triple pole type
- (b) have operating time less than 25 milliseconds at 5 times setting
- (c) be tuned to system frequency
- (d) have current setting range of 20 to 80% of 1 Amp
- (e) be voltage operated, high impedance type
- (f) be stable for all external faults
- (g) be provided with suitable non linear resistors across the relay to limit the peak voltage to 1000 volts

B) BACK-UP PROTECTION FOR 400/220 KV TRANSFER BUS-COUPLER/ BUS SECTIONALIZER/ MAIN BUS COUPLERANEL

The protection panel shall be similar to that specified under cl no 28.8.2 for 400/ 220 KV feeder.:

34.00 TRIPPING RELAY

High Speed Tripping Relay shall

- (a) be instantaneous (operating time not to exceed 10 milli-seconds).
- (b) reset within 20 milli seconds

- (c) be 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.

35.0 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.

36.0 BUS BAR PROTECTION

36.1 400kV Bus-bar Protection

Redundant (1+1) numerical Bus Bar protection scheme for each bus system (Bus1 +Bus2 Bus) for 400kV shall be provided. The scheme shall be engineered so as to ensure that operation of any one out of two schemes connected to main faulty bus shall result in tripping of the same.

36.2 Single bus bar protection scheme shall be provided for each main & transfer bus for 220kV voltage levels.

36.3 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) The scheme shall be based on the percentage-biased differential and low impedance, with a slope varying from 52 to 85%. In order to guard against mal-operations due to any spurious operation of the basic differential relay, a check feature shall also be incorporated. This check feature shall be built in feature of the relay. The check feature may be high speed over current starting relay normally said to coincide with the largest line CT primary current rating and high speed three phase under voltage relay connected to the bus VTs.

- (d) give hundred percent security up to 63KA fault level for 400KV & 220kV
- (e) 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
- (f) not give false operation during normal load flow in bus bars.
- (g) incorporate clear zone indication.
- (h) be of phase segregated and triple pole type
- (i) provide independent zones of protection (including transfer bus if any). If the bus section is provided then each side of bus section shall have separate set of bus bar protection schemes
- (j) include individual high speed electrically reset tripping relays for each feeder. However, in case of distributed Bus bar protection, individual trip relay shall not be required if bay unit is having trip duty contacts for breaker tripping.**
- (k) be transient free in operation
- (l) include continuous D.C. supplies supervision.
- (m) not cause tripping for the differential current below the load current of heaviest loaded feeder . Bidder shall submit application check for the same.**
- (n) shall include necessary C.T. switching relays wherever C.T. switching is involved and have 'CT' selection incomplete alarm
- (o) include protection 'IN/OUT' switch for each zone
- (p) In case of substations, where C&R Panels are located in Switchyard AC Kiosk, distributed type bus bar protection shall be provided for both 400kV & 220kV. Bus bar protection is decentralized type in which bay units and bus bar trip relays are in respective relay panels. The master control unit (MCU) i.e. MCU1 (Main-1) & MCU2 (Main-2) for bus-1 & bus-2 shall be housed in switchyard panel room located in the middle of the switchyard. All Bay units will be connected to the MCUs by FO connection.
- (q) shall include trip relays, CT switching relays(if applicable) , auxiliary CTs (if applicable) as well as additional power supply modules, input

modules etc. as may be required to provide a Bus-bar protection scheme for the complete bus arrangement i.e. for all the bay or breakers under this specification as per the Single line diagram and also for additional 1 nos. of ICTs and also 4 nos. of 400kV future line bays & 4 nos of 220kV future line bays. In case of distribution bus bar protection, the bay units for future bays may be installed in separate panel and same shall be located where bus bar protection panel (where central units are located) is installed.

36.4 Built-in Local Breaker Backup protection feature as a part of bus bar protection scheme shall be provided. The required inputs/outputs shall be wired for the same.

36.5 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.
- (b). The Central unit shall contain serial port also for system configuration via PC. The Bus-bar relay provided should have necessary communication ports required for communication with local PC.
- (c). End Fault protection shall be an in-built function in Bus bar protection relay. Output for End fault protection Operated for each bays shall be wired upto the TB for remote end tripping.

36.6 Minimum schematic requirement for Bus Bar protection panel.

36.6.1 The vendor should consider all the latest concepts/ technique's used in the Bus Bar protection schematics.

36.6.2 The status of CB & Bus isolators to be taken as an input to the relay for the zone selection.

36.6.3 Bus-bar trip relays for all the bays will be mounted either in Bus Bar protection panel or respective bay protection panel.

36.6.4 A common reset push button to be provided for all the trip relays.

36.6.5 Single distribution for complete Bus bar protection scheme shall be considered. However DC supply selector switch and Source -1, source-2 supervision shall be considered.

36.6.6 Zone In/Out Push buttons with illumination lamps shall be provided for each zone.

36.6.7 In each bus bar bay units, minimum 16BI's and 21BO's shall be considered.

37.0 FAULT RECORDER

37.1 The fault recorder shall be provided for transmission line and the fault recorder in-built feature of line distance relay is also acceptable provided the requirements of following clauses are met

37.2 Fault recorder shall be microprocessor based and shall be used to record the graphic form of instantaneous values of voltage and current in all three phases, open delta voltage & neutral current, open or closed position of relay contacts and breakers during the system disturbances.

37.3 The Fault recorder shall consist of individual acquisition units, one for each feeder and an Evaluation unit which is common for the entire Substation. Whenever, more than one acquisition units are connected to an Evaluation unit, necessary hardware and software shall also be supplied for on line transfer of data from all acquisition units to Evaluation unit. The acquisition unit is connected with evaluation unit being supplied as described in section sub-station automation through bus conforming to IEC 61850 ed1 & ed2 (Site selectable). In case of extension sub-station, one set of evaluation software shall be supplied and loaded in existing fault recorder evaluation unit. Automatic uploading of disturbance files from acquisition unit to evaluation unit shall be done through existing station bus only conforming to IEC 61850 ed1 & ed2 (Site selectable). Necessary configuration/updation shall be in the scope of the contractor.

37.4 Fault recorder shall have at least 8 analogue and 16 digital channels for each feeder.

37.5 Acquisition units shall acquire the Disturbance data for the pre fault and post fault period and transfer them to Evaluation unit automatically to store in the hard disk. The acquisition units shall be located in the protection panels of the respective feeders.

37.6 The acquisition unit shall be suitable for inputs from current transformers with 1A rated secondary and capacitive voltage transformers with 63.5V (phase to neutral voltage) rated secondary. Any device required for

processing of input signals in order to make the signals compatible to the Fault recorder equipment shall form an integral part of it. However, such processing of input signals shall in no way distort its waveform.

- 37.7 The equipment shall be carefully screened, shielded, earthed and protected as may be required for its safe functioning. Also, the Fault recorder shall have stable software, reliable hardware, simplicity of maintenance and immunity from the effects of the hostile environment of EHV switchyard which are prone to various interference signals typically from large switching transients.
- 37.8 The evaluation unit hardware shall be as described in clause no. 4.0 of section sub-station automation.
- 37.9 Necessary software for transferring the data automatically from local evaluation unit to a remote station and receiving the same at the remote station through owner's PLCC/VSAT/LEASED LINE shall be provided.
- 37.10 Evaluation software shall be provided for the analysis and evaluation of the recorded data made available in the PC under DOS/WINDOWS environment. The Software features shall include repositioning of analog and digital signals, selection and amplification of time and amplitude scales of each analog and digital channel, calculation of MAX/MIN frequency, phase difference values, recording of MAX/MIN values etc. of analog channel, group of signal to be drawn on the same axis etc, listing and numbering of all analog and digital channels and current, voltage, frequency and phase difference values at the time of fault/tripping. Also, the software should be capable of carrying out Fourier /Harmonic analysis of the current and voltage wave forms. The Disturbance records shall also be available in COMTRADE format (IEEE standard- Common Format for Transient data Exchange for Power System)
- 37.11 The Evaluation unit shall be connected to the printer to obtain the graphic form of disturbances whenever desired by the operator.
- 37.12 Fault recorder acquisition units shall be suitable to operate from 220V DC or 110V DC as available at sub-station Evaluation unit along with the printer shall normally be connected to 230V, single phase AC supply. In case of failure of AC supply, Evaluation unit and printer shall be switched automatically to the station DC through Inverter of adequate capacity which shall form a part of Distance recorder system. The inverter of adequate **capacity shall be provided to cater the requirement specified in section sub-station automation clause no. 8.0 and DR evaluation unit.**
- 37.13 The acquisition unit shall have the following features

- (a) Facility shall exist to alarm operator in case of any internal faults in the acquisition units such as power supply fail, processor / memory fail etc and same shall be wired to annunciation system.
- (b) The frequency response shall be 5 Hz on lower side and 250 Hz or better on upper side.
- (c) Scan rate shall be 1000 Hz/channel or better.
- (d) Pre-fault time shall not be less than 100 milliseconds and the post fault time shall not be less than 2 seconds (adjustable). If another system fault occurs during one post-fault run time, the recorder shall also be able to record the same. However, the total memory of acquisition unit shall not be less than 5.0 seconds
- (e) The open delta voltage and neutral current shall be derived either through software or externally by providing necessary auxiliary transformers.
- (f) The acquisition unit shall be typically used to record the following digital channels :
 - 1 Main CB R phase open
 - 2 Main CB Y phase open
 - 3 Main CB B phase open
 - 4 Main-1 carrier received
 - 5 Main-1 protection operated
 - 6 Main/Tie /TBC Auto reclosed operated
 - 7 Over Voltage -Stage-1 /2 operated
 - 8 Reactor / Stub/TEE-1/2/UF protection operated
 - 9 Direct Trip received
 - 10 Main-2 carrier received
 - 11 Main- 2/ Back Up protection operated
 - 12 Bus bar protection operated
 - 13 LBB operated of main /tie/TBC circuit breaker
 - 14 Tie/TBC CB R phase open
 - 15 Tie/TBC CB Y phase open
 - 16 Tie/TBC CB B phase open
- (g) In case the Fault recorder is in-built part of line distance protection, above digital channels may be interfaced either externally or internally.
- (h) Any digital signal can be programmed to act as trigger for the acquisition unit. Analog channels should have programmable threshold levels for triggers and selection for over or under levels should be possible.

37.14 The printer shall be compatible with the desktop PC and shall use Plain paper. The print out shall contain the Feeder identity, Date and time (in hour, minute and second up to 100th of a second), identity of trigger source and Graphic form of analogue and digital signals of all the channels. Two packets of paper (500 sheets in each packet) suitable for printer shall be supplied.

37.15 Each Fault recorder shall have its own time generator and the clock of the time generator shall be such that the drift is limited to +0.5 seconds/day, if allowed to run without synchronisation. Further, Fault recorder shall have facility to synchronise its time generator from Time Synchronisation Equipment having output of following types

- Voltage signal: (0-5V continuously settable, with 50m Sec. minimum pulse duration)
- Potential free contact (Minimum pulse duration of 50 m Sec.)
- IRIG-B
- RS232C

The recorder shall give annunciation in case of absence of synchronising within a specified time.

37.16 Substations where Time Synchronisation Equipment is not available, time generator of any one of the Fault recorders can be taken as master and time generators of other Fault recorders and Event loggers in that station shall be synchronised to follow the master.

38.0 VOID

39.0 DISTANCE TO FAULT LOCATOR (Built in Feature of Numerical Distance Protection Relays)

- a) be electronic or microprocessor based type.
- 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 3% 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

40.0 TIME SYNCHRONISATION EQUIPMENT

- 40.1 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.
- 40.2 Time synchronisation equipment shall include antenna, all special cables and processing equipment etc.
- 40.3 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.
- 40.4 Equipment shall operate up to the ambient temperature of 50 degree centigrade and 80% humidity.
- 40.5 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).
- 40.6 Equipment shall meet the requirement of IEC 60255 for storage & operation.
- 40.7 The system shall be able to track the satellites to ensure no interruption of synchronisation signal.
- 40.8 The output signal from each port shall be programmable at site for either one hour, half hour, minute or second pulse, as per requirement.
- 40.9 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 :

- Potential free contact (Minimum pulse duration of 50 milli Seconds.)
- IRIG-B
- RS232C / RS485
- SNTP Port

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

40.11 Time synchronisation equipment shall be suitable to operate from 220V DC or 110V DC as available at Substation.

40.12 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 control panels having display size of approx. 100 mm height.

41.0 RELAY TEST KIT

41.1 One relay test kit shall comprise of the following equipment as detailed here under

- 3 sets Relay tools kits.
- 2 nos Test plugs for TTB
- 2 nos. Test/isolation jack for online testing of relays
- 2 nos. Test plugs for using with modular type relays (if applicable)

42.0 TYPE TESTS

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

- Insulation tests as per IEC 60255-5
- High frequency disturbance test as per IEC 60255-4 (Appendix -E) 61000-4 -Class **IV (Not applicable for electromechanical relays)**
- Fast transient test as per IEC 1000-4, Level IV (Not applicable for electromechanical relays)
- 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, only performance tests are intended under this item.
- Conformance test as per IEC 61850 ed1 & ed2 (Site selectable)-10.

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 Distance to fault locator and Disturbance recorder)

In case there is a change either in version or in model (Except firmware) of the relay, the contractor has to submit the type test reports for the offered revision/model.

42.2 Steady state & Dynamic characteristics test reports on the distance protection relays, as type test, shall be based on test programme specified in Appendix A 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.

43.0 CONFIGURATION OF RELAY AND PROTECTION PANELS

The following is the general criteria for the selection of the equipments to be provided in each type of panel. However contractor can optimise the requirement of panels by **suitably clubbing the feeder protection and CB relay panels. But the Main-I and Main-II protection can not be provided in single panel.**

A) LINE PROTECTION PANEL

The Line Protection panel for transmission lines shall consist of following protection features/schemes. The protection system shall be suitable for one and half breaker scheme.

| Sl. No. | Description | 400kV | 220kV | 220kV Cable |
|---------|--|-------|-------|-------------|
| 1. | a). Main-1 Numerical Distance protection | 1 Set | 1 Set | -- |

| | | | | |
|-----|---|--------|--------|--------|
| | scheme | | | |
| | b). Main-1 Numerical Line differential protection scheme | -- | -- | 1 Set |
| 2. | a). Main-2 Numerical Distance protection scheme | 1 Set | 1 Set | -- |
| | b). Main-2 Numerical Line differential protection scheme | - | - | 1 Set |
| 3. | Over Voltage Protection Scheme | 1 Set | NIL | NIL |
| 4. | Fault Recorder | 1 Set | 1 Set | 1 Set |
| 5. | Distance to fault Locator | 1 Set | 1 Set | 1 Set |
| 6. | 3 phase Trip Relays | 2 Nos. | 2 Nos. | 2 Nos. |
| 7. | Flag relays , carrier receive relays ,aux. Relays timers etc as per scheme requirements | Lot | Lot | Lot |
| 8. | Under Voltage protection relay for isolator/earth switch | 2 Nos | 2 Nos | 2 Nos |
| 9. | AC 3phase 4 wire TVM Accuracy 0.2 with ABT and TOD features | 1 Set | 1 Set | 1 Set |
| 10. | Directional back up Overcurrent and E/F protection scheme | NIL | - | - |

B) TRANSFORMER PROTECTION PANEL :

The protection panel for Auto transformer/Transformer shall consists of the following features/schemes.

| Sl. No. | Description | HV side | |
|----------------|---|----------------|--------|
| | MV/LV side | | |
| 1. | Transformer Differential Protection scheme | 1 Nos. | Nil |
| 2. | Restricted Earth fault protection scheme | 1 no. | 1 no@ |
| | @ Not applicable for autotransformer | | |
| 3. | Directional back up O/C and E/F relay with non directional high set feature | 1 set | 1 set |
| 4. | Over Fluxing Protection scheme | 1 no. | 1 no |
| 5. | Overload protection scheme | 1 nos. | NIL |
| 6. | Three phase trip relays | 2 nos. | 2 nos. |
| 7. | CVT selection relays as per scheme requirement | Lot | Lot |
| 8. | AC 3 phase 4 wireTVM Accuracy 0.2 with ABT and TOD features | 1 Set | 1 Set |
| 9. | Neutral displacement relay Transformer tertiary | | 1 Set |

Note: 2 nos. of numerical under frequency relay with voltage protection feature shall be provided in Transformer panel for Bus 1 & Bus 2. The relay shall

have 4 stages of under frequency and 2 stages of frequency supervised with rate of change of frequency for low frequency load shedding.

C) REACTOR PROTECTION PANEL

The protection panel for Reactor shall consist of the following protection features/schemes:

| Sl. No. | Description | Qty. |
|----------------|--|--------------|
| 1. | Reactor Differential Protection scheme | 1 no. |
| 2. | Restricted Earth fault Protection scheme | 1 no. |
| 3. | Reactor back up impedance protection scheme | 1 set |
| 4. | Three phase trip relays (Only for Bus Reactor) | 2 nos. |
| 5. | CVT selection relay as per scheme requirement | Lot |
| 6. | Flag relays/ auxiliary relays for wiring Reactor | As required. |
| | Auxiliary protection contacts such Bucholtz, oil temperature, winding temperature, PRV etc as per scheme requirement | |

D) BACK-UP PROTECTION FOR 400KV/220kV TRANSFER BUS-COUPLER/ BUS SECTIONALIZER/ MAIN BUS COUPLER PANEL:

The protection panel shall be similar to that specified under cl no 28.8.2 for 400/ 220 KV feeder.:

| Sl. No. | Description | Qty. |
|----------------|---|-------------|
| 1. | Directional back up Overcurrent and E/F protection scheme | 1 Set |

F) BREAKER RELAY PANEL

The breaker relay panel shall comprise of the following

| Sl. No. | Description | With A/R | With out A/R |
|----------------|--|-----------------|---------------------|
| 1. | Breaker failure Protection Scheme | 1 No. | 1 No. |
| 2. | DC supply Supervision relay | 2 Nos. | 2 Nos. |
| 3. | Trip Circuit supervision relays# | 6 Nos. | 6Nos. |
| 4. | Autoreclose scheme (if its standalone) | 1 No. | NIL |

- | | | | |
|----|---|-----|-----|
| 5. | Flag relays, aux relays, timers, trip relays as per scheme requirements | Lot | Lot |
|----|---|-----|-----|

Note: Equipment/relays to be provided for CB relay panel may be accommodated in the panels to be provided for Transmission Line/ Reactor as applicable.

44.0 FOR ONE AND HALF BREAKER SCHEME (Two Bus System)

Instantaneous tripping of the remote end breaker shall be achieved through the direct carrier inter trip telelink (PLCC) in case of any of the following operations/ occurrences.

- i) Tripping of the 400kV main breaker when the tie breaker is open.
- ii) Tripping of the 400kV Tie breaker when the main breaker is open.
- iii) Operation of local breaker backup protection of main breaker or tie breaker.
- iv) Over voltage protection operation.
- v) Reactor Protection Operation.

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

The direct carrier inter-trip telelink (PLCC) for this purpose shall be provided by the purchasers.

44.2 FOR TWO MAIN & TRANSFER SCHEME (Three Bus System) :

Instantaneous tripping of the remote end breaker shall be achieved through the direct carrier inter-trip telelink (PLCC) in case of any of the following operation /occurrences

- i) Hand tripping of 400kV line Breaker.
- ii) Hand tripping of 400kV TBC (Transfer Bus Coupler) Breaker if the line is controlled by the TBC breaker.
- iii) Operation of local breaker backup protection.
- iv) Operation of transfer bus bar protection relay if the line is on the transfer bus
- v) Reactor Protection Operation.
- vi) Over voltage protection operation.
- vii) Busbar Protection.

45.0 BUS CONFIGURATION & BUS TRANSFER SCHEME

1. Bus-bar arrangement at the various EHV Sub-stations will generally be one of the following:

- a). Two main bus + one Transfer bus (3 bus system with or without sectionalizer breaker on main bus)
- b). Two main bus (One & half breaker system).
- c). Two main bus (with or without sectionalizer breaker on main bus)
- 2. Transfer bus wherever exists will have one transfer bus coupler breaker, and is used mainly for taking the load of any one circuit when the main breaker of that circuit is to be taken out for maintenance/repair.
- 3. When a circuit is taken on the transfer bus, all the protection circuits connected to that bay shall be transferred so as to trip the transfer breaker in the event of occurrence of any fault on the feeder.
- 4. The trip transfer scheme shall be such that it should be possible to transfer any circuit from its own breaker to the transfer breaker and vice versa, without any interruption in power.
- 5. The trip transfer scheme shall include one two position (normal-Transfer) switch having adequate contacts (Ways) to transfer all the trip circuits. All the trip wires shall be permanently connected to the main breaker irrespective of the position of the N-T switch, and in the Transfer position of the switch, the trip circuits shall be extended to the transfer breaker.

46.0 ERECTION AND MAINTENANCE TOOL EQUIPMENTS

All special testing equipment required for the installation and maintenance of the apparatus, instruments devices shall be furnished in relevant schedule

47.0 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.

48.0 Co-ordination of Drawings of associated equipments of other manufacturers:

- 1. The purchaser intends to procure all outdoor equipments associated with these panels from other manufacturers. The supplier is therefore required to co-ordinate the control and wiring schematics of these panels with control and wiring schematic of the outdoor equipment manufacturer.
- 2. The purchaser will intimate the supplier the details of the outdoor equipments manufacturers on whom purchaser orders have been placed for the supply of these equipments along with such relevant details such as P.O. No. and date, delivery period, and all other technical details such as rating data, wiring diagrams etc. The supplier shall co-ordinate these diagrams with that of the associated relay and protection panels, and shall

also seek such clarifications as are necessary from these manufacturers under intimation to the purchaser.

3. The purchaser will assist and or furnish the supplier with all relevant data as are necessary for completeness of co-ordination of the wiring diagrams and interlocking of equipment circuits.

49.0 DRAWINGS AND LITERATURES:

49.01 Tender drawings and literatures:

The following drawings and literatures shall be submitted along with tender documents.

- a) Principal layout drawings of the SIMPLEX Relay and protection with disposition of meters and control switches, relays. These layout drawings shall be for the following views:
 - i. Front face of panel.
 - ii. Inside view of panel.
- b) Illustrated literature with photographs of similar panels supplied by the manufacturer.
- c) Pictorial and sectional views of control switches, test terminal blocks, indicating instruments, exploded views of draw out type instruments etc.,
- d) Printed copies of illustrated, literature, general technical data, performance application, and specifications of relays, fault locators, etc.,
- e) Elementary schematic wiring diagrams of the various metering and protective schemes.

49.02 Contract Drawing:

In the event of an order, the supplier shall submit drawings, GTP and type test reports in triplicate for approval of the purchaser, prior to manufacture. After the drawings are approved six copies of each of the drawings printed on 90 GSM paper shall be supplied for immediate use.

The successful bidder should forward the drawings as follows.

- a) One set of reproducible, originals and 12 sets of copies of all approved drawings along with 12 sets of literature commissioning and maintenance manuals to the Chief Engineer, Electy., Tendering & Procurement, KPTCL, Kaveri Bhavan, Bangalore -560 009.

- b) Three sets of copies of all approved drawings along with three sets of literature and manuals to each of the consignee.
- c) Non supply or part supply of drawings, literature and manual will be deemed as incomplete supply of equipment.

The contract drawings shall cover the following

- a) Principal layout drawing as per clause No. 31.01 (a).
- b) Details of construction and dimensions of the cubicle and complete switch board.
- c) Foundation drawings indicating the cable entries and trenches etc.
- d) Elementary diagrams of all controls, metering, protection, annunciation and other circuits. All devices shall be numbered according to ASA code.
- e) Cabling and wiring diagram of the front and rear cubicles and interconnections between them. Ferrule numbers device members, grouping for cable take offs etc., shall be distinctly shown.
- f) Inter-connection diagram between switch board and switchgear equipment, power transformers, instrument transformers and other associated equipment.
- g) Dimensional outline, drilling diagram and special mounting arrangement, if any, of each type of the various devices on the switch board.
- h) Individual internal wiring diagram of all devices and elementary wiring diagrams or relays for internal wiring.
- i) Construction details of the switches, terminal blocks and test blocks etc.

49.03 LITERATURE:

In the event of an order, seven copies of each set of the following literatures shall be supplied.

- a) Literature describing construction, operation, testing, calibration, adjustment, rating, specifications, setting details of all the protective and auxiliary relays and control switches.

- b) Literature giving rated data, details of adjustments for calibration for the indicating instruments and integrating instruments.
- c) List of spare parts, identification number from removable parts of relays, instruments and switches etc., with the help of which the purchaser will be able to procure spare parts from the supplier at any subsequent time.
- d) Performance application of relays.
- e) Detailed internal drawings of all units / schematic diagrams of all, PCB's of the relays, reference voltages at convenient test points, functional description, operational details. This is essential for trouble shooting of the relays.
- f) The literature shall contain wave forms / voltages etc at selected points for easy identification of faulty units with in the modular unit.

50.0 TESTS, TEST CERTIFICATES AND INSPECTION:

50.01 The following routine tests shall be carried out on the panels at the factory:

- a) Checking of overall dimensions, thickness of panel sheet and paint film.
- b) Checking wiring and continuity of circuits.
- c) One minute HV withstand test – All equipment on panel and internal wiring shall be tested to withstand a voltage of 2KV to earth for one minute.
- d) Insulation resistance of the complete wiring, circuit by circuit with all equipment mounted on the panel.
- e) Verification of degree of protection as per IS -2147

50.02 All relays shall be subject to type tests and routine tests as per relevant standards, that is IS - 3231 or IEC - 60255.

50.03 All other components including indicating instruments and accessories installed within the panel shall be subject to type tests, routine tests and acceptance tests according to the standards to which they conform.

50.04 All routine and acceptance tests shall be conducted in the presence of the purchaser's representatives. No material shall be dispatched unless the purchaser communicates his written approval to these test certificates.

50.05 Type Tests Reports:

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).

50.06 Steady state & dynamic characteristics test reports on the distance protection relays as type test, shall be based on general guidelines specified CIGRE Committee 34 report on evaluation of characteristics and performance of power system protection relays and protective system A on simulator/network analyzer /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.

51.0 Spares

51.01 The tenderer shall recommend in his offer a set of spares as are required for a period of 5 (five) years in respect of relays and instruments quoted. All like spare parts shall be interchangeable with respect to each other and shall therefore be suitable for the parts/components that they would replace.

51.02. The tenderer shall indicate the life expectancy or shelf life of all such spares and their recommended method of storage.

51.03 Itemized unit price rate for each component shall be furnished in the schedule of prices in tender proposal sheets. The purchaser reserves the right to order for the spares which in his assessment are actually required.

52.0 MAINTENANCE TOOLS AND EQUIPMENT:

- 52.01 a) The tenderer shall offer in his tender a set of special tools as are necessary for routine maintenance and testing of the equipment. These shall include amongst others relay test jacks, patch cords, etc.
 - b) The tenderer is required to supply these tools arranged neatly in wooden boxes.
 - 52.02 a) The tenderer shall offer in his tender, instruments and equipment's for conducting tests on relays and instruments. The relay testing kits shall be suitable for conducting dynamic tests on the relays to ascertain their characteristics as also to conduct periodical calibration and maintenance tests.
 - b) The testing kits, shall be self contained compact portable units with built in power supply units and timers. If the test equipment contains more than one unit then no extensive inter unit wiring shall be involved at site. The kits shall be capable of being operated off the auxiliary AC & DC power supplies specified in this tender document.
- 52.03 Itemized unit price rate of each such tool/equipment shall be furnished in the schedule of prices in tender proposal sheets.

53.0 QUALITY ASSURANCE PLAN:

The tenderer shall invariably furnish the following information along with his offer failing which his offer shall be liable for rejection.

- a) Names of sub-suppliers of individual accessories.
- b) Information and copies of test certificates in respect of bought out accessories.
- c) List of manufacturing facilities available.
- d) List of areas in manufacturing process where stage inspections are carried out for quality assurance and details of such tests and inspection.
- e) The type tests certificates should however be not older than Ten (10) years as on the **last date of submission of bid**.

53.01 The supplier shall within 30 days of placement of order, submit following information to the purchaser.

- i) List of bought out accessories and the names of sub-suppliers selected from those furnished along with offer.
- ii) Type test certificates of the bought out accessories.
- iii) Quality assurance plan (QAP) with hold points for purchaser's inspection. The quality assurance plan and hold points shall be discussed between the purchaser and supplier before the QAP is finalised.

53.02 The supplier shall submit the routine test certificates of bought out items, at the time of routine testing of the fully assembled panel.

54.0 MINIMUM EXPERIENCE FOR QUALIFYING AS A TENDERER :

- i. Tenderers shall have a minimum experience of five years in the design, manufacture, testing and commissioning of Control and Relay panels, similar to the type specified in the present enquiry. At least 50% of the quantity of similar type of main protection relays i.e., distance and differential, over fluxing, REF relays and Bus bar protection relays called for in the present enquiry shall be in successful operation for a minimum period of two years. The tenderer shall furnish performance certificate for satisfactory operation of similar main protection relays for a minimum period of two years. The tenderer shall furnish the type test certificates for tests conducted on a similar relay not later than Ten years **as on the last date of submission of bid.**
- ii. The tenderer should be the original manufacturer of at least 50% of the total relay types mentioned, viz., distance relays, auto re-close relays, differential relays and back up protection relays, High speed trip relays, LBB, Bus bar protection relays, over-fluxing and REF relays.
- iii. The purchaser however reserves the right to waive the minimum experience condition stipulated in clause 36.00 (i) in case of Firm having collaboration with well experienced Firms. The experience of the collaborating Firms in the manufacture of similar type of main protection relays shall be not less than five years. The waiving of minimum experience condition will be considered by the purchaser only on furnishing the performance guarantee for the main protection relays manufactured by the collaborating Firms.

55.0 PERFORMANCE GUARANTEE :

The control and relay panels along with the main protection relays offered shall be guaranteed for satisfactory performance for a period of 42 months from the date of satisfactory commissioning of C & R Panels. The equipment/relays if found defective/failed within the above guarantee period shall be replaced or repaired by the supplier free of cost within one month from receipt of intimation. If the defective/failed equipments/relays are not replaced/repaired

as per the above guarantee clause, the corporation shall recover an equivalent amount plus 15% supervision charges from any of the supplier's bills.

56.0 TRAINING TO BOARD ENGINEERS :

56.01 The purchaser requires that training be imparted to eight Engineers of the Purchaser's organization in the testing, commissioning, calibration, adjustment, trouble shooting and attending to routing defects, mal-operations in the relays and instruments supplied. Such training shall be imparted at the supplier's works for a period of not less than 2 (two) weeks and shall be imparted free of cost. The to and fro travel expenses of these Engineers will be borne by the purchaser. However boarding, lodging and other incidental expenses related there to shall be borne by the supplier.

56.02 In case training is to be imparted at the works of the supplier's collaborators. Then the same shall be arranged for by the supplier.

56.03 The training shall be imparted before dispatch of the equipment.

57.0 DESPATCH :

57.01 The control and relay panels shall be dispatched in suitable crates with all instruments, relays, switches and other devices mounted in position and wired. Instruments which cannot be sent in this manner may be separately dispatched.

57.02 The detailed dispatch schedule for each control & relay panel board shall be supplied well in advance. In the schedule, items accompanying the control panel items separately despatched in crates and items for which only drilling and wiring is provided shall be separately listed.

57.03 The packing list for each shipment shall indicate complete details of equipment being shipped to enable to consignee to identify the parts and to ensure that no equipment stated to have been shipped has either lost in transit or if damaged, to initiate replacement proceedings and also to enable the insurance claims to be preferred. If the invoice does not contain full details, if any part not specifically mentioned in the packing list is missing in transit the supplier shall be responsible for supply of such parts to the purchaser without any extra cost.

58.0 DEVIATION FROM TECHNICAL SPECIFICATIONS :

58.01 The tender can suggest modification in the protective scheme detailed in the specification if it improves the discrimination selectivity and overall performance of the protection scheme, clearly giving all the details.

59.0 SCHEDULE OF REQUIREMENTS AND DELIVERY :

59.01 The schedule of requirement of components is detailed in annexure. The tenderer should furnish the breakup prices for various relays and meters for future addition and deletion.

59.02 Station wise schedule of requirement along with the desired delivery is detailed in Annexure. In case of new stations the basis of comparison will be on package basis i.e. on the complete requirement of a station.

59.03 The purchaser may ask for addition or deletion of some items during the time of verification of drawings. The Firm shall agree to supply any additions(at extra cost, if any).

59.05 In view of 41.04 and also due to other reasons, there may be change in the components of the panels which will be decided at the time of approval of drawings. In the event of difference of components between purchase order and approved drawing, payment will be made as per approved drawing.

60.0 SCHEDULE OF PRICE:

60.01 The tenderer should furnish the schedule of prices for each type of panel station wise. The supplies should be complete in all respects as stipulated in annexure and preference will be given to tenderers who confirm that this delivery can be met. The tenderer should indicate in this offer the breakup of time required for (1) collecting design parameters from purchaser, (2) Designing of panels and preparation of detailed drawings, (3) Approval of drawing, (4) fabrication of panels and testing and (5) transportation to site. This information will be used for the purpose of calculating penalty etc.

60.02 The tenderer shall furnish the breakup price for each of the component of panels. Decision in regard to adding or deleting any of the component rests with the purchaser.

61.0 GUARANTEED TECHNICAL PARTICULARS:

61.01 The tenderer should furnish the guaranteed technical particulars as called for in Annexure, failing which the offer is liable to be overlooked.

SECTION -2 - SUBSTATION AUTOMATION SYSTEM

1.0 GENERAL:

1.1 The substation automation system shall be offered from a manufacturer who must have designed, manufactured, tested, installed and commissioned Substation Automation System which must be in satisfactory operation on 220 KV system or higher for at least 2 (two) years as on the date of bid opening.

1.2 The Substation Automation System (SAS) shall be installed to control and monitor all the substation equipments from Remote Control Centre (RCC) as well as from local control centre.

The SAS shall contain the following main functional parts:

- Bay control Intelligence Electronic Devices (IEDs) for control & monitoring.
- Station Human Machine Interface (HMI)
- Redundant managed switched Ethernet Local Area Network communication infrastructure with hot standby.
- Gateway for remote control via industrial grade hardware (to RCC) through IEC 60870-5-104 protocol.
- Gateway for remote supervisory control (to RSCC), the gateway should be able to communicate with RSCC on IEC 60870-5-104 protocol. The specific protocol to be implemented shall be handed over to successful bidder. It shall be bidders responsibility to integrate his offered system with existing RSCC system for exchange of desired data. The exact IO point shall be decided during detailed engineering.

Note: The Contractor shall provide License for IEC 60870-5-104 Protocol and Integrate the SAS system to the KPTCL SCADA system.

- Remote HMI.
- Peripheral equipment like printers, display units, key boards, Mouse etc.

1.3 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) functions.

1.4 It shall include communication gateway, intelligent electronic devices (IED) for bay control and inter IED communication infrastructure. An architecture drawing for SAS is enclosed.

1.5 The communication gateway shall facilitate the information flow with remote control centers. The bay level intelligent electronic devices (IED) for protection and control shall provide the direct connection to the switchgear without the need of interposing components and perform control, protection and monitoring functions.

2.0 **SYSTEM DESIGN:**

2.1 **General system design.**

The Substation Automation System (SAS) shall be suitable for operation and monitoring of the complete substation including future extensions as given in Section-Scope of work.

The system 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, ensure long-term compatibility requirements and continuity of equipment supply and the safety of the operating staff.

The offered SAS shall support remote control and monitoring from Remote Control centers via gateways.

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 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.

Bidder shall provide the Bay level unit (a bay comprises of one circuit breaker and associated disconnect or, earth switches and instrument transformer, bay mimic) in the simplex relay and protection panels itself. The protection panels and PLCC panels (described in other section of Technical specifications) housed in air conditioned Kiosks suitably located in switch yard or in the relay room and Station HMI is located in Control Room for overall optimization in respect of cabling.

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 and a bay level.

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.

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.

The data exchange between the electronic devices on bay and station level shall take place via the communication infrastructure. This shall be realized using fibre-optic cables, thereby guaranteeing disturbance free communication. The fibre optic cables shall be run in G.I. conduit pipes. Data exchange is to be realised using IEC-61850 ed1 & ed2 (Site selectable) 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 where in the redundant connections are not envisaged, such that failure of one set of fibre shall not affect the normal operation of the SAS. However, failure of fibre shall be alarmed in SAS. Each fibre optic cable shall have four (4) spare fibres.

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 centres.

The GPS time synchronising signal (as specified in the section relay & protection) for the synchronization of the entire system shall be provided.

The SAS shall contain the functional parts as described in para 1.2 above.

2.3 Functional Requirements:

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

- Remote control centres.
- Station HMI.
- Local Bay controller IED

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. (see description in “Bay level control functions”).

2.3.1 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.

2.3.2 Command supervision: Bay/station Interlocking and blocking.

Software Interlocking is to be provided to ensure that inadvertent incorrect operation of switchgear causing damage and accident in case of false operation does not take place. In addition to software interlocking hardwired interlocking are to be provided for:

- a) Bus Earth Switch Interlocking.
- b) Transfer Bus Interlocking (if applicable).

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 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.

2.3.4 Self-supervision.

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

2.3.5 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 BAY LEVEL FUNCTIONS:

3.1 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 functionality in bay control/protection unit.
- Bay protection functions.

Separate IEDs shall be provided for bay control function and bay protection function.

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.

- Synchrocheck, voltage selection.
- Run Time Command cancellation
- Transformer tap changer control (Raise and lower of Tap) (for power transformer bays)
- Operation counters for circuit breakers and pumps
- Hydraulic pump/Air compressor control and runtime supervision /spring mechanism supervision
- Operating pressure supervision through digital contacts only.
- Display of interlocking and blocking.
- Breaker position indication per phase
- Isolator Position Indication
- Alarm annunciation
- Measurement display
- Local HMI (local guided, emergency mode)
- Interface to the station HMI.
- Data storage for at least 200 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 push buttons 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 detailed in Section-Relay & Protection panels.

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 –Relay & Protection panels.

3.1.2.2 **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 values for voltage (U) and current (I) shall be calculated in the Bay control/protection unit. The analogue values acquired/calculated in Bay control/Protection unit shall be displayed locally on the Station HMI and in the Control Centre. The abnormal values must be discarded. The analog values shall be updated every 2 seconds.

Threshold limit values be selectable for alarm indications.

3.2 **System level functions:**

3.2.1 **Status supervision:**

The position of each switchgear, e.g., circuit breaker, isolator, earthing 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 substation auxiliaries. The status and control of auxiliaries shall be done through separate one or more IED and all alarm and analog values shall be monitored and recorded through this IED.

Measurements:

The analogue values acquired/ calculated in bay control/ protection unit shall be displayed totally in the station HMI and in the control centre. The abnormal values must be discarded. The analog values shall be updated every 2 seconds. Threshold limit values shall be selectable for alarm indications.

3.2.2 **Event and alarm handling:**

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 ms. The tentative list for various feeders and system are enclosed as Annexure – I.

3.2.3 **Station HMI.**

3.2.3.1 **Substation HMI Operation:**

On the HMI the object has to be selected first. In case 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.

3.2.3.2 **Presentation and dialogues.**

General:

The operator station HMI shall be 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. 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 and measured values.
- Control dialogues with interlocking and blocking information details. This control dialogue shall tell the operator whether the device operation is permitted or blocked.
- Measurement dialogues.
- Alarm list, station / bay-oriented.
- Event list, station / bay-oriented.
- System status.

3.2.3.3 **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

3.2.3.4 **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 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.

3.2.3.5 **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.

3.2.3.6 **Event list.**

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

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.

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 for at least one month. The information shall be obtainable also from a printed event log.

The chronological event list shall contain:

- Position changes of circuit breakers, isolator and earthing devices.
- Indication of protective relay operations.
- Fault signals from the switchgear.
- Indication when analog 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.
- 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.

3.2.3.7 **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 acknowledgment 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 is 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.

3.2.3.8 **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
 - RSCC / SAS control
 - Errors etc.,
- shall be displayed.

3.2.3.9 **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.

3.2.4 **User-authority levels:**

It shall be possible to restrict activation of the process pictures of each object (bays, apparatus...) within a certain user authorisation 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 authorisation 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 log-in procedure. Only the system administrator shall be able to add / remove users and change access rights.

3.2.5 **Reports:**

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

- **Trend reports:**
 - Day (mean, peak)
 - Month (mean, peak)
 - Semi-annual (mean, peak)
 - Year (mean, peak)

➤ **Historical reports of selected analog values:**

- Day (at 15 minutes interval)
- Week
- Month
- 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 voltage 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 analog values.
- iii. Printouts of the maximum and minimum values and frequency of occurrence and duration of maximum and minimum values for each analog parameter for each circuit in 24 hours period.
- iv. Provision shall be made for logging information about breaker status like number of operation with date and time indications along with current value it interrupts (in both condition ie., manual opening and fault tripping).
- 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, temperature and status of pumps and fans for transformers.
- vii. Printout on adjustable time period as well as on demand system frequency and average frequency.
- viii. 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 data base.

3.2.6 Trend display (historical data):

It shall be possible to illustrate all types of process data as trends – input and output data, binary and analog 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.

3.2.7 Automatic disturbance file transfer:

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

3.2.8 Disturbance analysis:

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

3.2.9 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.

3.2.10 Automatic sequences:

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

3.2.12 A set of following ETVM reading display and reports (ETVM Provided in Relay & Protection Panel) are required in the Station HMI.

- i) To present data read from meters.
- ii) To schedule meter reading and to select individual meters for manual reading.
- iii) To remotely program the electronic meters.
- iv) To manage the billing data and prepare it for exporting to other systems.

Other than the above parameters, those specified in the Annexure CRP-TVM shall also be provided.

The contents and format of meter reading displays shall be subject to approval by the purchaser

3.3 Gateway:

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 Regional System Coordination Centre (RSCC).

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 centres (RCC & RSCC). 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 centres data scan and control commands may be different for different data points within the substation automation systems database.

3.3.2 Remote Control Centre Communication Interface:

Employer will supply communication channels between the Substation Automation System and the remote control centre. The communication channels provided by Employer will consist either of power line carrier, microwave, optical fibre, VSAT or leased line, the details of which shall be provided during detailed Engineering.

3.3.3 Interface equipment:

The Contractor shall provide interface equipment for communicating between Substation Automation System and Remote control centre and between Substation Automation System and Regional System Coordination Centre (RSCC). However, the communication channels available for this purpose are specified in the section project.

In case of PLCC communication any modem supplied shall not require manual equalization and shall include self-test features such as manual mark/space

keying, analog loop-back, and digital loop-back. The modems shall provide for convenient adjustment of output level and receive sensitivity. The modem should be stand alone complete in all respects including power supply to interface the SAS with communication channel. The configuration of tones and speed shall be programmable and maintained in non-volatile memory in the modem. All necessary hardware and software shall also be in the scope of bidder except the communication link along with communication equipment between substation control room and Remote Control Centre.

3.3.4 **Communication Protocol:**

The communication protocol for gateway to control centre must be open protocol and shall support IEC 60870-5-104 and IEC 61850 ed1 & ed2 (Site selectable) for all levels of communication for substation automation such as Bay to station HMI, gateway to remote station etc.

4.0 **SYSTEM HARDWARE:**

4.1 **Redundant Station HMI, HMI View Node, Remote HMI, Disturbance Recorder Work Station and Energy measurement workstation:**

The contractor shall provide redundant station HMI in hot standby mode. The servers used in these works station shall be of industrial grade.

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.

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 analog data (at 15 minutes interval) and digital data including alarm, event and trend data for thirty (30) days.
2. Storage of all necessary software.
3. 20 GB space for OWNER's use.

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

The Minimum requirement of **Redundant Station HMI, Main HMI View Node:**
Processor:i7 or above

RAM: 24GB.

Hard disk: 1TB

The Minimum requirement of **Energy Measurement System workstation and Disturbance Recorder Work Station:**

Processor: i7 or above
RAM: 8GB.
Hard disk: 1TB

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 21" diagonally in size 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 vis push button or other controls.

4.1.3 **Printer:**

It shall be robust & suitable for operation with a minimum of 132 characters per line. 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 printers mounted in the control room shall be provided with a separate printer enclosure each. The enclosure shall be designed to permit full enclosure of the printers at a convenient level. Plexiglas windows shall be used to provide visual inspection of the printers and ease of reading. The printer enclosures shall be designed to protect the printers from accidental external contact and each should be removable from hinges at the back and shall be provided with lock at the front.

All reports and graphics prints shall be printed on laser printer. One dot matrix printer shall be exclusively used for hourly log printing.

All printers shall be continuously online.

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 Filesystems. 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.

4.1.6 **Interconnection Cables & Wiring:**

The contractor shall provide all interconnecting wires, cables, connectors, terminations, local area network (LAN) cables and other wiring required by field devices and IED's including cabling required for interfacing with Marshalling Box. **The fiber optic cable between switchyard panel room (AC kiosk) and from switchyard panel room to control room shall be laid in rodent proof PLB pipe.**

4.1.5 **Switched Ethernet Communication Infrastructure:**

The bidder shall provide the redundant switched optical Ethernet communication infrastructure for SAS. The bidder shall keep provision of 50-100% spare capacity for employer use. One switch shall be provided to connect all IED's in one diameter for each 400kV yard and for two bays of 220kV yard to communication infrastructure. Earth switch shall have at least two spare ports for connecting bay level IED's and one spare port for connecting station bus.

4.2 **Bay level 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 external input analog 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 substation 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 400kV bays (a bay comprises of one circuit breaker and associated disconnecter, earth switches and instrument transformer). The bay level unit shall be equipped with analog and binary inputs / outputs for handling the control, status monitoring and analog 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 control unit to be provided for the bays shall be preferably installed in the CB relay panel/feeder protection panel for respective bay. Further in case of one and half breaker schemes, the BCU for Tie CB shall be provided in Tie CB relay panel. The Tie CB relay panel shall also house the Ethernet switch (es) to be provided for the diameter. The bay control unit for future bay (if required as per section project) shall be installed in a separate panel.

The bay level unit shall meet the requirements for withstanding electromagnetic interference according to relevant parts of IEC 61850 ed1 & ed2 (Site selectable). Failure of any single component within the equipment shall neither cause unwanted operation nor lead to a complete system breakdown.

4.2.1 **Input / Output (I/O) modules:**

The I/O module shall form a part of the bay level unit 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 digital inputs shall be reported by exception with 1 ms resolution. Contact bouncing in digital inputs shall not be assumed as change of state.

4.3 Switchyard panel room: **Air Conditioned Kiosk**

The RCC framed Air-conditioned Kiosk offered shall house Bay level units, bay mimic, relay and protection panels, PLCC panels etc. one each for a diameter in 400kV sub-station. In case of incomplete diameter the kiosk shall have necessary space for accommodating the future bay IEDs. The layout of equipment/panel shall be subject to Owner's approval. The Kiosk shall be provided with fire alarm system with at least two detectors with necessary power supply **if required and it shall be wired to SAS. The detailed requirement of Kiosk** is enclosed as Annexure-II. The air conditioner provided in Kiosk shall be monitored from substation automation system. One additional Kiosk for each voltage level, if required, shall be provided for housing bus bar protection panels at suitable location in switchyard.

4.4 **Extendibility in future:**

Offered substation automation system shall be suitable for extension in future for additional bays indicated in SLD & additional minimum 6 bays for each KV reference. 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 analog variable, alarm list, event list, modify interlocking logics etc., for additional bays / equipment which shall be added in future. There shall be provision for change of designation of bay as and when necessity arises.

5.0 **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.

5.1.1 **Station level software**

5.1.1.1 **Human-machine interface (HMI)**

The base HMI software package for the operator station shall include the main SAS functions. 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.

5.1.2 **Bay level software: System software:**

- 5.1.2.1 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 synchronising with the remaining system without any manual interface. This shall be demonstrated by contractor during integrated system test.

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

5.1.2.3 Network Management System:

The contractor shall provide a 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 workstation 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.

5.1.2.4 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.

6.0 TESTS:

The substation automation system offered by the bidder shall be subjected to following tests to establish compliance with IEC 61850 ed1 & ed2 (Site selectable) for EHV substation equipment installed in the control room and specified ambient conditions:

6.1 Type Tests:

6.1.1 Control IEDs and Communication Equipment:

- a) Power Input:
 - i. Auxiliary Voltage.
 - ii. Current Circuits.
 - iii. Voltage Circuits.

- iv. Indication
- 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

6.2 Factory Acceptance Tests:

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 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 itself. 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).

6.3 VOID

6.3.1 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. The device shall be from different manufacturer than the SAS supplier.

6.3.2 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.

6.4 Site Acceptance Test:

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 the specification.

7.0 **SYSTEM OPERATION:**

7.1 Substation Operation:

7.1.1 Normal Operation:

Operation of the system by the operator from the remote RCC or at the substation 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 mode 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 colour. 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.

8.0 POWER SUPPLY:

Power for the substation automation system shall be derived from substation 220 V DC system. Inverter of suitable capacity shall be provided for station HMI 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.

9.0 DOCUMENTATION:

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

- a) System Architecture Drawing.
- b) Hardware Specification.
- c) Sizing Calculations of various components.
- d) Clear procedure describing how to add an IED/bay/diameter in future.
Covering all major suppliers.

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 provided in "dfx" format.

- i. List of drawings.
- ii. Substation Automation System architecture.

- iii. Block Diagram.
- iv. Guaranteed Technical Parameters, Functional Design Specification and Guaranteed availability and reliability.
- v. Calculation for power supply dimensioning.
- vi. I/O Signal lists.
- vii. Schematic diagrams
- viii. List of Apparatus. List of Labels.
- ix. Logic Diagram (hardware & software). --Panel Kiosks layout drawing.
- x. GA of Kiosk and GTP.
- xi. Control Room Layout.
- xii. Test Specification for Factory Acceptance Test (FAT).
- xiii. Product Manuals.
- xiv. Assembly Drawing. Operators Manual.
- xv. Complete documentation of implemented protocols between various elements. Listing of software and loadable in CD ROM.
- xvi. 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 to CEE (T&P) and to each of the consignee.

10.0 TRAINING, SUPPORT SERVICES. MAINTENANCE AND SPARES:

10.1 Training:

Contractor personnel who are , experienced instructors and who speak understandable English shall conduct training. The contractor shall arrange on his own cost all hardware & software 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 to 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.

For all training courses, the travel (e.g., airfare) and per-diem expenses will be borne by the participants. The cost of all Training courses will be borne by the contractor. Employer will have the option to cancel any or all-training courses. The schedule location and detailed contents of each course will be finalized during Employer and Contractor discussions.

10.2 Computer System Hardware Course:

A computer system hardware course shall be offered, but at the system level only. The training course shall be designed to give Employer hardware personnel sufficient knowledge of the overall design and operation of the system so that they can correct obvious problems, configure the hardware, perform preventive maintenance, run diagnostic programs and communicate with contract maintenance personnel. The following subjects shall be covered:

a) System Hardware Overview:

Configuration of the system hardware.

b) Equipment Maintenance:

Basic theory of operation. maintenance techniques and diagnostic procedures for each element of the computer system. e.g. processors, auxiliary memories, LAN's routers and printers. configuration of all the hardware equipment's.

c) System Expansion:

Techniques and procedures to expand and add equipment such as loggers, monitors and communication channels.

d) System Maintenance:

Theory of operation and maintenance of the redundant hardware configuration, fail over hardware, configuration control panels and failover switches. Maintenance of protective devices and power supplies.

e) Subsystem Maintenance:

Theory of design and operation. maintenance techniques and practices, diagnostic procedures and (where applicable) expansion techniques and procedures. Classes shall include hands-on training for the specific subsystems that are part of Employer's equipment or part of similarly designed and configured subsystems. Computing All interfaces to the computing equipment shall be taught in details

f) Operational Training:

Practical training on preventive and corrective maintenance of all equipment, including use of special tools and instruments.

This training shall be provided on Employer equipment or on similarly configured systems.

10.3 Computer System Software Course:

The Contractor shall provide a computer system software course that covers the following subjects:

a) System Programming:

Including all applicable programming languages and all stand-alone service and utility packages provided with the system. An introduction to software architecture. effect of tuning parameters (OS software, Network software, database software etc.) on the performance of the system.

b) Operating System:

Including the user aspects of the operating system, such as program loading and integrating procedures, scheduling, management, service and utility functions and system expansion techniques and procedures.

c) System Initialization and Failover:

Including design, theory of operation and practice.

d) Diagnostics:

Including the execution of diagnostic procedures and the interpretation of diagnostic outputs.

e) Software Documentation:

Orientation in the organization and use of system software documentation.

f) Hands-on Training:

One week with allocated computer time for trainee performance of unstructured exercises and with the course instructor available for assistance as necessary.

10.4 Application Software Course:

The Contractor shall provide comprehensive application software courses covering all applications including the database and display building course. The training shall include:

a) Overview: Block diagrams of the application software and data flows. Programming standards and programme interface conventions.

b) Application Functions: Functional capabilities, design and major algorithms. Associated maintenance and expansion techniques.

c) Software Development: Techniques and conventions to be used for the preparation and integration of new software functions.

d) Software Generation: Generation of application software from source code and associated software configuration control procedures.

- e) software Documentation: Orientation in the organization and use of functional and detailed design documentation and of programmer and user manuals.
- f) Hands-on Training: One week, with allocated computer time for trainee performance of unstructured exercises and with the course instructor available for assistance as necessary.

Requirement of training:

The contractor shall provide training for two batches for two-weeks each for following courses:

| Sl. No. | Name of the Course |
|---------|--------------------------|
| 1. | Computer System Hardware |
| 2. | Computer System Software |
| 3. | Application Software |

11.0 **MAINTENANCE RESPONSIBILITY:**

11.1 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 the guarantee period as specified in the tender document contractor shall arrange bi-monthly visit of their representative to site to review the performance of system and in case any defects/shortcoming etc. is observed during the period the same shall be set right by the contractor within 15 days.

12.0 **RELIABILITY AND AVAILABILITY:**

12.1 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:

- a) Mechanical and electrical design.
- b) Security against electrical interference (EMI)
- c) High quality components and boards.
- d) Modular, well-tested hardware.

- e) Thoroughly developed and tested modular software.
- f) Easy-to-understand programming language for application programming.
- g) Detailed graphical documentation and application software.
- h) Built-in supervision and diagnostic functions.
- i) Security
- j) Experience of security requirements
- k) Process know--how
- l) Select before execute at operation
- m) Process status representation as double indications
- n) Distributed solution.
- o) Independent units connected to the local area network
- p) Back-up functions
- q) Panel design appropriate to the harsh electrical environment and ambient conditions.
- r) Panel grounding immune against transient ground potential rise.

Outage terms:

i. Outage:

The state in which substation automation system or a unit of SAS is unavailable for Normal Operation as defined in the clause 7.1 due to an event directly related to the SAS or unit of SAS. In the event, the owner has taken any equipment/system other than Substation Automation System for schedule-forced maintenance, the consequent outage to SAS shall not be considered as outage for the purpose of availability.

ii. 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.

iii. 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).

iv. Actual Outage hours (AOH):

The sum of actual outage duration within the reporting period $AOH = \Sigma AOD$
v. 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 substation automation system as a Whole after commissioning of total substation 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 and after rectification, the 1000 Hours period start after such rectification. If test object has not been met the test shall continue 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.

13.0 **SPARES:**

13.1 Consumables:

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

13.2 Availability Spares:

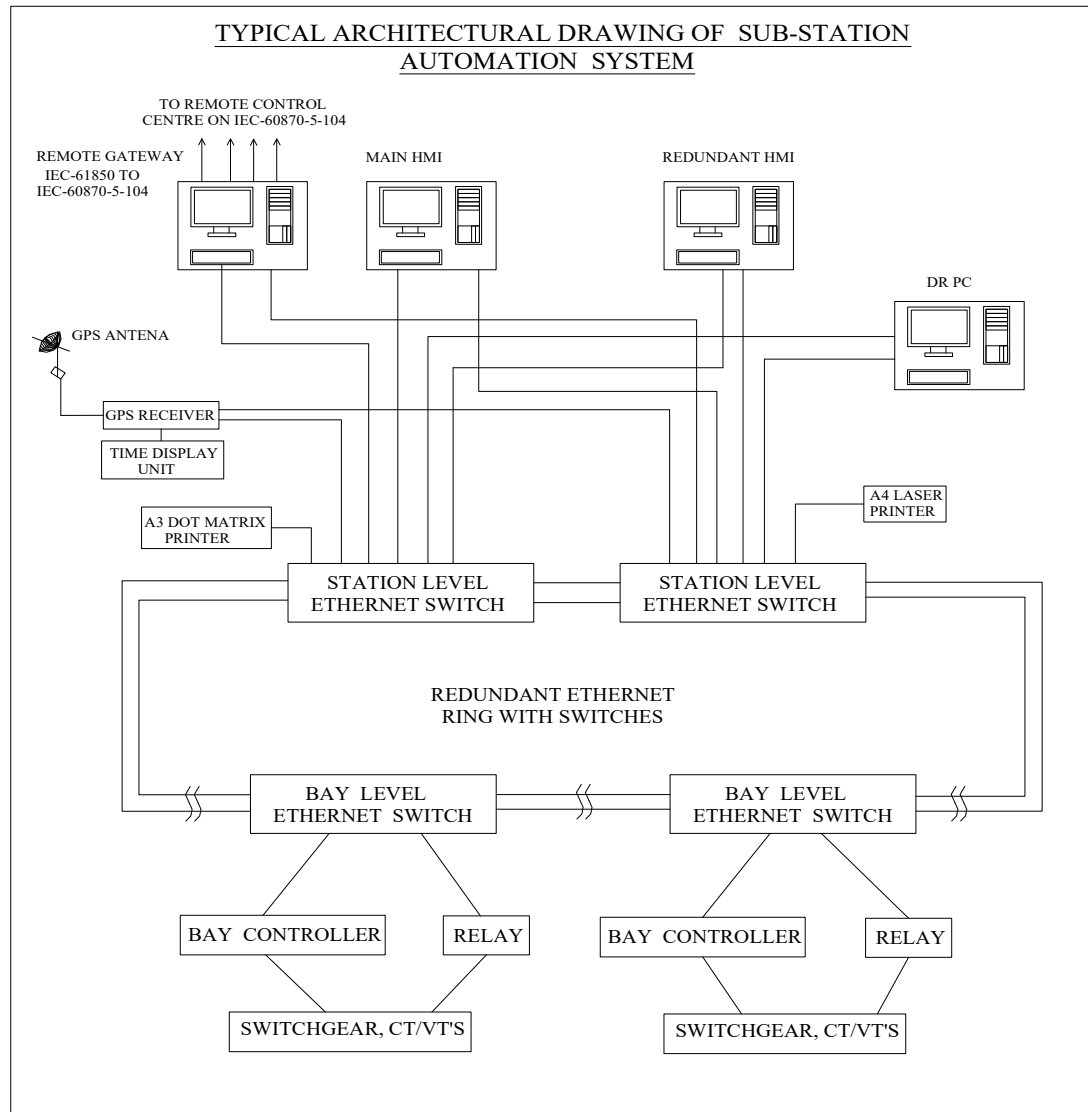
In addition to mandatory spare as listed in section project for SAS, the bidder is required to furnish the list of spares, which may be required for ensuring the guaranteed availability during the guaranteed availability period. The final list of spares shall form part of scope of supply and accordingly 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.

14.0 **LIST OF EQUIPMENTS:**

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

- a) Station HMI.
- b) Redundant Station HMI (in Hot standby mode).
- c) Bay level units along with bay mimic as detailed in section Scope of work.
- d) Disturbance Recorder Work Station (Maintenance HMI).
- e) Colour Laser Printer - 1 No. (For Reports & Disturbance Records).
- f) Dot Matrix Printer - (one each for Alarms and log sheets).
- g) All interface equipment for gateway to RCC and RSCC.
- h) Communication infrastructure between Bay level units, Station HMI Printers, gateways, redundant LAN etc.. as required.
- i) -void.
- j) Bay level unit for Auxiliary system (As per requirement) .
- k) Modem as per requirement.
- l) Energy Measurement System work station
- m) Any other equipment as necessary.
- n) **Data concentrator Sync 3000** -for collection of DR from Numerical relays:
The Data concentrator should collect the Disturbance Recordings from each numerical relays automatically and the data should be made available at existing RAS system (Remote DR System) of M/s Kalkitech in service at KPTCL SLDC, Bangalore. The required compatible software and hardware shall be provided including interfacing.



NOTES:

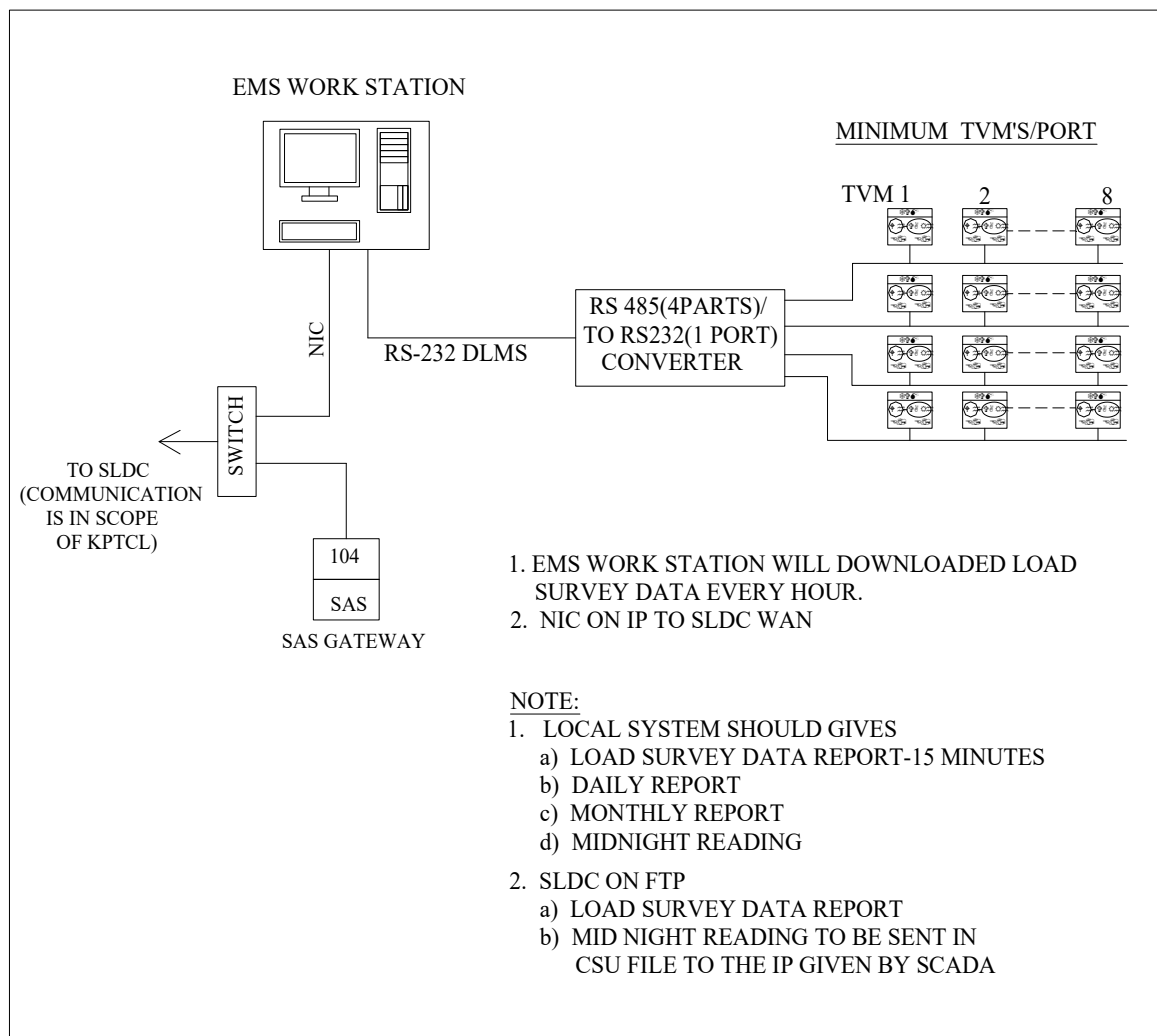
1. STATION BUS SHALL BE REALIZED BY HIGH SPEED **REDUNDANT** OPTICAL BUS USING INDUSTRIAL GRADE COMPONENTS AND SHALL BE AS PER IEC 61850 ed1 & ed2 (Site selectable).
2. IEDS FOR TWO BAYS MAY BE HOUSED IN ONE PANEL ALONG WITH ITS SWITCH.
3. INSIDE THE SUB STATION, ALL CONNECTIONS SHALL BE REALIZED AS PER IEC 61850 ed1 & ed2 (Site selectable) PROTOCOL.
4. FOR GATEWAY, IT SHALL COMMUNICATE WITH REMOTE SUPERVISORY CONTROL CENTRE (RSCC), REMOTE CONTROL CENTRE (RCC) ON IEC 60870-5-104 PROTOCOL
5. THE ROUTER SHALL COMMUNICATE ON IEC 60870-5-104 PROTOCOL
6. THE PRINTER AS REQUIRED SHALL BE CONNECTED AT STATION BUS DIRECTLY & CAN BE MANAGED EITHER FROM STATION HMI, HMI VIEW NODE OR DISTURBANCE RECORDER WORK STATION.

7. All IEC 61850 ed1 & ed2 (Site selectable) COMPLIANT SIGNALS FROM VARIOUS MONITORING EQUIPMENT/ACCESSORIES FROM TRANSFORMERS & REACTORS SHALL BE WIRED UPTO THE ETHERNET SWITCH.

Note:

1. The following Transformer and Reactors protection/control IEDs are provided, same shall be interfaced to the SAS and shall be shown in the Architecture drawing.
 - a. ITCS
 - b. On line DGA
 - c. Fiber optic temperature monitoring system.
 - d. On line drying system
2. System architecture shall be provided with dual redundant armoured fiber optic network.
3. The communication between substation to SLDC will be arranged by KPTCL. The data engineering has to be done by SAS supplier for integration into existing SLDC SCADA as per KPTCL requirements.
4. For all numerical relays confirming to IEC-61850 protocol necessary CID, ICD, PICS, MICS and PIXIT documents shall be provided in soft copy.
5. The SAS shall be suitable for extension in future for additional bays. The necessary software and hardware licenses shall be provided for additional bays. Minimum 50000 data points (tags) shall be provided.
6. Gateway shall be suitable for communicating minimum 4 numbers of remote control centers.
7. The DLMS TVM's are provided at all C&R panels. Suitable hardware and softwares shall be provided for integration to station SAS and remote SCADA.

TYPICAL ARCHITECTURAL DRAWING OF ENERGY MEASUREMENT SYSTEM



SECTION- IEC 61850 BASED ANNUNCIATOR:

- 1.0 The scope will form a part of supply of control and relay panel for EHV substations which includes installation, wiring, testing and commissioning of IEC 61850 based Annunciator systems with IEC61850 compliant SAS, for extending emergency annunciations/alarms of important events of the sub stations as listed below.**

| A. Mandatory signals for line panel | |
|--|--|
| 1 | CB Low Air Pressure/ Spring Discharged |
| 2 | CB Low Gas Pressure |
| 3 | CB Lockout |
| 4 | Main-1 /Main-2 /BCU Out of Service(Relay Faulty) |
| 5 | Main-1 /Main-2 VT Fuse Fail |
| 6 | Carrier Fail |
| 7 | CB Trip Circuit/ Trip Relay Circuit faulty |
| 8 | Distance Relay operated |
| 9 | Panel DC fail/ CB DC fail |
| 10 | Annunciator DC /AC fail |
| 11 | Annunciator Communication fail |
| 12 | CB Pole discrepancy operated |

| B. Mandatory signals for Power Transformer panel | |
|---|--|
| 1 | HV CB Low Air Pressure / Spring Discharged |
| 2 | HV CB Low Gas Pressure |
| 3 | HV CB Lockout |
| 4 | Differential/ REF/Back Up Relay/BCU Faulty |
| 5 | HV side CB Trip Circuit/ Trip Relay Circuit faulty |
| 6 | Differential Protection Operated |
| 7 | BZ/OSR/PRV operated |
| 8 | Back up Protection (HV/IV) operated |
| 9 | Panel DC fail/ CB DC Fail |
| 10 | 66kV CB Low Air Pressure / Spring Discharged |
| 11 | 66KV CB Low Gas Pressure |
| 12 | 66kV CB Lockout |
| 13 | Panel DC fail/ CB DC fail |
| 14 | Annunciator DC /AC fail |
| 15 | Annunciator Communication fail |
| 16 | Transformer oil level low |
| 17 | Transformer cooler bank /Buchholz trip |
| 18 | Tertiary OCR operated |
| 19 | HV CB pole discrepancy operated |
| 20 | HV/IV REF operated |
| 21 | Oil/Winding temperature High |
| 22 | Spare |
| 23 | Spare |
| 24 | Spare |

Sequence Of Events (SOE) from the annunciator will facilitate easier analysis of the incident whenever there is multiple trappings in the substation.

- 2.0 It is not the intent to specify completely herein all details of the design and construction of the Equipment. However, the equipment shall conform in all respects to high standards of engineering, design and workmanship. Moreover, the equipment shall be capable of performing continuous commercial operation as per the performance guarantees. The offered equipment shall be complete with all components necessary for their effective and trouble-free operation. Such components shall be deemed to be within the scope of tenderer's supply irrespective of whether those are specifically brought out in this Specification and/or the commercial order or not.
- 3.0 The annunciation shall be of visual and audible type. The visual annunciation shall be provided by annunciation facia. The audible alarm shall be provided by alarm buzzer or bell.
- 4.0 The annunciator facia shall be provided with translucent plastic window for alarm point with minimum (34X 69 mm). The facia plates shall be engraved in black lettering with respective inscriptions, which will be approved by KPTCL. Alarm inscriptions shall be engraved on each window in not more than three lines and size of the lettering shall not be less than 5mm.
- 5.0 The facia annunciators can be mounted in one panel for sub-station with kiosk arrangement and can be mounted in the respective panel in case of sub-station with control room concept and this annunciator will act as back up for emergency alarms.**

6.0 Service Condition

Equipment to be supplied under this specification shall be suitable for satisfactory operation under the following tropical conditions.

- 6.1 Maximum ambient temperature (°C): 50
- 6.2 Maximum temperature in shade (°C): 45
- 6.3 Minimum temperature in shade (°C): 3.5
- 6.4 Maximum daily average temperature (°C): 40
- 6.5 Relative humidity (%): 95
- 6.6 Maximum annual rain fall (mm): 1450
- 6.7 Maximum wind pressure (Kg/m²): 150
- 6.8 Maximum altitude above mean sea level (Mtrs.): 1000
- 6.9 Isoceraunic level (days/year): 50
- 6.10 Seismic level (Horizontal acceleration): 0.3g
- 6.11 Moderately hot and humid tropical climate, conducive to rust and fungus growth.
- 6.12 The climatic conditions are prone to wide variations in ambient conditions and the equipment offered shall be suitable for installation at any of the substations in the State.

7.0 Auxiliary Power Supply

The equipment shall suit for auxiliary supply voltage range of 80-250 VDC and 240VAC and shall suit to the rating, quality of the electrical supply system that will be made available by KPTCL for operation of the Annunciator panels. The Annunciator provided by the bidder shall be suitable for the same. The performance of the equipment shall not vary for the above auxiliary supply voltage variations

| | | |
|---|-----------|---|
| 1 | AC supply | Voltage variation +10% to -30% Frequency variation + 5% Both variations may occur simultaneously or independently |
| 2 | DC supply | +10% to -20% |

8.0 Standards

- 8.1 Unless, otherwise specified elsewhere in this specification, the performance and testing of the equipment shall conform to the latest revisions of all the relevant standards, as listed below, available at the time of placement of order.

| Sl.No | Description | Applicable standard |
|-------|-----------------------|--------------------------------|
| 1 | Ingress Protection | IP40 or better |
| 2 | ESD | IEC 61000-4-2 |
| 3 | EFT | IEC 61000-4-4 |
| 4 | Surge | IEC 61000-4-5 |
| 5 | Conducted Emission | CISPR 11 |
| 6 | Voltage dips | IEC 61000-4-11 |
| 7 | High Voltage Test | IEC 60255-5, 2 kV for 1 minute |
| 8 | Insulation Resistance | UL 508, > 50 k Ohms |

- 8.2 Equipment of other authoritative standards meeting with the requirement which ensure equal or better quality than the standards specified above may also be considered. When the equipment offered by the tenderer conform to other standards, salient points of difference between the standards adopted and the standards specified in this specification shall be clearly brought out in the offer. Two copies of such standards in authentic English translation shall be furnished along with the offer.

- 9.0 Detailed engineering regarding inter panel wirings to be done for the 61850 based annunciator panel, importing CID and ICD files from each of the IED's existing and preparation of scheme drawings is in the Bidders scope. Bidder shall import CID and ICD files from each of the IED's to the annunciator. Complete programming of the annunciator as per the approved scheme is to be done by the successful bidder.

- 10.0 Each bay shall be provided with an Annunciator having the following

- 10.1 Window Fascia: The Annunciator should be of Microprocessor based with High bright LED's. The Window color shall be site selectable for red and yellow colors.
- 10.2 Window Count: 12 windows for line & 24 Windows Transformer panel
- 10.3 Aux Supply: 80-250V AC/DC
- 10.4 Standby Supply: 230V AC

10.5 Communication:

- a. IEC61850 Client with Fiber Port and support for Both Ed.1.0 and Ed.2.0
- b. The Annunciator should have capability of Both MMS and GOOSE messaging.
- c. Any Annunciator window can be configured to any MMS tag.
- d. Multiple MMS tags can be mapped to one Annunciator window.
- e. Window mapping to be done through serial port.
- f. Annunciator Should be capable of accessing Report control blocks of IED's (both on data change and polling method)
- g. Sequence of Events (SOE) for individual annunciators should be available through serial port (RS-485 / RS-232)
- h. Annunciator should have provision to connect to the Ethernet switches in the Substation.
- i. No Hardwiring of signals from Bay / panels to the Annunciator.
- j. Annunciator should have facility to import CID/ICD files of the IED's.
- k. Maximum nodes of 500 per Annunciator.
- l. Loss of communication monitoring and mapping to any window.
- m. Annunciator should have facility to invert GGIO MMS Tags through serial port

10.6 General features:

- a. Self-supervision of AC and DC input supply of the Annunciator and mappable to any window by Serial port
- b. Annunciator should have capability to drive indicating lamps directly for showing breaker status etc.
- c. The Annunciator should have group selection for Trip, Nontrip and DC fail relays through serial port and to operate respective hooter relays

11.0 The proposed annunciator shall be interfaced to the respective bay level Ethernet switch.

12.0 Tests

12.1 Type Tests

The basic Annunciator offered in the Tender should have been successfully type tested at any of the internationally accredited laboratory OR NABL accredited laboratory in line with relevant Standards and the Technical Specification within the last 7 years prior to the date of the Tender. Copies of type test reports shall be submitted along with the offer.

12.2 List of Type test

The list of type tests shall include the following
EMI/EMC:

- a. Conducted Emission: As per CISPR-11
- b. Electrostatic Discharge: As per IEC 61000-4-2
- c. Electrical Fast Transient Immunity Test: As per IEC 61000-4-4
- d. High Energy Surge Immunity Test: As per IEC 61000-4-5
- e. Line Voltage Dips Test: As per IEC 61000-4-11

12.3 Type test for IEC 61850 port shall be furnished by the successful bidder. Also necessary test reports for fulfilling cyber security norms shall be furnished.

13.0 All acceptance and routine tests as stipulated in the relevant standards shall be carried out by the supplier in the presence of the Purchaser's representative without any extra cost.

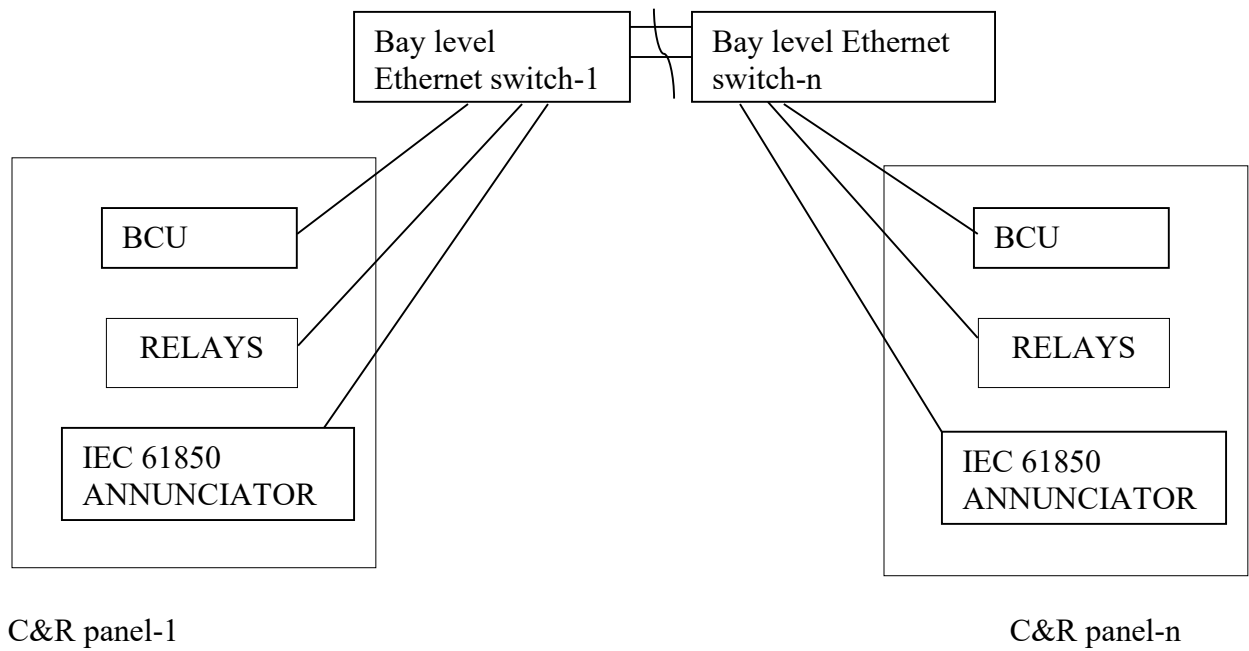
14.0 Immediately after finalization of the program of acceptance/routine testing, the supplier shall give four weeks advance intimation to the purchaser, to enable him to depute his representative for witnessing the tests.

15.0 The supplier shall carryout all the relevant physical verification and functional tests as applicable at his works on all the equipment. Copies of these test certificates duly endorsed by the supplier's testing engineer shall be furnished to the inspecting officer of the Board. The inspecting officer reserves the right to insist for repetition of functional tests on any or all the annunciators offered for inspection, & the supplier shall arrange for the same.

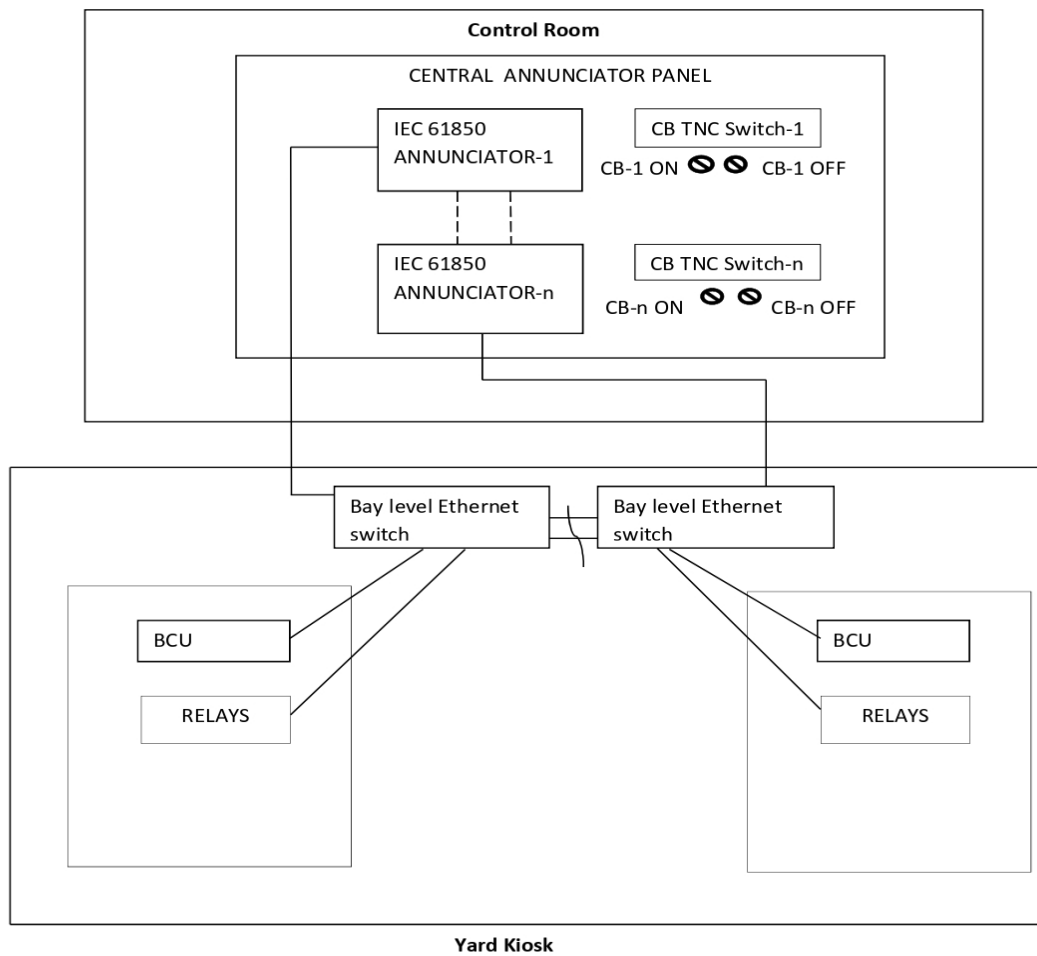
16.0 Training

Onsite training for the O&M staff shall also be provided during commissioning to cover operation, maintenance, and trouble- shooting for the equipment.

17.0 **System architecture for substations with control room concept**



18.0 System architecture for substations with Kiosks arrangement:



15.0 ANNEXURE – I

(GTP IAS)

Basic Monitoring requirements are:

- Switchgear status indication
- Measurements (U, I, P, Q, f)
- Event
- Alarm
- Winding temperature of transformers
- Ambient temperature
- Status and display of 415 V LT system, 220V & 48 V DC system.
- Status of display of Nitrogen injection Fire protection system and Air conditioning system.
- Acquisition of all counters in PLCC panels through potential free contacts from PLCC or independently by counting the receive/send commands.
- Acquisition of alarm and fault record from protection relays
- Disturbance records.
- Monitoring the state of batteries by displaying DC voltage, charging current and load current etc.
- Tap-position of transformer

List of Inputs:

The list of input for typical bays is as below:

Analog inputs:

- i) For line
 - Current R-phase
 - Y-phase
 - B-phase
 - Voltage R-Y phase
 - Y-B phase
 - B-R phase

- ii) For transformer
 - Current R-phase
 - Y-phase
 - B-phase
 - WTI (for transformer and reactor)
 - OTI (for transformer and reactor)
 - Tap position (for transformer only)
- iii) For bus coupler and TBC
 - Current R-phase
 - Y-phase
 - B-phase
- iv) Common
 - a) Voltage for Bus-I & Bus-II
 - Voltage R-Y phase
 - Y-B phase
 - B-R phase
 - b) Frequency for Bus-I & Bus-II.
 - c) Ambient temperature (switchyard).
 - d) Kiosks Temperature.
 - e) LT system
 - i. Voltage R-Y, Y-B, B-R of Main Switchboard Section-I.
 - ii. Voltage R-Y, Y-B, B-R of Main Switchboard Section-II.
 - iii. Voltage R-Y, Y-B, B-R of Diesel Generator.
 - iv. Current from LT transformer-I.
 - v. Current from LT transformer-II.
 - vi. Current from Diesel Generator.
 - vii. Voltage of 220 V DCDB-I.
 - viii. Voltage of 220 V DCDB-II.
 - ix. Current from 220 V Battery Set-I.
 - x. Current from 220 V Battery Set-II.
 - xi. Current from 220 V Battery charger-I.

- xii. Current from 220 V Battery charge-II.
- xiii. Voltage of 48 V DCDB-I.
- xiv. Voltage of 48 V DCDB-II.
- xv. Current from 48 V Battery set-I.
- xvi. Current from 48 V Battery set-II.
- xvii. Current from 48 V Battery charger-I.
- xviii. Current from 48 V Battery charger-II.

Digital Inputs:

The list of input for various bays/SYSTEM is as follows:

1. Line bays

- i) Status of each pole of CB.
- ii) Status of Isolator, Earth switch
- iii) CB trouble
- iv) CB operation/closing lockout
- v) Pole discrepancy optd
- vi) Trip coil faulty
- vii) LBB optd
- viii) Bus bar protn trip relay optd
- ix) Main bkr auto recloser operated
- x) Tie/transfer auto recloser operated
- xi) A/r lockout
- xii) Tie/transfer bkr a/r lockout
- xiii) Direct trip-I/II sent
- xiv) Direct trip-I/II received
- xv) Main I/II blocking
- xvi) Main I/II-Inter trip send
- xvii) Main I/II-Inter trip received
- xviii) O/V STAGE – I operated
- xix) O/V STAGE – II operated
- xx) FAULT LOCATOR FAULTY
- xxi) MAIN-I/II CVT FUSE FAIL
- xxii) MAIN-I PROTN TRIP
- xxiii) MAIN-II PROTN TRIP
- xxiv) MAIN-I PSB ALARM
- xxv) MAIN-I SOTF TRIP
- xxvi) MAIN-I R-PH TRIP
- xxvii) MAIN-I Y-PH TRIP
- xxviii) MAIN-I B-PH TRIP
- xxix) MAIN-I START
- xxx) MAIN-I/II Carrier aided trip
- xxxi) MAIN-I/II fault in reverse direction
- xxxii) MAIN-I/II ZONE-2 TRIP

- xxxiii) MAIN-I/II ZONE-3 TRIP
- xxxiv) MAIN-I/II weak end infeed optd
- xxxv) MAIN-II PSB alarm
- xxxvi) MAIN-II SOTF TRIP
- xxxvii) MAIN-II R-PH TRIP
- xxxviii) MAIN-II Y-PH TRIP
- xxxix) MAIN-II B-PH TRIP
- xl) MAIN-II start
- xli) MAIN-II aided trip
- xlii) MAIN-I/II fault in reverse direction
- xliii) Back-up o/c optd
- xliv) Back-up e/f optd
- xlv) 220V DC-I/II source fail
- xlvi) SPEECH CHANNEL FAIL
- xlvii) PLCC Protection Channel-I FAIL
- xlviii) PLCC Protection Channel-II FAIL

2. Transformer bays

- i) Status of each pole of CB, Isolator, Earth switch
- ii) CB trouble
- iii) CB operation/closing lockout
- iv) Pole discrepancy optd
- v) Trip coil faulty
- vi) LBB optd
- vii) Bus bar protn trip relay optd
- viii) REF OPTD
- ix) DIF OPTD
- x) OVERFLUX ALARM (MV)
- xi) OVERFLUX TRIP (MV)
- xii) OVERFLUX ALARM (HV)
- xiii) OVERFLUX TRIP (HV)
- xiv) HV BUS CVT 1/2 FUSE FAIL
- xv) MV BUS CVT 1/2 FUSE FAIL
- xvi) OTI ALARM/TRIP
- xvii) PRD OPTD
- xviii) OVERLOAD ALARM
- xix) BUCHOLZ TRIP
- xx) BUCHOLZ ALARM
- xxi) OLTC BUCHOLZ ALARM
- xxii) OLTC BUCHOLZ TRIP
- xxiii) OIL LOW ALARM
- xxiv) back-up o/c (HV) optd
- xxv) back-up e/f (HV)optd
- xxvi) 220v DC-I/II source fail
- xxvii) TAP MISMATCH
- xxviii) GR-A PROTN OPTD

- xxix) GR-B PROTN OPTD
- xxx) back-up o/c (MV) optd
- xxxi) back-up e/f (MV)optd

3. Transformer bays

- i) Status of each pole of CB, Isolator, Earth switch
- ii) CB trouble
- iii) CB operation/closing lockout
- iv) Pole discrepancy optd
- v) Trip coil faulty
- vi) LBB optd
- vii) Bus bar protn trip relay optd
- viii) REF OPTD
- ix) DIF OPTD
- x) HV BUS CVT 1/2 FUSE FAIL
- xi) OTI ALARM/TRIP
- xii) PRD OPTD
- xiii) BUCHOLZ TRIP
- xiv) BUCHOLZ ALARM
- xv) OIL LOW ALARM
- xvi) Back-up impedance relay
- xvii) 220v DC-I/II source fail
- xviii) GR-A PROTN OPTD
- xix) GR-B PROTN OPTD

4. Line/Bus Reactor bays

- i) Status of each pole of CB, Isolator, Earth switch
- ii) CB trouble
- iii) CB operation/closing lockout
- iv) Pole discrepancy optd
- v) Trip coil faulty
- vi) LBB optd
- vii) Bus bar protn trip relay optd
- viii) REF OPTD
- ix) DIF OPTD
- x) Line/ BUS CVT 1/2 FUSE FAIL
- xi) OTI ALARM/TRIP
- xii) PRD OPTD
- xiii) BUCHOLZ TRIP
- xiv) BUCHOLZ ALARM
- xv) OIL LOW ALARM
- xvi) Back-up impedance relay
- xvii) 220V DC-I/II source fail
- xviii) GR-A PROTN OPTD
- xix) GR-B PROTN OPTD

5 Busbar Protection

- i) Bus bar main-I trip
- ii) Bus bar main-II trip
- iii) Bus bar zone-I CT open
- iv) Bus bar zone-II CT open
- v) Bus transfer CT sup. Optd
- vi) Bus transfer bus bar protn optd
- vii) Bus protection relay fail

6. Auxiliary system

- i) Incomer-I On/Off
- ii) Incomer-II On/Off
- iii) 415V Bus-I/II U/V
- iv) 415v bus coupler breaker on/off
- v) DG set bkr on/off
- vi) Alarm/trip signals as listed in Section: DG set
- vii) LT transformer-I Buchholz Alarm & trip
- viii) LT transformer-II Buchloz Alarm & trip
- ix) LT transformer-I WTI Alarm & trip
- x) LT transformer-II WTI Alarm & trip
- xi) LT transformer-I OTI Alarm & trip
- xii) LT transformer-II OTI Alarm & trip
- xiii) PLCC exchange fail
- xiv) Time sync. Signal absent
- xv) Alarm/trip signals as listed in Section: Battery and Battery charger
- xvi) 220v DC-I earth fault
- xvii) 220v DC-II earth fault
- xviii) Alarm/trip signals as listed in Section: Fire protection system& Nitrogen system.

7. Kiosk System:

- i) AC Compressor 1 ON/OFF
- ii) AC Compressor 2 ON/OFF
- iii) Fire Detection 1 ON/OFF
- iv) Fire Detection 2 On/OFF
- v) Kiosk Temperature High Alarm

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 **KPTCL** use in future.

ANNEXTURE - BAY KIOSKS

Specification of Kiosk

1 SPECIFICATIONS OF AC BAY KIOSKS- SWITCHYARD PANEL ROOM

- 1** The switchyard panel room shall be constructed to house Relay & protection panels, PLCC panel etc., and one each for one diameter in 400kV side and one each for 2 nos line bays on 220kV side. In case of incomplete diameter the switchyard panel room shall have necessary space for accommodating the future bay C&R panels. The layout of the equipments/panels shall be subject to Owners approval. The switchyard panel room shall be provided with necessary illumination (AC LED lighting with additional 10% emergency DC operated LED fixtures), fire alarm system with at least two detectors with necessary power supply if required and it shall be wired to SAS. The switch yard panel room shall be RCC framed structure building. The detailed constructional requirement of switchyard panel room is detailed in the typical drawing enclosed and also in Section-Civil of Technical specification.

The size of the Bay Kiosks in the Switchyard shall be as follows:

In case of 400kV S/Y: Bay Kiosk of size 4M (H) x 10.5M (L) x 4M (W) is envisaged to accommodate bay control unit, bay protection units, PLCC panel etc of each diameter (ie., two numbers of 400kV bays) for one and half breaker system. The size of bay Kiosk to accommodate bay control unit, bay protection units etc in case of three bus system shall be 4M (H) x 6.0M (L) x 4M (W). Two numbers of window type air conditioner of 1.5 ton capacity shall be provided for each bay control room in case of one and half breaker system. However, 1 No. of window type air conditioner of 1.0 ton capacity shall be provided for each bay control room in case of three bus system.

In case of 220kV S/Y: Bay Kiosk of size 4M (H) x 6.0M (L) x 4M (W) is envisaged to accommodate bay control unit, bay protection units, PLCC panel etc of two numbers of 220kV bays. One number of window type air conditioner of 1.0 ton capacity shall be provided for each bay Kiosk.

The sizes of bay Kiosks and capacity of air conditioner is indicative only. Actual size of bay Kiosks and capacity of air conditioner will be decided during the engineering. The Bidder shall furnish the Air-conditioning sizing calculation and provide the required nos. of units. Each KIOSK shall be provided with redundant air conditioner.

2. Air-Conditioning:

The air conditioning system shall be provided in the Kiosks to be used for housing panels having control and protection equipments. These kiosks shall be placed in the switchyard area generally unmanned; therefore, the air-conditioning system shall be rugged, reliable, maintenance free and designed for long life. The

air conditioner provided in switchyard panel room shall be monitored from Substation Automation System.

i. Operation:

The air conditioning is required for critical application i.e. for maintaining the temperature for critical sub-station control and protection equipment. To provide redundancy for such critical applications, each kiosk shall be installed with environment control system comprising of two units (1 main +1 standby) of air conditioners working in conjunction through a microprocessor based controller for desired operation. The system shall be designed for 24 Hours, 365 Days of the year to maintain the inside kiosk temperature for proper operation of the critical equipment. One of the air-conditioner shall be running at a time and on failure of the same or as described hereunder, the other unit shall start automatically. To ensure longer life of the system, the redundant units shall also be running in cyclic operation through the controller. However, during running of one air-conditioner unit, if inside temperature of the shelter reaches to a predefined (i.e. 35°C), the other unit shall start running to maintain the temperature less than 24°C and gives alarm for such situation. After achieving this temperature, the other unit shall again shut off. No heating is envisaged from air conditioning system inside the kiosk to maintain the temperature.

ii. Sequence of Operation of the Unit:

Suitable arrangement shall be made to operate the unit in the following order. However, the actual operation arrangement shall be finalized during detailed engineering.

1. Evaporator Fan
2. Condenser Fan
3. Compressor

iii. Construction:

The air conditioning unit shall be completely self-contained. All components of the units shall be enclosed in a powder coated cabinet and colour of same shall be matched with kiosk colour. The unit shall be assembled, wired, piped, charged with refrigerant and fully factory tested as a system to ensure trouble free installation and start up. Suitable isolation or other by passing arrangement shall be provided such that any unit/component could be maintained/repared without affecting the running standby unit. The maintenance of unit shall be possible from outside the kiosk.

iv. Required Features of Various Components:

The compressor shall be very reliable, trouble free and long life i.e. hermitically sealed Scroll type of reputed make suitable for continuous operation. Compressor should be installed on vibration isolated mountings or manufacturer's recommended approved mounting. Valve shall be provided for charging/topping up of refrigerant. The bidder shall furnish details of their compressor indicating the MTBF, life of compressor and continuous run time

of compressor without failure. The contractor shall also furnish details of all accessories i.e. refrigeration system, evaporator coil, condenser coil, evaporator blower filter, cabinet, indoor supply and return grill etc.

- 3 The kiosk shall be erected at least 300 mm above the finished ground level with suitable pedestal to avoid any entry of water.
- 4 Each Kiosk shall be provided with a 4.5 Kg CO₂ type (Carbon Di-Oxide) Fire Extinguisher which shall be suitably mounted on outside of kiosk. The extinguisher has to be easily accessible for operator.
- 5 Necessary temperature transducer (along with all accessories) shall be provided in the kiosk to monitor the temperature inside the kiosk.

6 Fire Alarm System

The air conditioned kiosk shall be provided with fire alarm system with at least two no. of ionization type detectors and the same shall be monitored from the control room building.

- 7 **Modular Multi-diameter cable sealing system** consisting of frames, blocks and accessories to be installed wherever the electrical/ instrumentation/ communication cables underground and over-ground enter or leave bay Kiosks/control rooms/sub-stations. Cable sealing to be with Multi-diameter type peel-able roxylon blocks of different sizes (20: 4mm to 14.5mm, 30: 10mm to 25mm, 40: 21.5mm to 34.5mm, 60: 28mm to 54mm, 90: 48mm to 71mm, 120: 67.5mm to 99mm) to be provided for simple, easy and quick to assemble and re-assemble. 30% spare block on the frame to be provided with usable Multi-diameter blocks with center plug, so that these spare blocks can be used for expansion in future for wide range of cables, solid blocks should not be used on frame. Cable sealing system should have been type tested for fire/water/smoke tightness and supplier shall have local presence by way of full infrastructure having service support, training support and stocks support and also have necessary sales support for any change/extension in future. Frames and stay-plate material should be galvanized steel and for compression single piece wedge with galvanized steel bolts should be used.

ANNEXURE – RPP –TVM

NOTE: PLEASE REFER THE UPLOADED DOCUMENT FOR DLMS ICS COMPLIANT TVM SEPARATELY

FOR ANNEXURE – FEEDER PANEL – SAS

RELAY & PROTECTION PANEL FOR 400/220 KV FEEDERS STATIONS WITH
SUBSTATION AUTOMATION SYSTEM.

The SIMPLEX panel shall generally consist of following items:

| Sl. No. | PARTICULARS | QUANTITIES | | |
|-----------|--|---------------|--------------|--------------|
| | | 4L | 2L | 2L Cable |
| A | BCU & BREAKER RELAY PANEL: | | | |
| 1 | Bay Control Intelligent Electronic Device As per Cl. No. 3.1.1.1 – Over view 3.1.1.2 – Control & Selection. 3.1.1.3 – Synchronisation & energizing check. 3.2 – System level function 3.2.1 – Status supervision. 3.1.2.2 – Bay Monitoring function 3.2.2 – event & alarm handling. | 1 No. | 1No. | 1No. |
| 2. | Selector switch for control of 400/220KV CB & 400/220KV isolator from local, Remote Bay control unit and remote – SCADA/SAS | 1 No. each | 1No. each | 1No. each |
| 3 | CVT and Bus VT Selector Relay | 1 No. | 1 No. | 1 No. |
| 4 | Indication & alarm As described in Annexure of specification | 1 No. | 1 No. | 1 No. |
| 5 | Breaker relays shall be as per the details furnished under Cl. No. 43-F – Configuration of relay & protection panel – Breaker relay panel | 1 Set | 1 Set | 1 Set |

ANNEXURE – FEEDER PANEL – SAS

RELAY & PROTECTION PANEL FOR 400/220 KV FEEDERS FOR STATIONS WITH
SUBSTATION AUTOMATION SYSTEM.

| Sl. No. | PARTICULARS | QUANTITIES | | |
|-----------|---|-------------|--------|----------|
| | | 4L | 2L | 2L Cable |
| B | PROTECTION RELAY PANEL: | | | |
| 1 | Line protection relay shall be provided as per the details furnished under Cl. No. 43-A – Configuration of relay & protection panel Note: For 400kV short line/UG Cable & 220kV Cables: Optic fiber/ADSS/OPGW is used for communication for tripping the other end relays, Communication protocol of IEC 61850 ed1 & ed2 (Site selectable) & IEC 60870-5-103 shall be used in case the other end relays are with SAS. Communication protocol of IEC 60870-5-104 shall be used in case other end relays are with SCADA system (only RTU) | 1 Set | 1 Set | 1 Set |
| 2. | Other devices: | | | |
| | a) Test terminal block | As required | | |
| | b) PVC circuit labels | 2 Nos. | 2 Nos. | 2 Nos. |
| | c) One label indicating manufacturers name, P. O. details drawing reference number etc. | 1 No. | 1 No. | 1 No. |
| | d) Internally mounted equipments | 1 Set | 1 Set | 1 Set |
| | e) Other equipments | As required | | |

ANNEXURE – TBC/BS/MBC PANEL – SAS

RELAY & PROTECTION PANEL FOR 400/220 KV TRANSFER BUS-COUPLER/BUS SECTIONALIZER/MAIN BUS –COUPLER FOR STATIONS WITH SUBSTATION AUTOMATION SYSTEM.

The SIMPLEX panel shall generally consist of following items:

| Sl. No. | PARTICULARS | QUANTITIES |
|---------|---|------------|
| | | 4/2-TBM |
| A | BCU & BREAKER RELAY PANEL: | |
| 1 | Bay Control Intelligent Electronic Device As per Cl. No. – 43-A 3.1.1.1 – Over view 3.1.1.2 – Control & Selection. 3.1.1.3 – Synchronisation & energizing check. 3.2 – System level function 3.2.1 – Status supervision. 3.1.2.2 – Bay Monitoring function 3.2.2 – event & alarm handling. | 1 No. |
| 2. | Selector switch for control of 400/220KV CB & 400/220KV isolator from local, Remote Bay control unit and remote – SCADA/SAS | 1 No. each |
| 3 | CVT and Bus VT Selector Relay | 1 No. |
| 4 | Indication & alarm As described in Annexure of specification | 1 No. |
| 5 | Breaker relays shall be as per the details furnished under Cl. No. 43-F – Configuration of relay & protection panel – Breaker relay panel | 1 Set |

ANNEXURE – TBC/BS/MBC PANEL – SAS

RELAY & PROTECTION PANEL FOR 400/220 KV TRANSFER BUS-COUPLER/BUS SECTIONALIZER/MAIN BUS – COUPLER FOR STATIONS WITH SUBSTATION AUTOMATION SYSTEM.

| Sl. No. | PARTICULARS | QUANTITIES |
|---------|---|-------------|
| | | 4/2 TBM |
| B | PROTECTION RELAY PANEL: | |
| 1 | Transfer Bus-Coupler / Bus Sectionalizer / Main Bus-Coupler protection relay shall be provided as per the details furnished under Cl. No. 43-D – Configuration of relay & protection panel | 1 Set |
| 2. | Other devices: | |
| | a) Test terminal block | As required |
| | b) PVC circuit labels | 2 Nos. |
| | c) One label indicating manufacturers name, P. O. details drawing reference number etc. | 1 No. |
| | d) Internally mounted equipments | 1 Set |
| | e) Other equipments | As required |

ANNEXURE – TRANSFORMER PANEL – SAS

RELAY & PROTECTION PANEL FOR 400/220 KV AUTO TRANSFORMER FOR STATIONS WITH SUBSTATION AUTOMATION SYSTEM.

The SIMPLEX panel shall generally consist of following items:

| Sl. No. | PARTICULARS | QUANTITIES |
|-----------|--|------------|
| | | 4T |
| A | BCU & BREAKER RELAY PANEL: | |
| 1 | Bay Control Intelligent Electronic Device As per Cl. No. 3.1.1.1 – Over view 3.1.1.2 – Control & Selection. 3.1.1.3 – Synchronisation & energizing check. 3.2 – System level function 3.2.1 – Status supervision. 3.1.2.2 – Bay Monitoring function 3.2.2 – event & alarm handling. | 1 No. |
| 2. | Selector switch for control of 400/220KV CB & 400/220/33KV isolator from local, Remote Bay control unit and remote – SCADA/SAS | 1 No. each |
| 3 | CVT and Bus VT Selector Relay | 1 No. |
| 4 | Indication & alarm As described in Annexure of specification | 1 No. |
| 5 | A) Breaker relays shall be as per the details furnished under Cl. No. 43-F - with out Auto recloser relay. – Configuration of relay & protection panel – Breaker relay panel | 1 Set |
| | B) In addition to be above additional Auxilliary Relays for Transformer protection/Supervision to be provided as per Cl. No. 33.8 & also suitable for each Single Phase Transformer. | 1 Set |

ANNEXURE – TRANSFORMER PANEL – SAS

RELAY & PROTECTION PANEL FOR 400/220/33 KV TRANSFORMER FOR STATIONS
WITH SUBSTATION AUTOMATION SYSTEM.

| Sl. No. | PARTICULARS | QUANTITIES |
|-----------|--|-------------|
| | | 4T |
| B | PROTECTION RELAY PANEL: | |
| 1 | Transformer protection relay shall be provided as per the details furnished under Cl. No. 43-B – Configuration of relay & protection panel –Transformer protection Panel. | 1 Set |
| 2. | Other devices: | |
| | a) Test terminal block | As required |
| | b) PVC circuit labels | 2 Nos. |
| | c) One label indicating manufacturers name, P. O. details drawing reference number etc. | 1 No. |
| | d) Internally mounted equipments | 1 Set |
| | e) Other equipments | As required |

ANNEXURE – REACTOR PANEL – SAS

RELAY & PROTECTION PANEL FOR 400KV REACTORS FOR STATIONS WITH
SUBSTATION AUTOMATION SYSTEM.

The SIMPLEX panel shall generally consist of following items:

| Sl. No. | PARTICULARS | QUANTITIES |
|---------|--|------------|
| | | 4T |
| A | BCU & BREAKER RELAY PANEL: | |
| 1 | Bay Control Intelligent Electronic Device As per Cl. No. 3.1.1.1 – Over view 3.1.1.2 – Control & Selection. 3.1.1.3 – Synchronisation & energizing check. 3.2 – System level function 3.2.1 – Status supervision. 3.1.2.2 – Bay Monitoring function 3.2.2 – event & alarm handling. | 1 No. |
| 2. | Selector switch for control of 400KV CB & isolator from local, Remote Bay control unit and remote – SCADA/SAS | 1 No. each |
| 3 | CVT and Bus VT Selector Relay | 1 No. |
| 4 | Indication & alarm As described in Annexure of specification | 1 No. |
| 5 | A) Breaker relays shall be as per the details furnished under Cl. No. 43-F - with out Auto recloser relay. – Configuration of relay & protection panel – Breaker relay panel | 1 Set |
| | B) In addition to be above additional Auxilliary Relays for Transformer protection/Supervision to be provided as per Cl. No. 33.8 | 1 Set |

ANNEXURE – REACTOR PANEL-SAS

RELAY & PROTECTION PANEL FOR 400KV REACTOR FOR STATIONS WITH
SUBSTATION AUTOMATION SYSTEM.

| Sl. No. | PARTICULARS | QUANTITIES |
|-----------|--|-------------|
| | | 4R |
| B | PROTECTION RELAY PANEL: | |
| 1 | Reactor protection relay shall be provided as per the details furnished under Cl. No. 43-C – Configuration of relay & protection panel –Reactor protection Panel. | 1 Set |
| 2. | Other devices: | |
| | a) Test terminal block | As required |
| | b) PVC circuit labels | 2 Nos. |
| | c) One label indicating manufacturers name, P. O. details drawing reference number etc. | 1 No. |
| | d) Internally mounted equipments | 1 Set |
| | e) Other equipments | As required |

ANNEXURE – BUS BAR PANEL – SAS

RELAY & PROTECTION PANEL FOR 400/220 KV BUS BARS FOR STATIONS WITH SUBSTATION AUTOMATION SYSTEM.

The SIMPLEX panel shall generally consist of following items:

| Sl. No. | PARTICULARS | QUANTITIES |
|-----------|---|-------------|
| 1 | PVC Circuit labels | 2 Sets |
| 2 | Internal equipment and small wiring like cubicle | 1 Set |
| 3 | | |
| | a) Percentage Biased differential and low impedance numerical Bus bar protection Relay – confirm to Cl. No. 36 of specification. b) In built LBB feature as part of bus bar protection, in addition to LBB provision in Main protection scheme. | 1 Set |
| | Note: i) For 400kV: Redundant (1+1) BBP scheme for each bus system – Refer Cl. No. 36.1 ii) For 220kV: Single BBP scheme for each main and Transfer bus Refer Cl. No. 36.2 | |
| 4 | Bus bar CT secondary supervision and shorting relays | As required |
| 5 | DC Controlling Voltage supervision relays | 1 Set |
| 6 | High speed tripping relay for tripping of breakers | As required |
| 7 | CT selection / switching relays with adequate number of NO/NC contacts | As required |
| 8 | Bus Zone Indication relays | As required |
| 9 | Terminal blocks suitable for testing of the above relay | As required |
| 10 | DC fail indication. The offer should include if necessary marshalling kiosks for CT wiring etc., that are needed for satisfactory working and other internal equipments. The scheme shall be suitable for adding additional line / transformer in each station and all necessary accessories are to be provided. | |

SCHEDULE OF REQUIREMENT FOR SUB-STATION AUTOMATION SYSTEM IN 400KV STATIONS

Particulars

- 1) Station Human Machine Interface**
- 2) Hot Stand by Station HMI.**
- 3) DR work station.**
- 4) Energy measurement work station.**
- 5) Redundant managed switched Earth net Local area Network communication infrastructure including optic fibre cable etc., with hot stand by (to RCC & RSCC)**
- 6) Gate way for remote control via industrial grade hardware through IEC 60870-5-104 protocol.
The contractor shall provide Licence for IEC 60870-5-104 Protocol and Integrate the SAS system to the KPTCL SCADA system.**
- 7) Peripheral equipment line printer display unit key Board mouse etc.,**
- 8) system software and Hardware for reliable operation of SAS in conformity with Technical specification.**
- 9) Other accessories required for reliable operation of SAS as per Technical specification.**
- 10) For all numerical relays confirming to IEC 61850 ed1 & ed2 (Site selectable) protocol,all CID, ICD & PICS, MICS and PIXIT documents shall be provided in soft copies.**
- 11) The display of parameters, events, alarms, Metered & measured data in HMI shall be done as per KPTCL Engineer's direction at site.**

ANNEXURE –RP –GTP
SECTION – RELAY AND PROTECTION PANEL
SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS OF CONTROL EQUIPMENT
AND RELAYS

| | Bidder's Name | |
|-----------|---|--|
| Sl. No. | Description | |
| A. | <u>PANELS :</u> | |
| I | Description, Construction & formation details : | |
| 1 | Make and Type reference of manufacturer | |
| 2 | Type | |
| | i) type of construction or simplex | |
| | ii) type of scheme | |
| | a) for line | |
| | b) for power transformer | |
| 3 | Thickness of sheet steel (mm): | |
| | i. Door, Top and Bottom of panel | |
| | ii. Other | |
| 4 | Tentative overall dimensions (L*B *H) (mm) of each panel | |
| 5 | Dead weight of each panel (Kgs) | |
| 6 | Approximate weight of each panel with all components (Kgs) | |
| 7 | Details of packing for transport | |
| 8 | Overall dimensions of transport package (L*B*H) (mm) | |
| 9 | Approximate gross weight of transport package (Kgs) | |
| 10 | Exterior paint film thickness (microns) and paint colour | |
| 11 | Interior paint film thickness (microns) and paint colour | |
| 12 | Cubicle Lighting : Volts, wattage, Type of holder and fitting whether provided with door control switch or not. | |
| 13 | Safety earthing : | |
| | a. Material of conductor | |
| | b. Size (W*T) (mm) | |
| | c. Surface treatment and finish of conductor. | |
| | d. Type of end connection | |
| 14 | Panel front/rear component identity board | |
| | a. Material | |

| | | |
|----------------|--|--|
| | b. Size | |
| | c. Size of lettering and colour | |
| | d. Method of fixing | |
| Sl. No. | Description | |
| 15 | Panel wiring : | |
| | a. Type and material of wire conductors, insulation and voltage grade. | |
| | b. Conductor cross sectional area or strands/gauge of wire and colour scheme adopted for : | |
| | i. VT secondary circuits and annunciation circuit. | |
| | ii. Other Circuits. | |
| | c. Type of wire termination | |
| 16 | Mimic bus details : | |
| | a. Type painted / strip fixed | |
| | b. Width (mm) | |
| | c. Whether colour scheme specified will be followed | |
| | d. If not specify deviations. | |
| II. | TERMINAL BLOCKS AND CONNECTORS (USED FOR PANEL WIRING) | |
| 1 | Make and Type reference of manufacturer | |
| 2 | Insulation and voltage grade | |
| 3 | Constructional details | |
| 4 | Current rating of studs, size and material | |
| 5 | Whether shrouding provided or not | |
| 6 | Whether space terminals provided or not | |
| 7 | Literature enclosed. | |
| III. | INDICATING LAMPS : | |
| 1 | Wattage and voltage of lamp | |
| 2 | Size of lens and material thereof | |
| 3 | Type of lamp holder | |
| 4 | Whether provided with series resistor? If yes, specify Ohmic value power loss | |
| IV | FUSE HOLDERS AND FUSES : | |
| 1 | Make and Type reference of manufacturer | |
| 2 | Insulation and voltage grade | |
| 3 | Type of Insulation material | |
| 4 | Type of fuses | |
| 5 | Rating of fuses provided for different circuits | |
| 6 | Literature enclosed. | |

| Sl. No. | Description | |
|----------------|--|--|
| VI. | SELECTOR SWITCHES : | |
| 1 | Make and Type reference of manufacturer | |
| 2 | Type of handle / Switch | |
| 3 | Mounting details | |
| 4 | Number of positions | |
| 5 | Number of contracts available in each position. | |
| | a. Open | |
| | b. Close | |
| 6 | Making capacity of contacts | |
| 7 | Breaking capacity of contacts | |
| 8 | Whether locking arrangement is available. | |
| 9 | Whether detailed literature and drawings enclosed. (YES/NO) | |
| VII. | PUSH BUTTONS : | |
| 1 | Make and Type reference of manufacturer | |
| 2 | Mounting details | |
| 3 | Type of contact | |
| 4 | Current and voltage rating | |
| 5 | No. of contacts | |
| | a. NO | |
| | b. NC | |
| 6 | Whether shrouding provided to prevent inadvertent operation (YES/NO) | |
| 7 | Whether provided with integral engraved inscription plates (YES/NO) | |
| VIII | AUXILIARY CT's VT'S : | |
| 1 | Make and Type reference of manufacture | |
| 2 | a. Type | |
| | b. Ratios available | |
| | c. Burden V A | |
| | d. Standard to which it conforms | |
| | e. Accuracy class | |
| | f. Short time current / voltage rating | |
| | g. Temperature rise | |
| | h. One minute power frequency withstand voltage | |
| | j. Mounting dimensional details | |
| | j. Weight | |

| Sl. No. | Description | |
|------------|---|--|
| | k. Panel in which to be provided with quantity thereof and connected ratio | |
| 3 | For CT's only | |
| | a. Knee point voltage (KPV) (Volts) | |
| | b. Excitation current at KPV and 50% KPV (ma) | |
| | c. Internal impedance of primary and secondary windings in ohms | |
| 4 | Literature enclosed. | |
| IX. | SPACE HEATERS : | |
| 1 | Make and Type reference of manufacture | |
| 2 | Type of space heater (Tubular / strip type) | |
| 3 | Rating Wattage | |
| 4 | Whether thermostat provided (YES/NO) | |
| II | INSTRUMENT TEST TERMINAL BLOCKS : | |
| 1 | Make and Type reference of manufacturer | |
| 2 | Insulation class and rating | |
| 3 | Size and mounting details | |
| 4 | Type of CT terminal shorting mechanism (LINK / SCREW) | |
| 5 | Type of VT terminal Isolating Mechanism | |
| 6 | Whether detailed literatures enclosed. (YES/NO) | |
| C | GENERAL PROTECTION RELAYS : | |
| I | The tenderer shall furnish guaranteed Technical particulars for all types of relay offered, in the following proforma (separate sheet shall be enclosed for each type of relay :) | |
| 1 | Manufacturer's name or trade marks | |
| 2 | Type designation | |
| 3 | Size and mounting details (whether in draw out case) | |

| Sl. No. | Description | |
|-----------|--|--|
| 4 | Rated Values of both input and auxiliary energizing quantities | |
| 5 | Values of the limits of the operative range(s) of the auxiliary energising quantity (ies) | |
| 6 | Contacts data, Number and rating of main and auxiliary contacts | |
| 7 | Rated value or setting range of the characteristic quantities and or angle | |
| 8 | Limiting short-time thermal withstand values | |
| 9 | Limiting dynamic values. | |
| 10 | i. Burden data (in case of poly input relays - data shall be furnished for appropriate set of input terminals). | |
| | a. At highest tap - AC current / voltage coil | |
| | b. At lowest tap - AC current / voltage (coil) | |
| | ii. DC power consumption. | |
| 11 | Impulse and dielectric test voltage(s) | |
| 12 | Details of accessories (If essential to the relay performance) | |
| 13 | Details of accessories (Optional items) | |
| 14 | Whether provided with seal in trip contacts | |
| 15 | a. Type of operating characteristics | |
| | b. Accuracy of operating characteristics, operating time with details | |
| 16 | H.F. disturbance test voltage (s) | |
| 17 | Whether literature enclosed | |
| 18 | Type of relay flag indicator and rating of target coil | |
| II | In addition to the above details, the following details shall also be furnished for relays specified below : | |
| 1 | DOCR / DEFR : | |
| | a. Directional sensitivity | |
| | b. Minimum voltage at which the directional units operate | |
| | c. Characteristic angle | |
| 2 | OVER FLUXING RELAY : | |
| | a. Whether provided with timer if so time setting available for Alarm and delayed trip. | |

| | | |
|----------|--|--|
| 3 | Distance Protection Scheme for 400KV/220KV Lines: | |
| A | Type of distance measuring element | |
| | a. Starting unit | |
| | i. Type of scheme | |
| | b, No. of measuring element or comparator with details | |
| | c. Setting range of the distance measurement | |
| | d. No. of zones | |
| | i. Overall range for all zones. | |
| | ii. Reach setting range at rated current. | |
| | Zone - 1 (forward) - ohms | |
| | Zone - 2 (forward) - ohms | |
| | Zone - 3 (forward) - ohms | |
| | Off set zone 3 reverse - ohms | |
| | Zone extension (if any) | |
| | e. Characteristic of each zone | |
| | Zone - 1 | |
| | Phase fault unit | |
| | Earth fault unit | |
| | Zone - 2 | |
| | Phase fault unit | |
| | Earth fault unit | |
| | Zone - 3 | |
| | Phase fault unit | |
| | Earth fault unit | |
| | Zone - 3 off set | |
| | Zone -1 in ohms | |
| | 1. Reach of the relay along with characteristic angle at rated current and voltage | |
| | 2. Reach of the relay in resistive direction at rated current & voltage | |
| | 3. Reach in reactive direction at rated current & voltage | |
| | Zone - 2 in ohms | |
| | 1. Reach of the relay along with characteristic angle at rated current and voltage | |
| | 2. Reach of the relay in resistive direction at rated current & voltage | |
| | 3. Reach in reactive direction at rated current | |

| | | |
|--|--|--|
| | & voltage | |
| | Zone - 3 in ohms | |
| | 1. Reach of the relay along with characteristic angle at rated current and voltage | |
| | 2. Reach of the relay in resistive direction at rated current & voltage | |
| | 3. Reach in reactive direction at rated current & voltage | |

| Sl. No. | Description | |
|----------------|--|--|
| | Zone - 3 in Reverse ohms | |
| | 1. Reach of the relay along with characteristic angle at rated current and voltage | |
| | 2. Reach of the relay in resistive direction at rated current & voltage | |
| | 3. Reach in reactive direction at rated current & voltage | |
| | f. Power swing blocking characteristic setting | |
| | i. Forward reach | |
| | ii. Reverse reach | |
| | g. Setting range of residual compensation | |
| | h. Setting range of mutual compensation | |
| | i. (i) Operating time | |
| | Zone - 1 | |
| | (ii) Time setting range | |
| | Zone -2 | |
| | Zone -3 | |
| | Power swing blocking | |
| | j. Accuracy | |
| | Zone - 1 (reach) | |
| | Zone - 2 (reach) | |
| | Zone - 3 (forward reach) | |
| | K. Polarising scheme | |
| | Zone - 1 | |
| | Zone - 2 | |
| | Zone - 3 | |
| B. | <u>Additional features provided :</u> | |
| | a. Fault locator | |
| | b. Carrier aided tripping scheme | |
| | c. Power swing blocking | |
| | d. Broken conductor detection | |
| | e. Synchronous check | |

| | | |
|-----------|--|--|
| | f. Weekend infeed | |
| | g. Switch on to fault | |
| | h. Fuse failure supervision | |
| C. | Facilities available for Fault Locator | |
| | a. Name and type reference of manufacturer | |
| | b. Rating and setting available | |
| | c. Rated V A burden | |
| | d. Power consumption voltage and current element | |

| | | |
|----------|---|--|
| | e. Memory capacity with details | |
| | f. Triggering method | |
| | g. Accuracy | |
| | h. Method of accuracy | |
| D | Auto Recloser: | |
| | a) Reclosing facilities available b) Single phase/three phase dead time range. c) Reclaim time range d) No. of modes selectable by selection switch e) Provision of Check synchronizing features and its time setting, range phase angle setting, voltage difference setting. f) Provision of deadline charging set range of voltage. g) Lock out facility. | |
| E | Disturbance Recorder: | |
| | a) No. of event channels b) No. of analog signals. c) Sampling rate d) Recording Band width e) Over current triggering – range. f) Under current triggering – range. g) Over voltage triggering – range. h) Pre fault time – range. i) Post fault time – range. j) Limit time – range. k) No. of recorded disturbances. l) Total recording time with 8 Analog and 16 event channels recorder. m) Voltage channels – details. n) Period of built in calendar. o) Current channels – details, | |
| F | EVENT RECORDER | |
| | a) Time tagging resolution. b) Events capacity i) Max. NO. of events per disturbance report. | |

| | | |
|---|--|--|
| | ii) Max. No. of disturbance reports | |
| | c) Time tagging error with synchronization. i) Once in One second ii) Once in ten seconds. iii) Once in sixty seconds | |
| | d) Timer tagging error without synchronization. | |
| 4 | Restricted Earth fault Relay. a) Manufacturer Type P designation b) Operating time 2 x setting | |
| 5 | Differential protection scheme : | |
| | a. No. of restraining coils and operating coils. | |
| | b. Harmonic restraints provided with details | |
| | c. Rated VA Burden and power consumption of | |
| | i. Restraining coil | |
| | ii. Operating coil | |
| | d. Type of slope setting : If variable, range of slope setting through fault current stability. Maximum & minimum range of HV / MV / LV current ratio over which the relay can be used. | |
| | e. Whether provided with switching inrush current restraint, if so type. | |
| 6 | Trip circuit supervision relay: a) Name of manufacturer. b) Type & Designation. c) Whether preclosing & post closing supervision provided. d) Time delay | |
| 7 | High speed trip relay a) Name of manufacturer. b) Type & Designation. c) Contact rating. Current rating- i) Continuous rating ii) Rating for 5 secs. d) Break Resistive load inductive load (with L/R = 40 msec. e) Operating time at rated voltage (max). f) Resetting time. g) Whether supervisory relay included. | |
| 8 | Local breaker back up protection. a) Name of manufacturer. b) Type & Designation. c) Operating time d) Resetting time e) Setting range | |

| | | |
|------------|--|--|
| | i) current ii) time | |
| 9 | Bus bar protection a) Name of manufacturer. b) Type & Designation. c) Type of relay (numerical) d) Principle of operation (biased/low impedance) e) Operating time f) Resetting time g) Setting range. i) Current ii) time. h) Whether will it cause tripping for the differential current below the load current of heavily loaded feeder (Bidder shall submit application check for the same). | |
| III | The tenderer shall confirm whether the following details will be furnished at the time of approval of drawings: | |
| | a. Identification and location of removable parts. | |
| | b. Data of permit suitable connection of the relay (including the polarity) | |
| | c. Data concerning the earthing of metallic part | |
| | d. To indicate parts of modules which should not be replaced without observing precaution prescribed by the manufacturer. | |

**GUARANTEED TECHNICAL PARTICULARS FOR ELECTRONIC
TRIVECTOR METERS**

| Sl. No. | PARTICULARS | |
|----------------|---|--|
| 1 | Type of Meter | |
| 2 | Class of Accuracy | |
| 3 | Standard to which the meter conforms | |
| 4 | Current rating for which accuracy is guaranteed for | |
| | a. Basic Current (ib) | |
| | b. Continuous Current overloading capability | |
| | c. Short time over current | |
| | d. Minimum Starting Current | |
| 5 | a)Voltage rating for which accuracy is guaranteed for | |
| | b)Over voltage withstand capacity - continuous | |
| | c)Voltage Range | |
| 6 | Other Parameters for which accuracy is guaranteed | |
| | a. Reference Temperature | |
| | b. Standard Reference Frequency (Hz) | |
| | c. Accuracy Guaranteed for | |
| | d. Frequency Range | |
| | e, For single Phase Loads / In- put | |
| | f. For two Phase Loads / In - put | |
| | g. For In-put / Loads without neutral in -puts unbalanced Voltages | |
| | h. Temperature Range | |
| | i. P F range | |
| | j. Time | |
| 7 | Insulation Resistance | |
| 8 | Sampling Plan for measurement of Voltage, Current and Frequency | |
| 9 | Power Loss in each Current circuit at Basic Current in VA & WATT | |
| 10 | Power Loss in each Voltage circuit at reference in VA & WATT | |
| 11 | Display device (Hardware details) | |
| | a. Type of Display i.e. LCD | |
| | b. Character size of display digits | |
| | c. No. of Display digits used | |

| | | |
|----|---|--|
| | 1. For data | |
| | 2. For parameter identification | |
| | d. Life of display unit (Guaranteed) | |
| | e. Method adopted for digit over flow | |
| 12 | Display details (Software) | |
| 13 | a. Non-volatile memory retention time in absence of power | |
| | b. Non - volatile memory capacity in KB. | |
| | c. RAM Capacity | |
| | d. Maximum number of Parameters which can be stored in non-volatile Memory at each half an hour intervals for Six Months. | |
| 14 | Maximum demand | |
| | a. Parameters that can be dynamically selected | |
| | b. Integration Period Range | |
| | c. Provision for Automatic Rest | |
| | d. Type of MD Computation | |

| Sl. No. | Description | |
|----------------|--|--|
| 15 | Communication Inter-phase available | |
| | - for calibration | |
| | - for data transfer | |
| 16 | Electro magnetic interference / Electro magnetic comparativity level | |
| 17 | Mounting arrangement | |
| 18 | Meter sealing arrangement | |
| | a. Meter body | |
| | b. Meter terminal block | |
| | c. MD reset bush button | |
| | d. Battery unit | |
| 19 | Degree of protection against moisture etc., | |
| 20 | a. Provision for real time clock | |
| | b. Real time clock accuracy | |
| | c. Life of real time clock (Guaranteed) | |
| 21 | Power Supply backup | |
| 22 | Measuring principle employed for | |
| | a. KWH | |
| | b. KVAH | |
| | c. RKVAH | |
| | d. Maximum demand parameters | |
| | e. PF | |

| | | |
|------|--|--|
| NOTE | 1. Measuring principle adopted for each of the items above should be specified. | |
| | 2. Measurement logic employed in case of Harmonics and contents up to which meter recognizes for measurement shall be furnished. | |
| 23 | Abnormal conditions that will be identified with limiting values | |
| 24 | Guarantee period offered for | |
| | a. Performance and accuracy | |
| | b. Components not covered under guarantee | |
| 25 | Micro processor | |
| | a. Address in bits | |
| | b. Sampling rate | |
| 26 | Compatibility of the software for the following | |
| | a. For generation of consumer bill directly with the existing KPTCL billing software | |
| | b. Compatibility of software provided for MRI, down loading from earlier version already supplied to KPTCL | |
| | c. Compatibility of software for generation of report for earlier versions | |

| Sl. No. | Description | |
|---------|---|--|
| 27 | Additional features available | |
| 28 | Agreement to furnish protocol details for development of required software through third party | |
| 29 | Platform on which the meter communicates | |
| 30 | Levels of security | |
| | a. For changing real time | |
| | b. For changing display parameters | |
| | c. For changing Load survey parameters | |
| | d. For changing TOD Registers, clock setting | |
| | e. Measuring principle, computation | |
| 31 | Specification of reference standard offered | |
| 32 | Specification of Laptop Computer offered | |
| 33 | Specification of MRI kit offered | |
| 34 | Specification of equipment offered for checking communication capability through RS232/RS485 port | |

SCHEDULE OF GUARANTEED TECHNICAL PARTICULARS OF SUB-STATION AUTOMATION

GUARANTEED TECHNICAL PARTICULARS

| Sl. No. | Particulars | |
|----------|---|--|
| A | SUBSTATION AUTOMATION SYSTEM MASTER CONTROL UNIT OF HMI | |
| a) | Name and Country of Manufacture. | |
| b) | Manufactures type and designation | |
| c) | Memory capacity i) Hard Disk ii) RAM | |
| | Operating system software type | |
| d) | Type of drives provided i) 3.5" Floppy & MG drive. | |
| | ii) Magnetic optical drive (rewritable) | |
| e) | Update time of i) digital input ii) Analog Input | |
| f) | Response time for i) Alarm Function ii) Control Function | |
| g) | Response time for i) Alarm function ii) Control function | |
| h) | Whether semi or fully colour graphic type | |
| i) | Total number of bay units which can be connected without effecting the response/update time of the system | |
| j) | Whether facility and hardware for transfer of data to remote sub-station motorized. | |
| k) | Communication protocol adopted for i) Bay unit ii) RSCC/LDC | |
| l) | Applicable standard | |
| m) | Type of auxiliary supply required | |
| n) | Speed of data processing in instruction per sec. | |
| o) | List of manufacture whose bay units can be connected to master unit without additional. | |
| p) | Whether equipment offered is of industrial grade | |
| q) | All necessary software provided for proper functioning of the system as a whole. | |
| r) | List of all software provided | |
| s) | Max. Possible distance return bay unit & master. | |
| t) | Weight | |

| Sl. No. | Particulars | |
|----------------|---|--|
| u) | Dimensions | |
| v) | Power Consumption | |
| | aa) CPU | |
| | ab) Processor speed | |
| | ac) Hard disk | |
| | a) Type b) Capacity | |
| | ad) Cache Memory a) On Chip b) On Board | |
| | ae) Communication Port | |
| | af) VDU a) Screen size b) Resolution | |
| B | BAY CONTROL UNIT | |
| | a) Name of Country of Manufacture | |
| | b) Manufacturers type and designation | |
| | c) Type of Mounting | |
| | d) No. of bay control units offered | |
| | e) Memory capacity | |
| | f) Data Storage capacity | |
| | g) Standard applicable | |
| | h) Rated auxiliary voltage | |
| | i) Rated frequency | |
| | j) No. of binary inputs | |
| | k) No. of outputs | |
| | l) Language | |
| | m) Type of Communication protocol | |
| | n) No. & type of communication port | |
| | o) Operation temperature range | |
| | p) System response time | |
| | q) (i) Exchange of display ii) Presentation of binary change iii) Presentation of analog change | |
| | iv) Order to process output v) Order to update display vi) Report generation | |
| | vii) Max. temperature Max. Humidity | |
| r) | Whether data is received on failure of unit. If yes, indicate the duration | |

| Sl. No. | Particulars | |
|----------------|---|--|
| s) | Speed of transmission between bay and Master control unit | |
| t) | No. of inputs it can accommodate (specify voltage & current separately) | |
| | a) Digital | |
| | b) Analog | |
| u) | Resolution for digital inputs | |
| v) | Update time of | |
| | a) analog inputs | |
| | b) digital inputs | |
| w) | Whether data processing is done in bay unit or master control unit. | |
| x) | Power concentration | |
| y) | Humidity | |
| z) | Dimensions | |
| C) | KEYBOARD | |
| | i) Name & county of Manufacture | |
| | ii) Manufactures type & designation | |
| | a) Operation | |
| | b) Engineers. | |
| | iii) Whether standard or the numerical keyboard included in the programming terminal. | |
| D) | Local Area Network LAN | |
| | 1) Standard | |
| | 2) Protocol | |
| | 3) Communication Medium | |
| | 4) Speed | |
| | 5) Maximum distance | |
| E) | Network Operating system | |
| F) | SCADA Software | |
| | 1) Supplies | |
| | 2) Operating system | |
| | 3) Facilities Provided (Full details to be enclosed in separate sheet) | |

| Sl. No. | Particulars | |
|----------------|---|--|
| G) | Printer <ul style="list-style-type: none"> 1) Colour Printer 2) Manufacturer name 3) Country of Manufacture 4) Model type 5) A3 and A4 size paper supplied 6) Throughput rate 7) Resolution 8) Available data interface 9) Print colour 10) Max. Temperature 11) Max. Humidity. | |
| G(b) | Alarm/Event Printer | |
| | <ul style="list-style-type: none"> 1) Manufacturer name 2) Country of Manufacture 3) Model type 4) Paper Size 5) Paper Loading Facility 6) Print head 7) Throughput 8) Resolution 9) Available Data Interface 10) Print Colour 11) Max. temperature 12) Max. Humidity (Rh.) | |

| Sl. No. | Particulars | |
|----------------|---|---------------|
| G(c) | SCANNER | |
| | 1) Manufacturer name 2) Country of Manufacture 3) Model type 4) Paper Size 5) Resolution 6) Available Data interface | |
| H | Following information is attached separately with the bid a) Type, Make and Model No. for each item/sub-item with relevant catalogues / descriptive information | Yes/No |
| | b) List of installation of similar Equipment now in service with contact | Yes/No |
| | Persons name and address | Yes/No |
| | Detailed drawing with dimensions of each equipment panel and interfaces | Yes/No |
| | Full functional description specific to project along with proposed Architecture/scheme enclosed | Yes/No |
| I | SYSTEM SOFTWARE 1) Multitasking operating system 2) Background executive 3) File handling utility 4) Magnetic tape/disk data transfer utility 5) Online debugger 6) Object Module library utility 7) Report generator utility for display & Print 8) Communication utility 9) Graphic display generation utility 10) Online system backup capability 11) Test and Maintenance Programs (Diagnostic software) 12) System generation at site 13) Data base utility 14) Data acquisition, processing and alarm monitoring/reporting 15) Communication 16) Operator interface (MMI) 17) Network Operating system 18) Utilities like debugging and software downloading 19) Mathematical and logic function | |

| Sl. No. | Particulars | |
|----------------|---|----------------|
| II | PROCESS SOFTWARE | |
| | 1) Plant data base 2) Control software 3) Graphic display with points assignment 4) Logs or reports with points assignment 5) Software for communication with external computer system 6) Relay setting software 7) Any other software. | |
| | Note: Bidder shall supplement information in this Data Sheet with a write up on each topic | |
| | CPU Processing capacity Word Length Programmable real time clock | Yes/No. |
| | Watch dog timer | Yes/No. |
| | Auto Restart | Yes/No |
| | Time synchronization | Yes/No |
| | PROCESS INPUT SYSTEM | |
| | No. of high resolution inputs | |