

KARNATAKA POWER TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATION

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

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

SECTION –1 RELAY & PROTECTION PANEL

CLAUSE	PARTICULARS
1.00	SCOPE.
2.00	BRIEF DESCRIPTION OF PROJECT.
3.00	STANDARDS.
4.00	CLIMATIC & GEOGRAPHICAL CONDITONS
5.00	SYSTEMS DETAILS.
6.00	AUXILLARY SUPPLY.
7.00	TYPE OF PANEL.
8.00	CONSTRUCTIONAL FEATURES.
9.00	MOUNTING.
10.00	PAINTING.
11.00	WIRING.
12.00	TERMINAL BLOCKS AND TERMINAL CONNECTORS.
13.00	SPACE FOR CONTROL CABLE AND CABLE GLANDS.
14.00	VOID.
15.00	NAME PLATE AND MARKINGS.
16.00	INTERNALLY MOUNTED EQUIPMENTS,
17.00	FUSES.
18.00	EARTHING.
19.00	VOID
20.00	TEST TERMINAL BLOCKS.
21.00	CONTROL SWITCHES,
22.00	VOID
23.00	PUSH BUTTON SWITCHES.
24.00	SYNCHRONIZING EQUIPMENTS.
25.00	VOID.
26.00	INDICATING AND INTEGRATING EQUIPMENTS.
27.00	RELAYS.
28.00	PROTECTION SCHEME.
29.00	PROTECTION PHILOSOPHY
30.00	CO-ORDINATION OF DRAWINGS OF ASSOCIATED EQUIPMENTS OF OTHER MANUFACTURES.
31.00	DRAWINGS AND LITERATURES
32.00	TESTS, TEST CERTIFICATES AND INSPECTION
33.00	SPARES
34.00	MAINTENANCE TOOLS & EQUIPMENT
35.00	QUALITY ASSURANCE PLAN

36.00	MINIMUM EXPERIENCE FOR QUALIFYING AS A TENDER.
37.00	PERFORMANCE GUARANTEE
38.00	TRAINING TO BOARD ENGINEERS
39.00	DESPATCH
40.0	DEVIATON FROM TECHNICAL SPECIFICATION
41.00	SCHEDULE OF REQUIREMENTS & DELIVERY
42.0	SCHEDULE OF PRICE.
43.0	GUARANTEED TECHNICAL PARTICULARS.

ANNEXURE-RPP1-SAS
ANNEXURE- RPP2-SAS
ANNEXURE- RPP3-SAS
ANNEXURE- RPP4-SAS
ANNEXURE- RPP5-SAS
ANNEXURE- RPP6-SAS
ANNEXURE- RPP7-SAS
ANNEXURE - SAS

SECTION-2 SUB-STATION AUTOMATION:

CLAUSE	PARTICULARS
1.0	GENERAL
2.0	SYSTEM DESIGN
3.0	BAY LEVEL FUNCTIONS
4.0	SYSTEM HARDWARE
5.0	SOFTWARE STRUCTURE
6.0	TESTS
7.0	SYSTEM OPERATION
8.0	POWER SUPPLY
9.0	DOCUMENTATION
10.0	TRAINING, SUPPORT SERVICE, MAINTENANCE & SPARES
11.0	MAINTENANCE RESPONSIBILITY
12.0	RELIABILITY & AVAILABILITY
13.0	SPARES
14.0	LIST OF EQUIPMENTS
	ANNEXURE – I (GTP IAS) ANNEXURE-RRP-TVM

SECTION-3 IEC 61850 BASED ANNUNCIATOR:

SECTION-1

KARNATAKA POWER TRANSMISSION CORPORATION LIMITED

TECHNICAL SPECIFICATION FOR RELAY & PROTECTION PANELS WITH SUB-STATION AUTOMATION SYSTEM FOR 220KV SUB- STATIONS

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 for 220KV 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. All such components/ accessories / software shall be supplied at no extra cost.

- 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 type test reports shall not be 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.

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:
- Main protection i.e. distance scheme and differential scheme shall be of fast acting numerical type.
 - Back up protection shall be of numerical type.
- 2.03 There may be changes in components ordered as per purchase order and as per approved drawing. However, subsequent inspection and supply of panels shall conform to the approved drawing.
- 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. 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	220 KV	110KV	66 KV	33 KV
1	Nominal system voltage (KV)	220	110	66	33
2	Highest system voltage (KV)	245	123	72.5	36
3	No. of phases	3	3	3	3
4	Frequency (Hz)	50	50	50	50
5	Method of grounding	Effectively earthed	Effectively earthed	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.

6.00 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) 220V for 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%

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%

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.

7.00 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 rear of the control panel and either from rear or front of relay panel. 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 and rear 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.

8.00 CONSTRUCTIONAL FEATURES:

8.01 Relay Panel shall be of Simplex type design. 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 either more number of panels or panels with larger dimensions. 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 existing control room should be in conformity with space availability in the control room.

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.

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 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 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.
- 9.00 **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. Like wise 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.

10.00 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 a 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 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	1.5sq. mm
3	AC/DC Auxiliary control supply circuits	1.5sq. 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 transformer circuits	Blue
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 throughs extending through out 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.

12.00 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 from thermosetting resin dielectric and shall be of AC 1100V grade. The studs shall be fully threaded and shall be of tin plated brass. The size of the studs 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.

13.00 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 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 10 Sq. mm for NCT Circuits.
 4 C x 6 Sq. mm for PT Circuits and D.C.
 10 C x 2.5 Sq. mm for Isolator.
 2 C x 2.5 Sq. mm. for coupling capacitor.

14.00 MIMIC DIAGRAM: VOID

15.00 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.

16.00 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.

18.00 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 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 & nuts for connection with cable armours & 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 equipments inside the panels.

19.00 INDICATING LAMPS: VOID

20.00 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.

21.00 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	3	7
2. inductive load with L/R = 40 ms	0.2	---

21.07 VOID

22.00 SYNCHRONIZING SWITCHES: VOID

23.00 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.

24.00 SYNCHRONIZING EQUIPMENT: (Applicable for 220KV Sub-Station only)

24.01 The model sequence of synchronizing of various voltage classes in the station is as follows:

- a) Synchronizing outgoing 220 kV lines with any one of the main buses.
- b) Synchronizing 220KV and 110/66 kV breaker of Power transformer.
- c) Synchronizing outgoing 110/66 kV lines with any one of the main buses.

25.00 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.

26.06 VOID

26.07 VOID

27.00 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.

- 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 & mall 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 or static 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 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.
- k). 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.

28.00 PROTECTION SCHEME:

28.01 Protection scheme shall consist of following :

- a) The main protection, distance and differential protection relays are required to protect the 220KV, 110KV, 66KV lines and 220/110/11KV or 220/66/11KV, 110/33-11KV, 66/33KV, 66/11 KV and 33/11KV Power Transformers and clear the fault within shortest possible time with reliability, selectivity and full sensitivity to all type of faults. The relay shall be fast acting numerical type.
- b) Back up protection shall be of numerical type.

28.02 Protection Scheme for 220KV lines :

The line protection relays are required to protect the line & clear the faults on line within shortest possible time with reliability, selectivity & full sensitivity to all types of faults on the lines. The general concept is to have two main protections having equal performance requirement specially in respect of time called as Main-I & Main-II for 220kV lines & cables and to have Main & backup protection for 110/66kV Lines. Main 1 and Main 2 relays shall be provided with minimum 24BI's and 24BO's.

The maximum fault current could be as high as 40KA at 220KV and 31.5KA at 110KV & 66KV, but the minimum fault current could be as low as 20% of the rated current of CT secondary. However for stations in Bangalore city, the maximum fault current could be 40KA at 66KV. The starting & measuring relays characteristic should be satisfactory under the extremely varying conditions.

For 220KV lines the protection relays shall be suitable for use with capacitor voltage transformers having non-electronic damping and transient response as per IEC.

Fault Recorder, Distance to fault Locator and Over voltage relay (Stage-I) 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 clause.

Auto reclose relay function if offered as an integral part of line distance protection relay, shall be acceptable for 220kV lines only provided the auto reclose relay feature meets the technical requirements as specified in the respective clause.

Following protections shall be provided for each of the transmission lines:

For 220kV Lines:

Main-I : Numerical distance protection scheme with inbuilt OC/EF protection.

Main-II : Numerical distance protection scheme of a make different from that of main-I with inbuilt OC/EF.

For 220kV XLPE Cables:

Main-I : Numerical line differential protection scheme with inbuilt distance protection.

Main-II : Numerical line differential protection scheme with inbuilt distance protection of make different from that of Main-I.

A) Numerical Distance Main-I & Main-II Distance Protection scheme for 220 kV lines:

Numerical distance protection shall be suitable for use with permissive under reach and over reach required. Relay shall have continuous self-monitoring and diagnostic feature.

The detailed description of protection is given here under:

Numerical Distance Protection scheme shall :

- i. Be suitable for one amp CT secondary and $110/\sqrt{3}$ V AC potential from potential transformer of 220 KV Bus.
- ii. Be modular in construction.
- iii. Have high speed non-switched distance relay for three phase systems to clear all type of line faults within the set reach of the relay.
- iv. It should cover at least two line sections completely with 25% additional margin.
- v. Measure all type of faults without the need to switch the measuring elements to the faulty phase or phases. Zone switching to extend the reach of the measuring elements is not allowed. The reach of each zone shall be independently and individually adjustable over wide range in suitable steps, for each of the zone measuring elements in steps of 1%. The memory circuits with defined characteristics shall be provided in all three phases to ensure correct operation during close-up 3 phase faults and other adverse conditions.
- vi. Have a maximum operating time up to trip impulse to circuit breaker, (with CVT being used on line side) under source to line impedance ratios under all possible combinations of fault (with all filters included) at 50% of zone-1 reach, as given below:

For SIR 0.01-4 - About 30 ms at nearest end and 40 ms at other end of line.

AND

For SIR 4 –15 - About 35 ms at nearest end and 45 ms at other end of line.

(Carrier transmission time is not included in the operating time indicated above. The maximum carrier transmission time may be taken as 20ms. However, any reduction in carrier time should be directly reflected as reduction in maximum operating time)

- vii. Have stepped time-distance characteristics and shall have at least two directional and one non-directional independently variable time graded distance protection zones to cover two adjacent line sections.
- viii. a) Three zones and one reverse zone of operation shall be available. The reach of the relay for zones 1, 2 & 3 should be able to cover line lengths as per clause (iv) above. The relay shall have an adjustable characteristics angle setting range of 30-75 degree.

(b) Be field selectable for various over reaching, under reaching setting and blocking/inter tripping communication scheme.

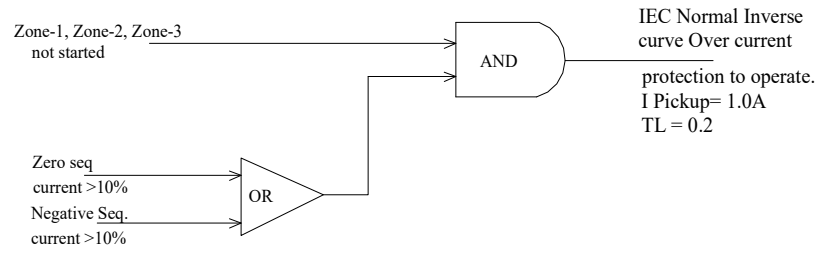
- (c) Have quadrilateral or lens characteristics with a facility to set resistance and reactance independently to cater for arc resistance on short lines and load discrimination for long lines.
- ix. Ensure that this long coverage is consistent with limitations imposed by heavy loading and sound phase components of fault current.
- x. 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 characteristics of starting relays are such that it cannot pick up because of very low infeed, under-voltage relays may also be used as supplementary relays.
- xi. Have two independent continuously variable time setting range of 0-3 seconds for zone-2 and 0-5 seconds for zone-3.
- xii. Have a maximum resetting time of about 35 milli sec.
- xiii. Have facilities for offset features with adjustable 10-20% of zone-3 setting.
- xiv. Have residual compensation variable from 30- 150%.
- xv. Operate instantaneously when circuit breaker is closed to zero volt 3-phase fault.
- xvi. Be suitable for single & three phase Auto re-closing and auto tripping at both ends.
- xvii. 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.
- xviii. Be selective between internal and external faults.
- xix. Include fuse failure protection which shall:
 - a1) Monitor all the three fuses of CVT/IVT circuit, and associated cable against open circuit
 - a2) Inhibit trip circuits on operation and initiate annunciation.
 - a3) Have an operating time less than 7 milliseconds.
 - a4) Remain inoperative for system earth faults.
 - a5) Be of solid state type.
- xx. Have facility for under voltage & over voltage protection.
- xxi. Have self diagnostics feature.
- xxii. Have facility for current & voltage supervision.
- xxiii. The circuit failure protection be provided as a back up protection in case of failure protection be provided as a backup protection as required by object protection.
- xxiv. Suitable number of potential free contacts (if required, multiplied through reed relays only) be provided, on each distance scheme for carrier aided tripping, auto re-closing, circuit breaker failure sequence of events recorder and data acquisition system..

- xxv. Mutual compensation unit shall be provided such that healthy feeder protection shall not mal-operate for faults in other lines of multi circuit lines.
- xxvi. The scheme shall be adaptable for carrier blocking principle for purpose of simultaneous inter tripping of breakers connected to the fault section and to prevent tripping of breakers connected to healthy section. The directional elements at the two ends of the protected line shall be inter locked by the power line carrier and shall trip the breakers at the two ends of the protected line breakers at the two ends simultaneously for fault in the protected zone. The blocking signal shall be transmitted to prevent the circuit breakers from tripping in the event of fault external to the protected zone. This shall not prevent the breakers tripping due to the second and third zone elements acting as back-up protective relays. The direction comparison carrier relaying shall provide instantaneous back-up protection and the second and third zone elements delayed back-up.
- xxvii. A separate out of step or power swing blocking relay shall be included to prevent tripping of the breaker during power swings and system disturbances. The breaker shall however be caused to trip if the disturbance lasts for an interval of time equal to or greater than the third zone time setting.
- Nevertheless the impedance loci of the distance relays shall be such that they have maximum tendency to operate on power swings caused by system disturbances.
- Note:** Provision of optional features other than those indicated above may be indicated separately. Provision may be made in the relay for up-dating these optional features at a later date whenever required by KPTCL.
- xxviii. The distance relay shall be compatible for use with PLCC equipments and auto re-close scheme existing. Further, the complete scheme shall also be flexible.
- xxix. The distance protection scheme shall be suitable for any length (short lengths also) of transmission line. Any limitations in this regard shall be clearly specified by the bidder.
- xxx. Include a directional and non-directional backup Inverse Definite Minimum Time (IDMT) over current & earth fault relay with normal inverse characteristics as per IEC-60255-3 as a built in feature.
- xxxi. The relays shall have following features either built-in or separately:
- a) Fault locator of an accuracy of 3% or better.
 - b) Synchronizing check.
 - c) Weak end in feed.
 - d) Power swing blocking.
 - e) Broken conductor detection.
 - f) Compatibility with carrier protection scheme.
 - g) Compatibility with Single pole/three pole auto re-closer.
 - h) Disturbance Records.
 - i) Compatibility with sub-station automation even logger..
 - j) Auto Re-Closer.
 - k) Direction & Non-directional OCR & EFR

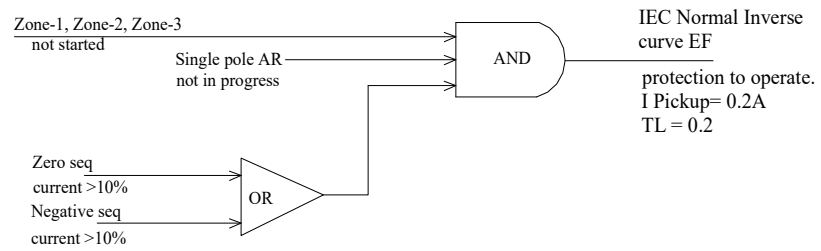
- xxxii) All trip relays used in transmission line protection scheme shall be of self/electrical reset type depending on application requirement.

LOGIC FOR DOCR (LINE PROTECTION)

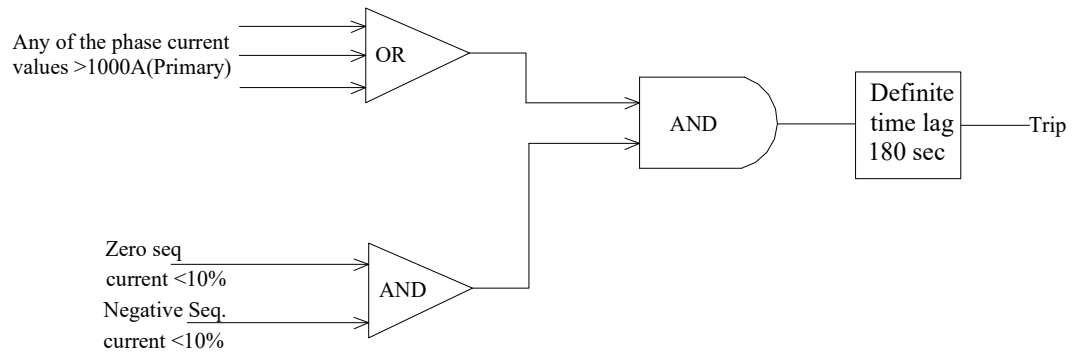
LOGIC FOR DOCR (LINE PROTECTION)



LOGIC FOR DEFR (LINE PROTECTION)

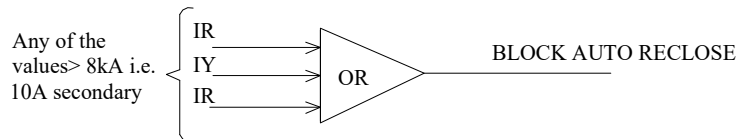


LOGIC FOR DIRECTIONAL OVER CURRENT PROTECTION (OVERLOAD)



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.

B) Auto Re-Closing:

Auto re-closing relay shall

- i) Be provided only for 220 kV line protection scheme. It shall be preferably built in feature of the Main-I/Main-II distance relaying scheme. The bidder shall co-ordinate the auto re-close relaying scheme with that of the circuit breaker so as to ensure satisfactory and reliable operation of the auto re-closing scheme.
- ii) Have single-phase or/ and three phase re-closing facilities.
- iii) Have a continuously variable single phase dead time range of 0.1 – 2 secs.
- iv) Have a continuously variable three phase dead time range of 0.1-2 secs.
- v) Have a continuously variable reclaim time range of 5-25 seconds.
- vi) Incorporate a four-position selector switch from which single phase/three phase/single and three phase auto re-closer and non-auto re-closure mode can be selected.
- vii) Have facilities for selecting check synchronizing or dead line charging features. It shall be possible at any time to change the required feature by reconnection of links.
- viii) Be of single shot type.
- ix) Include check synchronizing relay which shall:
 - a) Have a time setting continuously variable between 0.5-5 seconds with facility of additional 10 secs.
 - b) Have a response time within 200milli seconds with the timer disconnected.
 - c) Have a phase angle setting not exceeding 35 degree.
 - d) Have a voltage difference setting not exceeding 10%.
- x) Include dead line charging relay which shall:

- a) Have two sets of relays and each set shall be able to monitor the three phase voltage.
 - b) Have one set connected to the line CVTs with a fixed setting of 20% of rated voltage.
 - c) Have one set connected to the bus IVTs with a fixed setting of 80% of rated voltage.
 - d) Incorporate necessary auxiliary relays and timers to give comprehensive scheme.
- xi) Also be possible to lockout the auto re-closing transformer scheme relays when the carrier protection associated with main distance protection schemes are out of service/faulty.
- xii) Have separate “Auto re-close operation” and “circuit breaker lock out” annunciation shall be provided.

C) Fault Locators function:

The fault locator shall be based on the impedance measurement of the line and shall be static, microprocessor based only. It shall be capable of measuring the location of the fault from the relaying point with an accuracy of 3% or better, for all types of faults including broken conductor detection. It shall be ON LINE type. The fault locator shall measure the measuring signals prior to the fault, during fault, before tripping of the breaker and store them in the memory and process them at later stages. The accuracy of the measurement shall not be affected / influenced by line loading prior to the fault, remote in feed, magnitude of the fault resistance or mutual effect of parallel line(s), CVT transients, DC component in fault current, heavy load conditions, temperature variations, frequency divisions. The fault locator shall have built in display unit for showing fault location, faulty phase(s), current and voltage magnitudes and their phase relationships. The fault locator shall be capable of being combined with the respective distance protection for phase selection information. The calculation of line protection shall take place when any of the line protections operate on fault. The calculation by the fault locator shall be based on measuring values prior to and during the fault. These data shall be stored in the memory of fault locator and calculation shall be made after tripping of the line breakers. The distance to fault shall be shown as % of line length or actual fault location in KM. The fault locator shall be suitable for its application with three (3) cycle circuit breaker.

D) DISTURBANCE RECORDER FUNCTION

Disturbance recorder (DR) 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 and neutral current, open or closed position of relay contacts and breakers during the system disturbances.

Necessary auxiliary VTs to generate open delta voltage, shall be supplied by the bidder. The bidder shall furnish along with the offer a typical printout for simulated conditions on original paper.

The disturbance recorder system shall be capable of accommodating eight analog and sixteen event channels for each feeder. DR shall acquire the fault data and store them in non-volatile memory.

Necessary software and hardware for down loading the data captured by disturbance recorder to the personal computer available in the sub-station shall be included in the scope

The disturbance recorder shall incorporate the features as described below:

i. Simplicity of maintenance and repair:

The number and type of modules employed shall be minimized.

The modules shall be of plug-in type and shall be easily accessible for maintenance and repair wherever required.

ii. Immunity from the effects of hostile environment:

The equipment shall be designed to operate satisfactorily even when subject to the effects of severely hostile electrical environment -such as interference signals arising out of switching transients.

iii. Interface with PC

The DR should have an interface arrangement for transfer / storage of data to a PC. Necessary PC software, special cables etc., shall be part of DR and should be included in the offer.

PC based user friendly, disturbance recorder evaluation software shall be provided for the analysis and evaluation of the, record data made available in the PC. 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 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.

iv. Scan Rate

The frequency response shall be 5 Hz on lower side and 250 Hz or better on upper side. The DR shall have a scan rate of 1000 Hz/channel or better.

v Starting Sensors

The, equipment shall have inherent to it starting sensors based on over voltage, rate of change of current, and rate of change of frequency. The starting sensors, on pick up, shall preserve the fault data acquired during the period of system disturbance, including pre-fault and post fault time in solid state memory. Preserved fault data shall not get erased unless operator erases.

vi. Pre-fault and Post-fault Time:

Pre-fault shall not be less than 160 ms and the post-fault time adjustable at a minimum of 2 seconds and a maximum of not less than 5 seconds. If another system disturbance occurs during one post-fault run time the recorder shall also be able to record the same.

vii Amplitude and event Resolution

Amplitude resolution shall not be less than 8 bit. Event resolution shall be 2 ms or better.

viii Print out

The print out shall contain the following:

- a. Feeder identity.
- b. Date & time (1 hour, minute & second up to 100th of a second)
- c. Identity of trigger source.
- d. Graphic form of analog and event signals of all the channels.

ix. Time generator

Each disturbance recorder shall have its own time generator. Facility shall exist of synchronize the time generator from station time synchronization equipment having output of following types at 30 min interval.

- a. Voltage signal:
(0-5V continuously settable with 50m sec. Min. pulse duration).
- b. Potential Free Contact-
(Minimum pulse duration of 50m second)
- c. IRIG - B.
- d. RS232C/RS 485.

Sub-stations where station time synchronization equipment is not available, time generator of any one of the disturbance recorders can be taken as master and facility shall exist to synchronize the time generators of other disturbance recorders and event loggers in that station with respect to it. The recorder shall give annunciation in case of absence of synchronization pulse within a specified time. The clock of the time generator shall be such that, the drift is limited to ± 0.5 seconds / day, if allowed to run without synchronization. Facility shall exist to display the time in hour, minute and seconds on the front of panel.

28.02.A Protection Scheme for 220kV cables

The cable protection relays are required to protect the cable and clear the faults on cable within shortest possible time with reliability, selectivity and full sensitivity to all type of faults on lines. In case of 220kV XLPE cables, the general concept is to have two fast operating protection scheme. The current differential protection will be used as Main-I & Main-II protection.

I. Numerical Main-I & Main-II Current Differential Protection Scheme:

- 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", ¾ x 19" and ½ x 19" cases shall be available.
- GPS time synchronization module with GPS receiver used for time synchronization shall be available.

28.03 Protection Scheme for 110 & 66kV lines

A. Numerical Distance protection scheme for 110 & 66KV Lines:

Numerical distance protection shall be suitable for use with permissive under reach and over reach required. Relay shall have continuous self monitoring and diagnostic feature.

The detailed description of protection is given here under.

The numerical distance protection shall:

- Be suitable for one amp CT secondary and $110/\sqrt{3}$ V AC Potential from potential transformer of 110KV/ 66 KV Bus.
- Be static and modular in construction.
- Have high speed switched distance relay for three phase systems to clear all type of line faults within the set reach of the relay, under all operating conditions.
- It should cover at least two line sections completely with 25% additional margin.
- Measure all type of faults by switching over to the measuring elements. The reach of each zone shall be independently and individually adjustable over wide range in suitable steps of 1%. Memory circuits with defined characteristics shall be provided in all three phases to ensure correct operation during close-up 3 phase faults and other adverse conditions.
- The protection scheme shall be fast and first zone shall energize the circuit breaker trip coil in about one and half cycle. The tripping time of the second and third zone should be adjustable to any desired value through a separate timing unit.
- Have stepped time distance characteristics and shall have at least two directional and one non-directional independently variable time graded distance protection zones to cover two adjacent line sections.
- Three zones and one reverse zone of operation shall be available. The reach of the relay for zones 1, 2 & 3 should be able to cover line lengths as per clause (iv) above. The relay shall have an adjustable characteristics angle setting range of 30-75 degree.
 - Be field selectable for various over reaching, under reaching setting and blocking/ inter tripping communication scheme.

- (c) Have mho/rectangular/polygonal/circular/oval/lens/quadrilateral characteristics with a facility to set resistance and reactance independently to cater for arc resistance on short lines and load discrimination for long lines.
- ix. Ensure that this long coverage is consistent with limitations imposed by heavy loading and sound phase component of fault current.
- x. 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 characteristics of starting relays are such that it cannot pick-up because of very low infeed, under voltage relays may also be used as supplementary relays.
- xi. Have facilities for offset features with adjustable 10-20% of zone -3 setting.
- xii. Have residual compensation variable up to 150%.
- xiii. Operate instantaneously when circuit breaker is closed to zero volt 3 phase fault.
- xiv. Have a continuous current rating of two times the 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.
- xv. Be selective between internal and external faults.
- xvi. Include fuse failure protection which shall:
 - a1) Monitor all the three fuses of VT circuit, and associated cable against open circuit.
 - a2) Inhibit trip circuits on operation and initiate annunciation.
 - a3) Have an operating time less than 7 milliseconds.
 - a4) Remain inoperative for system earth faults.
 - a5) Be of solid state type.
- xvii. Have facility for under voltage and over voltage protection.
- xviii. Have self-diagnostic feature.
- xix. Have facility for current & voltage circuit supervision.
- xx. Suitable number of potential free contacts (if required, multiplied through reed relays only) be provided, on each distance scheme.
- xxi. Mutual compensation unit shall be provided such that healthy feeder protection shall not mal-operate for faults in other lines of multi circuit lines. (This clause applicable for line protection of 110 and 66KV lines of 220KV sub-stations only).
- xxii. A separate out of step or power swing blocking relay shall be included to prevent tripping of the breaker during power swings and system disturbances. The breaker shall however be caused to trip if the disturbance lasts for an interval of time equal to or greater than the third zone time setting.

Nevertheless the impedance loci of the distance relays shall be such that they have minimum tendency to operate on power swings caused by system disturbance.

- xxiii. The relay shall have the following features either built-in or separately.
- a) Weakend in feed.
 - b) Power swing blocking.
 - c) Broken conductor detection.
- xxiv. All trip relays used in transmission lines protection scheme shall be of self/electrical reset type depending on application requirement.

NOTE: Provision of optional features other than those indicated above may be indicated separately. Provision may be made in the relay for updating these optional features at a later date whenever required by KPTCL.

B. Protection Scheme for 110 & 66kV Cables

The Cable protection relays are required to protect the cable and clear the faults on cable within shortest possible time with reliability, selectivity and full sensitivity to all type of faults on lines. In case of 110kV & 66kV XLPE cables the current differential protection will be used as Main protection.

Numerical Current Differential Protection Scheme:

- 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.

28.04. Protection scheme for 220/110/11KV, 220/66/11KV, 110/33-11KV, 66/33KV and 66/11kV Power Transformer Numerical Differential Protection.

A) Numerical Differential Relay

- a) It shall consist of fully numerical/digital type, variable percentage, biased type differential relay. It shall be triple pole type, with faulty phase identification/ indication.
- b) The percentage bias shall be low near rated current, sufficient to allow for OLTC tap variation and CT errors, but shall increase automatically for severe through faults to ensure stability even under CT saturation errors. It shall offer low burden to CTs.
- c) The relays shall be suitable for rated current of 1 Amp and have three instantaneous high set over current units.
- d) The relay shall remain stable under initial magnetizing inrush current, sympathetic inrush when adjacent transformers are charged, through fault stability and over fluxing conditions. The relay shall have second harmonic restraint feature.
- e) The relay shall be very fast in operation with an operating time not greater than 30 milli seconds at 5 times setting.
- f) The relay shall be accompanied by interposing auxiliary current transformers for angle and ratio correction or have internal features in the relay to take care of angle and ratio corrections.
- g) The bias setting of the relay shall be adjustable with range of 20 – 50 %.
- h) The relay shall have a disturbance feature to record graphic form of instantaneous values of current in all two/three winding transformer in 6 analog channels, during faults and disturbances for pre fault and post fault period. The disturbance recorder shall have the facility to record the following external digital channel signals apart from the digital signals pertaining to differential relay.
 - i) REF Protection operated.
 - ii) HV & LV breaker status.
 - iii) Bucholtz/OLTC surge relay alarm / trip.
 - iv) WTI/OTI/PRD alarm/trip of transformer necessary hardware and software for down loading the data captured by disturbance recorder to personal computer available in the sub-station automation system shall be included in the scope.

Note: Disturbance recorder shall be provided only for 100MVA/150MVA-220/66/11KV Transformer/100MVA 220/110/11KV Transformer.

B) Restricted Earth fault Protection:

The restricted earth fault protection shall

- a) Be single pole static/Numerical type.
- b) Be of high speed, instantaneous current operated and high impedance type.
- c) Have a current setting range of 10-40% of 1 Amp.

- d) Be tuned to the system frequency. It shall have high rejection of DC component of fault current.
- e) Have suitable non-linear resistor to limit the peak voltage to 1000 volts.

C) Over fluxing protection:

- a) Over flux protection relays shall be provided for HV side of 220/110/11KV transformer / 220/110/66KV transformer and shall be of static type.
- b) The relay shall monitor the voltage (volts)/frequency (Hertz) and shall have a continuous adjustable setting between 100 to 130% of nominal volts/ hertz ratio.
- c) Relay shall have inverse time characteristic compatible with transformer over fluxing.
- d) The relay shall be energized by two separate time delay relays to work in two stages for a time delayed alarm and time delayed trip. The variable time setting of alarm shall be in the range of 2-5 secs and that for trip in the range of 5-30 secs. Relay shall have a high resetting ration of 98% or better.

D) Transformer overload relay:

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.

E) Auxiliary relay:

The transformer protection panel shall be wired for buchholz alarm and trip, oil temperature alarm and low oil level. The auxiliary flag relays shall be provided for contact multiplication wherever they are needed for buchholz alarm/trip, winding temperature alarm/trip, oil temperature alarm/trip, pressure relief device trip, oil surge relay trip. Current operated relays shall be preferred to voltage operated relays.

Note: REFT, Over flux relay & auxiliary relays shall be separately provided externally and shall not be inbuilt features of differential relay.

28.05 BACK UP PROTECTION:

28.05A) Back-up Directional Over Current & Earth fault protection scheme for 110kV & 66kV Lines & UG Cable :

- 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 (for over current protection)
 - 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 (for earth fault protection)
- 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 lead.
 - 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.
- i. The operating coil of the DEFR shall be connected in the residual circuit of the star connection of the line CT's. The polarizing voltage for DEFR shall be obtained from the open delta connection of the VT secondary circuit.
- ii. The backup protection as aforesaid shall operate independently of the main protection distance relay, to provide protection for the line section, in the event of failure of the distance relays, to clear the faulty section or failure of the main protection scheme relay.
- iii. It should be possible to convert the directional relays to non-directional type by suitable means.

28.05-B Numerical Back-up Over Current & Earth fault protection scheme with high set feature for Power Transformer:

- b) Shall have three over current and one earth fault element (s) which shall be either independent or composite unit (s).
- c) The scheme shall include necessary VT fuse failure relays for alarm purposes.
- d) 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 each high set instantaneous unit of continuously variable setting range of 500-2000% of rated current.
 - have a characteristic angle of 30/45 degree lead.
 - include hand reset flag indicators or LEDs.
- e) 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 each high set instantaneous unit of continuously variable setting range 200-800% of rated current.
 - have a characteristic angle of 45/60 degree lead.
 - 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.
- i. The backup protection as aforesaid shall operate independently of the main protection differential relay, to provide protection for the transformer section, in the event of failure of the differential relays, to clear the faulty section or failure of the main protection scheme relay.
 - ii. It should be possible to convert the directional relays to non-directional type by suitable means.

28.06 Local Breaker Back up protection:

- a) Each breaker shall be provided with breaker fail protection to overcome failure of breaker mechanism. In such a case adjacent circuit breaker and/or remote end breaker are required to be tripped.
- b) The relay shall be based on current principle and be set to operate after main protection operates and CB has not opened out, with some safety margin.
- c) It shall have the following features:
 - i) It shall be triple pole type and suitable for station DC supply. It shall have three over current elements. Each element shall be arranged to get individual initiation from the corresponding phase of line/transformer protection.
 - ii) Static measuring element with short consistent pick up time of approximately 4 to 5 ms and short setting time.
 - iii) It shall have an operating time of less than 15 milliseconds and a resetting time of less than 15 milliseconds.
 - iv) It shall have a setting range of 5 - 80% of rated current and have a continuous thermal withstand of two times rated current irrespective of the setting.
 - v) It shall have a timer with continuously adjustable setting range of 0.1 - 1 seconds.
 - vi) No power consumption from DC auxiliary circuit during normal service.
 - vii) It shall trip through bus bar protection scheme and lock out all the local breakers. Simultaneously a direct trip signal shall be sent to remote end circuit breaker and lock out its auto re-closing features.

It shall be provided with necessary auxiliary relays to make comprehensive schemes.

Note: LBB relay as inbuilt function of Main-I/Main-II distance/differential relay is also acceptable.

28.07 Bus Coupler Panel:

- a) Bus coupler is used for transferring circuits or feeder or transformer from one bus to another. In case of outage of circuit breaker in respect of the line/transformer circuits, the bus coupler breaker is used for the same.
- b) It is proposed to provide transfer trip protection scheme to all the line / transformers, to facilitate transfer of open and close commands from line/ transformer panels to the bus coupler panel, when one of the lines/transformers CB is faulty.
- c) The control panel wiring of all feeders and transformers shall include the above facility.
- d) Bus coupler shall be suitable for bi-directional power flow.
- e) Two numbers of non-directional over current relays and one number non-directional earth fault relay shall be provided when the breaker is used as bus coupler.
- f) **2 nos. of numerical under frequency relay with voltage protection feature shall be provided in the Bus coupler panel if station provided with bus coupler panel if not same shall be provided in 220/66kV transformer panel. 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.**

28.08 Tripping Relay:

Each panel shall be provided with instantaneous DC operated tripping relay. The relay shall have adequate number of normally open and normally close contacts to meet the requirement of scheme, other functions like auto re-closing relay, LBB relay, fault locator disturbance recorder, event logger wherever applicable. The maximum operating time of the relay shall not exceed ten milliseconds and reset within 20 milliseconds. Relay shall be provided with operation indicator for each element coil.

28.09 Tripping Circuit Supervision Relay.

- a) Each trip coil of circuit breaker shall be provided with an independent trip circuit supervision relay. These relays shall be mounted in the control panel associated with the circuit breakers. Two trip coils will be provided in each pole of 220 KV CB. However, in respect of 110KV, 66KV & 33KV CB there will be only 2 nos. of trip coils for all the three poles of CB.
- b) These relays shall monitor the healthiness of each phase of the trip circuit while the breaker is in open or closed position and give an alarm for the loss of DC supply or for faults in the trip coil or for faults in the trip circuit such as leads, auxiliary contacts. The relay shall have a time delay on drop off of not less than 200 milliseconds and be provided with operation indication.
- c) Trip supervision relay shall be located in the panel.
- d) The relay shall have adequate contacts for providing connection to alarm and event logger.

28.10 DC Supply monitoring relay:

The relay shall be capable of monitoring the failure of DC supply to which it is connected. Separate DC supply monitoring relay shall be provided for DC main circuit, control circuit of tripping relay and protection circuit of each panel. It shall have adequate potential free contact to meet the scheme requirement. The relay shall have a time delay on drop off of not less than 100msecs and be provided with operation indicator/flag. Indicating lamp and separate alarm for DC fail shall be provided and shall be operated by 230V AC single phase supply. Push buttons for test and accept shall be provided.

28.11 Voltage Selection Relay:

The relay shall operate from auxiliary DC supply voltage and it shall have sufficient number of contacts for extending bus VT supply voltage to relays and meters depending on the bus to which that particular line is connected.

Under no circumstances there shall be either paralleling of two VT supplies through voltage selection relay or reserve charging of VT secondaries. The relay design shall be such that operation of the selector relay used will open the operating circuit of the other relay.

28.12 INTERLOCKING:

The control circuits for operation of the disconnecting switches in the line shall be so designed that the following interlocking features are provided for usual conditions of operation and all the necessary devices, auxiliary relays shall be included in the supply of control panels.

The other interlocks required are (a) it should not be possible to operate either of the bus selector isolators unless the other bus selector isolator, bypass isolator and line breaker is in de-energized condition. (b) it should not be possible to operate the by-pass isolator when the main breaker and the breaker disconnect isolators (on either side of the breaker) all are in closed position. (c) during change over from the line breaker to bus coupler control, both breakers will be closed and it will be necessary to close both the bus selector isolators for making the change over. The interlock required is that it should not be possible to operate either of the bus selector isolators when the line is in service, unless the bus coupler is also closed. (d) If the earth switch of the line isolator is connected to ground, it shall not be possible to close the bus isolator, by-pass isolator or the line isolator or the breaker.

28.13 220KV BUS BAR PROTECTION:

- a) The bus bar protection shall be of numerical and modular construction.
- b) The bus bar protection scheme offered shall be very fast acting and have maximum operating time up to trip impulse to trip relay, for all types of faults of 15 millisecond at 5 times setting value.
- c) The scheme shall be based on the percentage-biased differential and low impedance, circulating current principle with a slope varying from 50 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 set to coincide with the largest line CT primary current rating and high speed 3 phase under voltage relay connected to the bus VTs.

- d) The bus bar protection scheme shall not give rise to false operation during normal load flow in bus bar. The bus bars protection shall be stable for heavy through faults condition upto maximum 40KA fault level for 220KV and shall operate correctly positively for all faults within the protected zone(s) even under conditions of CT saturation. For every severe internal faults the relay shall operate and seal-in within the above time i.e. the relays decision shall be made before CT saturation takes place.
- e) The bus bar protection scheme offered shall be adaptable to different CT ratios in different bays in any particular substation. The scheme shall allow the use of multi-tap interposing CTs for ratio matching purposes. It should be possible to extend the scheme for any limits on the number of additional bays or on the increasing fault level of the bus. The scheme offered shall include the cost of ICT's required for this purpose.
- f)
 - i) The scheme shall be single zone protection. The entire bus consisting of two sections shall be treated as single zone.
 - ii) The scheme shall be provided with independent zones of protection for each bus of double bus with zone indication. (two zone protection) This scheme shall be provided wherever called for. However, during bypassing of line transformer breaker through bus coupler, two zone protection will be converted to single zone protection.
- g) The protection scheme shall provide continuous supervision for the various CT secondary pilot wires. In case of any open circuiting of CT secondary the relevant zone of protection shall be shorted and an appropriate alarm initiated.
- h) The bus bar protection scheme shall include continuous DC supply supervision.
- i) It shall include high speed tripping relays conforming to clause 28.08 for each feeder / transformer circuits including future ones.
- j) As an optional feature the scheme shall provide facilities for built-in automatic testing at regular intervals. The automatic testing feature shall incorporate injection of currents through each input circuit of the relay and shall check for basic operation as well as stability against external faults. The total time taken for automatic testing shall be less than 30 milliseconds, during which time the tripping shall be blocked. In case of failure of any zone the relevant zone shall be blocked and an alarm initiated.
- k) In case of sub-stations where the C&R Panels are located in the switchyard AC Kiosk, distributed type bus bar protection shall be provided.
- l) Shall include trip relays, CT switching relays(if applicable), auxiliary CTs (if applicable) as well as additional power supply module, input modules etc as may be required to provide a bus bar protection scheme for the complete bus arrangement ie., for all the bays or breakers including future bays as per the single line diagram and also for additional 1 No. transformer of the same rating and also 4 numbers of 220kV future lines. In case of distributed bus bar protection, the bay units for future bays may be installed in a separate panel & same shall be located where bus bar protection panel is installed.
- m) It shall have 'CT' selection incomplete alarm wherever CT switching is involved.

- o) If CT switching relays are provided then the switching relays shall be provided only after an ICT. Switching of main CT secondaries shall not be carried out.
- p) Include protection “IN/OUT” switch for each zone.
- q) In each bus bar bay units, minimum 16BI’s and 21BO’s shall be considered.

28.14 Time Synchronization Equipment:

- a) The Time synchronization equipment shall receive the co-ordinated universal Time (UTC) transmitted through Geo positioning satellite system (GPS) and synchronize equipments to the Indian standard time in a sub-station.
- b) Time synchronization equipment shall include antenna, all special cables and processing equipment etc.
- c) It shall be compatible for synchronization of Event Loggers, Disturbance recorders and SCADA at a sub-station through individual port or through Ethernet realized through optic fibre bus.
- d) Equipment shall operate up to the ambient temperature of 50 degree centigrade and 100% humidity.
- e) The synchronization 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).
- f) Equipment shall meet the requirement of IEC 60255 for storage & operation.
- g) The system shall be able to track the satellites to ensure no interruption of synchronization signal.
- h) The output signal from each port shall be programmable at site for either one hour, half hour, minute or second pulse, as per requirement.
- i) 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.
 - Voltage signal: Normally 0-5V with 50milli seconds minimum pulse duration. In case any other voltage signal required, it shall be decided during detailed engineering.
 - Potential free contact (minimum pulse duration of 50 milli seconds).
 - IRIG-B
 - RS232C/RS 485
 - SNTP port

- j) The equipment shall have a periodic time correction facility of one second periodicity
- k) Time synchronization equipment shall be suitable to operate from 220V DC or 110V DC as available at sub-station.
- l) 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.

28.15 Rely Test Kit

One relay test kit shall comprise of the following equipment as detailed here under should be supplied:

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

28.16 VOID

29.00 PROTECTION PHILOSOPHY:

220kV substations are provided with dual DC source. The Main-1 & Main- II distance protection are to be connected to different DC sources ie source -1 and source -2. The trip coils TC1 & TC2 of circuit breakers are also to be energized by different DC sources ie source -1 & source-2.

A) 220 KV Line protection

Carrier aided, high speed, numerical distance scheme (with fault locator, auto re-close, disturbance records and event recorder) as Main-I & Main-II protection. The Main-II protection shall operate independent of Main-I protection. In addition to this if cable is used for lines, line differential protection is used as Main- I and Main-II–protection.

The voltage source from three nos. of C.V.T. provided for each line shall be used for line charged indication, auto re-close and synchronization etc., The voltage source for protection and meter circuits of the line feeder will be from the selected bus/line CVT. Provision can be made in the panel with change over switch to transfer potential to bus VTs, in case of failure of CVT.

B) 110 KV / 66 KV LINE PROTECTION

Numerical distance scheme as principal protection and directional over current / directional earth fault numerical relays as back-up protection. The back-up protection shall operate independent of primary protection. In addition to this, if cable is used for lines, line differential protection is used as Main protection and directional over current/directional earth fault relays as back up protection.

The voltage source for protection and meter circuits of the line feeder will be from the bus VTs.

- a) For 220KV sub-stations.

The voltage source from line CVT shall be used for line charged indication and synchronization etc. The voltage source for line feeder for protection circuits shall be from selected line CVT/Bus VT and for metering circuits will be from the bus V.T's.

- b) For 110 & 66 KV sub-stations:

The voltage source for protection and metering circuits of the line feeder will be from Bus V.T's

C) Power Transformer Protection:

The protection scheme should trip the circuit breaker on HV and MV/ LV side of transformer for any fault in the transformer.

- a) The differential protection scheme and REF as principle protection.
- b) The directional numerical OCR / EFR provided on HV side and DOCR/DEFR provided on MV/LV side shall act as back up protection.
- c) Transformer Overload protection with two stages
- d) Three number of circulating current relay for protection of 11kV Tertiary winding in case of 220/110/11KV, 100MVA and 220/66/11KV, 100MVA/150MVA Transformer provided.
- e) The trip impulses received from Buchholz relay, winding temperature relay, pressure relief device, oil surge relay etc., provided by the transformer manufacturer, shall trip the breaker through an auxiliary relay.
- f) The necessary matching transformers required for the protection scheme shall be supplied by the bidder and is deemed to be part of differential protection.
- g) The back up protection shall operate independent of primary protection.

D) Bus Bar Protection:

- a) The 220KV bus bars shall be protected by a high speed circulating current / differential protection.
- b) The relays shall be of numerical design and the scheme shall cover all the 220KV Bus and feeder circuits.

30.00 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.

31.00 DRAWINGS AND LITERATURES:

31.01 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.

31.02 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.

31.03 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.

32.00 TESTS, TEST CERTIFICATES AND INSPECTION:

32.01 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

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

32.03 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.

32.04 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.

32.05 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.
 - 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 Event logger distance to fault locator and Disturbance recorder).
- 32.06 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.

33.00 Spares

- 33.01 The tenderer shall recommend in his offer a set of spares as are required for a period of 10 (Ten) 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.
- 33.02. The tenderer shall indicate the life expectancy or shelf life of all such spares and their recommended method of storage.
- 33.03 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.

34.00 MAINTENANCE TOOLS AND EQUIPMENT:

- 34.01 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.
- 34.02 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.

34.03 Itemized unit price rate of each such tool/equipment shall be furnished in the schedule of prices in tender proposal sheets.

35.00 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 Seven (07) years as on the last date of submission of bid.

35.01 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.

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

36.00 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 Seven 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.

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

38.0 TRAINING TO BOARD ENGINEERS :

- 38.01 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.
- 38.02 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.
- 38.03 The training shall be imparted before dispatch of the equipment.

39.0 DESPATCH :

- 39.01 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.
- 39.02 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.
- 39.03 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.

40.0 DEVIATION FROM TECHNICAL SPECIFICATIONS :

- 40.01 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.

41.0 SCHEDULE OF REQUIREMENTS AND DELIVERY :

- 41.01 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.
- 41.02 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.
- 41.03 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).
- 41.04 In case of new 220KV stations space constraints may result in the layout being modified into single bus both on 220 KV & 110/66 KV sides. In this event the bus coupler panel will be deleted from requirement.
- 41.05 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.

42.00 SCHEDULE OF PRICE:

- 42.01 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.
- 42.02 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.

43.0 GUARANTEED TECHNICAL PARTICULARS:

- 43.01 The tenderer should furnish the guaranteed technical particulars as called for in Annexure, failing which the offer is liable to be overlooked.
- 43.02 Guaranteed technical particulars for panels for different voltage class shall be furnished separately.**

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 and from existing 220/66kV Khodays Substation.

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.

- Energy Measurement system, DR work station.
 - Remote Station Control center (RSCC) HMI system with IEC 60870-5-104 protocol to monitor and control from existing 220/66kV Khodays Substation-1No
 - 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-Project.

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 control IED (a bay comprises of one circuit breaker and associated disconnect or, earth switches and instrument transformer in the simplex relay and protection panels itself (described in other sections of technical specifications) located in control room. Station HMI is also 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 1+1 mode, excluding the links between individual bay IEDs to switch, such that failure of one set of fibre shall not affect the normal operation of the SAS. However, it 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.
- LocalBay 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 disconnector, 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.
- 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 (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.
- 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.

3.2 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.

3.2.2 **Measurements.**

a) Analog 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. The measured values 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 shall be selectable for alarm indications.

3.2.3 **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.

3.2.4 **Station HMI.**

3.2.4.1 **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.

3.2.4.2 **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 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.

3.2.4.3 HMI design principles:

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

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

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

3.2.4.4 Process status displays and command procedures:

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

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

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

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

3.2.4.5 System supervision & display.

The SAS system shall be comprehensively self-monitored such that faults are immediately indicated to the operator, possibly before they develop into serious situations. Such faults are recorded as a faulty status in a system supervision display. This display shall cover the status of the entire substation including all switchgear, IEDs, communication infrastructure and remote communication links and printers at the station level etc.

3.2.4.6 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.

3.2.4.7 **Alarm list:**

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

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

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

Whenever an alarm condition occurs, the alarm condition must be shown on the alarm list and must be displayed in a flashing state along with an audible alarm. After 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.

3.2.4.8 **Object picture:**

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

- Type of blocking
- Authority

- Local / remote control
- RSCC / SAS control
- Errors etc.,
shall be displayed.

3.2.4.9 **Control dialogues:**

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

- Breaker and disconnecter
- Transformer tap-changer.

3.2.5 **User-authority levels:**

It shall be possible to restrict activation of the process pictures of each object (bays, apparatus...) within a certain user 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.

3.2.6 **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.
- 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.

3.2.7 Trend display (historical data):

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

3.2.8 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.

3.2.9 Disturbance analysis:

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

3.2.10 IED parameter setting:

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

3.2.11 Automatic sequences:

The available automatic sequences in the system should be listed and described (e.g., sequences related to the 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, Energy Measurement System workstation and Disturbance Recorder Work Station:

The contractor shall provide redundant station HMI in hot standby mode.

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.

SSD: 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 console via 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 of CD-ROM / DVD-ROM with 700 MB or more capacity. 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.

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 IEDs bays of 220 KV, 110 KV/66 KV yard to communication infrastructure.

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 220 KV. , 110 KV & 66 KV bays (a bay comprises of one circuit breaker and associated disconnector, 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 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 Extendibility in future:

Offered substation automation system shall be suitable for extension in future for additional bays indicated in SLD & additional 4 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 shutdown 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:

1) Power Input:

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

2) Accuracy Tests:

- I. Operational Measured Values.
- II. Currents.
- III. Voltages.
- IV. Time resolution.

3) Insulation Tests:

- I. Dielectric Tests.
- II. Impulse Voltage withstand Test.

4) Influencing Quantities.

- I. Limits of operation.
- II. Permissible ripples
- III. Interruption of input voltage.

5) 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.

6) Function Tests:

- I. Indication
- II. Commands
- III. Measured Value Acquisition
- IV. Display Indications

7) 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. If the FAT comprises only a certain portion of the system for practical reason, it has to be assured that this test configuration contains at least one unit of each and every type of equipment incorporated in the delivered system.

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 **Integrated Testing:**

The integrated system tests shall be performed as detailed in subsequent clauses as per the following configuration:

- Redundant Station HMI, DR workstation with all IEDs & printers.

All other switches for complete substation as detailed in section project shall be simulated as needed:-

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.

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 **Field tests:**

The field tests shall completely verify all the features of SAS hardware and software

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 color. The operator prompting shall distinguish between:

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

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

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

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

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) Response Time Calculation.
- e) Functional Design Document.

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.

List of drawings.

Substation Automation System architecture.

Block Diagram.

- Guaranteed Technical Parameters, Functional Design Specification and Guaranteed availability and reliability.
- Calculation for power supply dimensioning.
- I/O Signal lists.
- Schematic diagrams

List of Apparatus.

- List of Labels.
- Logic Diagram (hardware & software). -Panel
- Panel layout drawing.

- GA of and GTP.
- Control Room Layout.
- Test Specification for Factory Acceptance Test (FAT).
- Product Manuals.
- Assembly Drawing.
- Operators Manual.
- Complete documentation of implemented protocols between various elements.
- Listing of software and loadable in CD ROM.
- Other documents as may be required during detailed engineering.

Two sets of hard copy and Four sets of CD ROM containing all the as-built documents/drawings shall be provided 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 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 Contractor shall quote training prices individually for each of the courses as. indicated in Price Schedule.

Employer will have the option to cancel any or all-training courses. In the case of cancellation, the rate quoted against the respective course will not be paid to the Contractor.

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.

10.5 **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.	
3.	Computer System Software
4.	Application Software

11.0 **MAINTENANCE RESPONSIBILITY:**

11.1

Maintenance Responsibility during theGuaranteed 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.

12.0 **RELIABILITY AND AVAILABILITY:**

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

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

Outage terms:

1) Outage:

The state in which substation automation system or a unit of SAS is unavailable for Normal Operation 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.

2) Actual outage duration (AOD):

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

3) Period Hours (PH):

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

4) Actual Outage hours (AOH):

The sum of actual outage duration within the reporting period

$$AOH = \sum AOD$$

5) Availability:

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

12.1 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 SPA RES :

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:**

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.

- i, Station HMI.
- ii. Redundant Station HMI (in Hot standby mode).
- iii. Bay level units along with bay mimic.

IV. Disturbance Recorder Work Station (Maintenance HMI).

v. Colour Laser Printer - 1 No. (For Reports & Disturbance Records).

vi. Dot Matrix Printer - (one each for Alarms and log sheets).

vii. All interface equipment for gateway to RCC and RSCC.

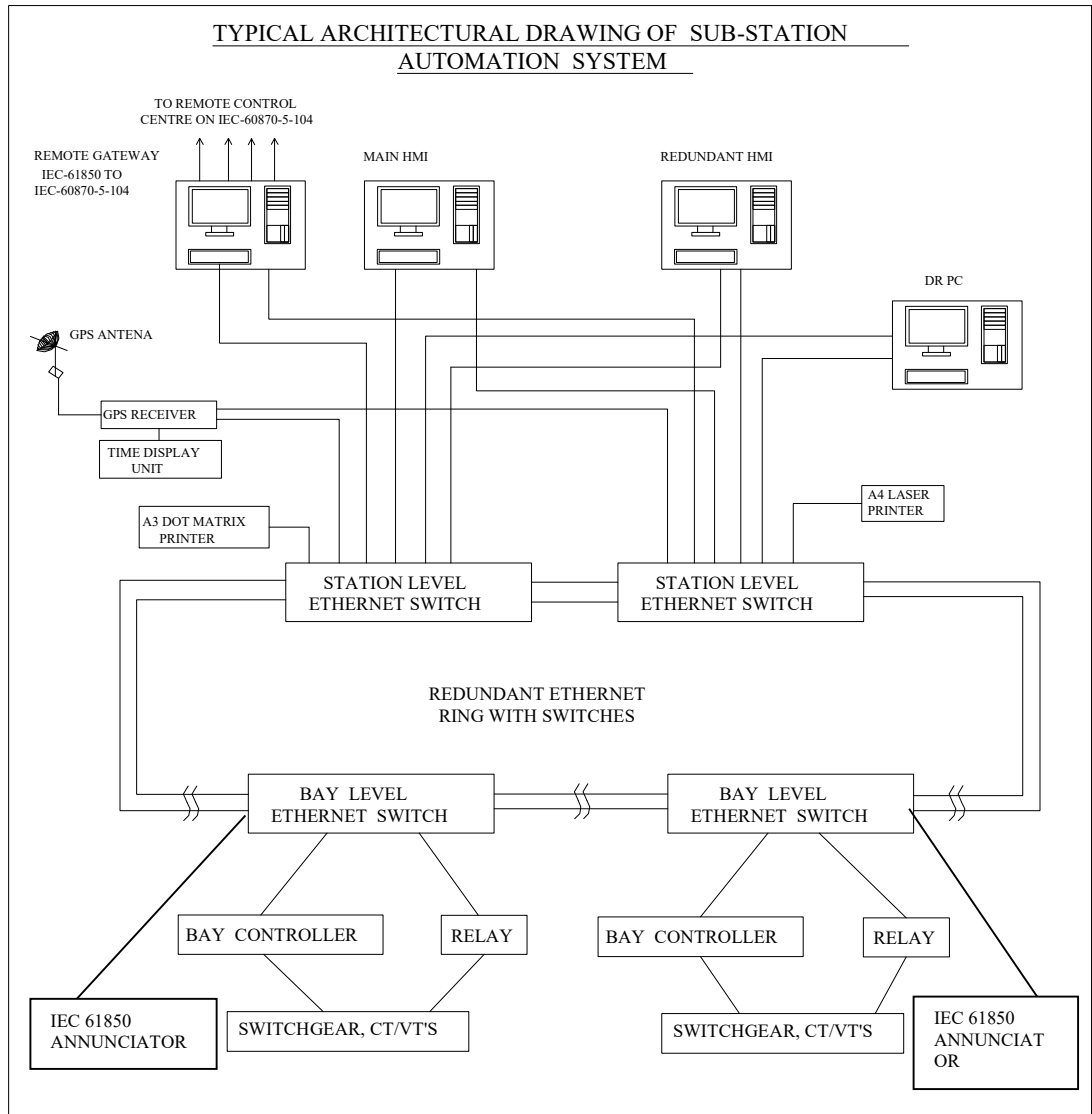
viii. Communication infrastructure between Bay level units, Station HML Printers, gateways, redundant LAN etc.. as required.

ix. Energy Measurement System Workstation

x. DR work station

xi. Any other equipment as necessary.

x. 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:

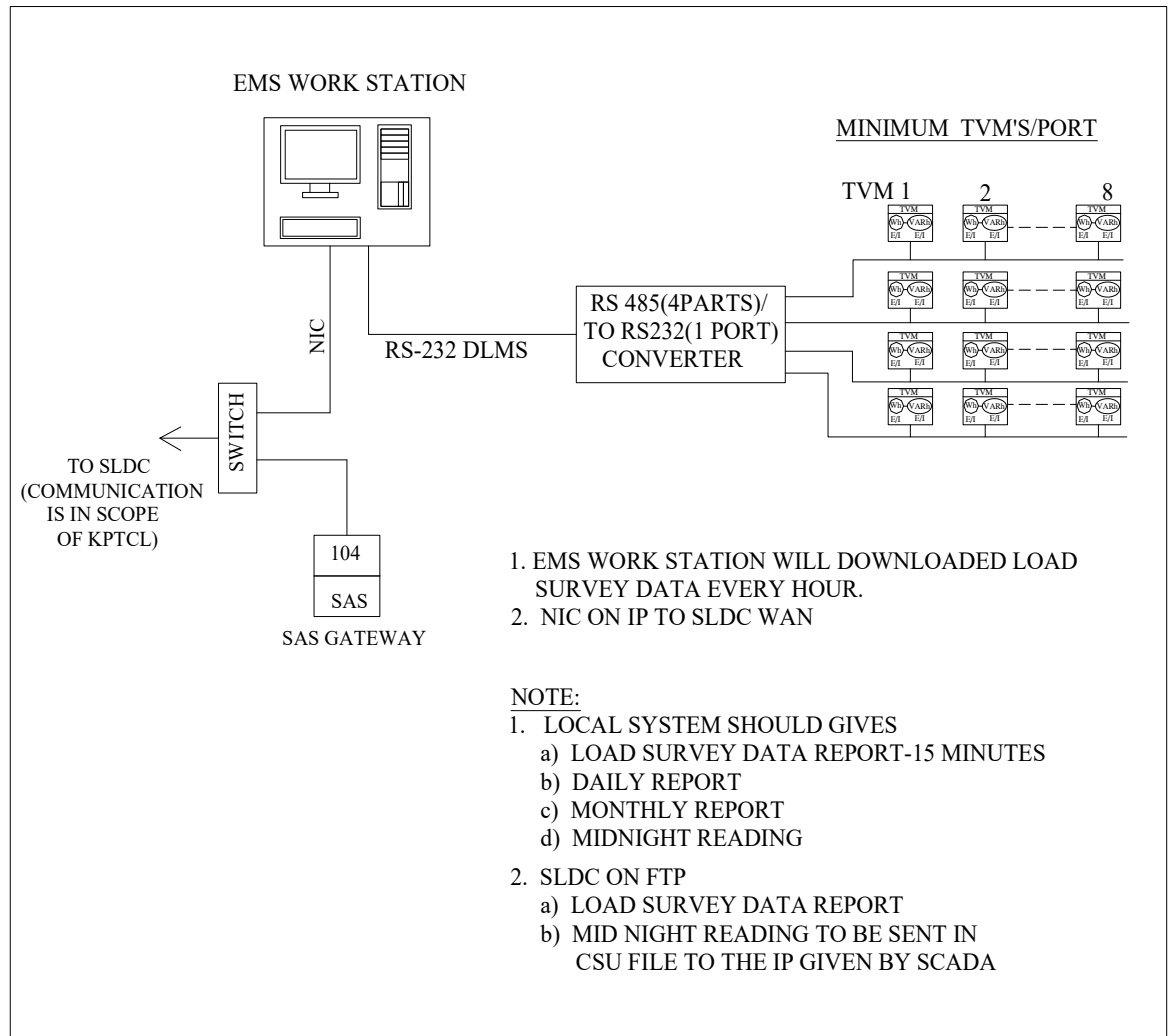
1. STATION BUS SHALL BE REALIZED BY HIGH SPEED REDUNDANT OPTICAL BUS USING INDUSTRIAL GRADE COMPONENTS AND SHALL BE AS PER IEC 61850 Ed1 & Ed2 (Site selectable).
2. IEDS FOR TWO BAYS MAY BE HOUSED IN ONE PANEL ALONG WITH ITS SWITCH.
3. INSIDE THE SUB STATION, ALL CONNECTIONS SHALL BE REALIZED AS PER 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-3 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

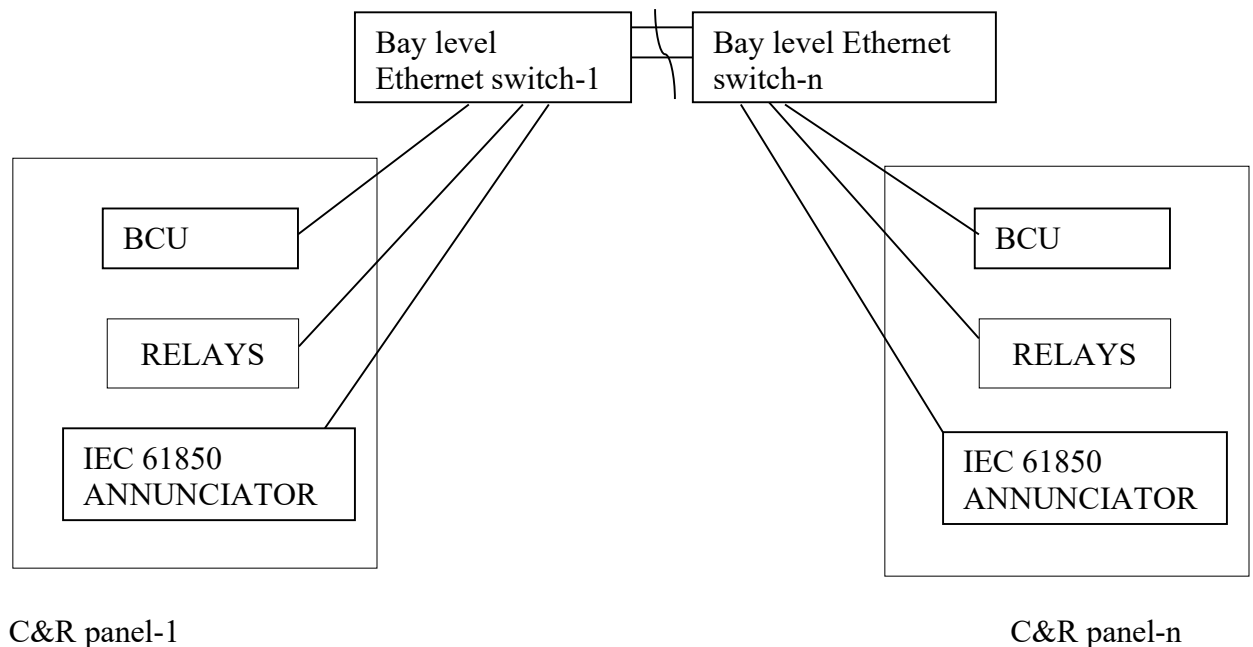
The basic Annunciator offered in the Tender should have been successfully type tested at any of the internationally accredited laboratory OR NABL accredited laboratory in line with relevant Standards and the Technical Specification within the Ten(10) years prior to the date of the Tender. Copies of type test reports shall be submitted along with the offer.

12.2 List of Type test

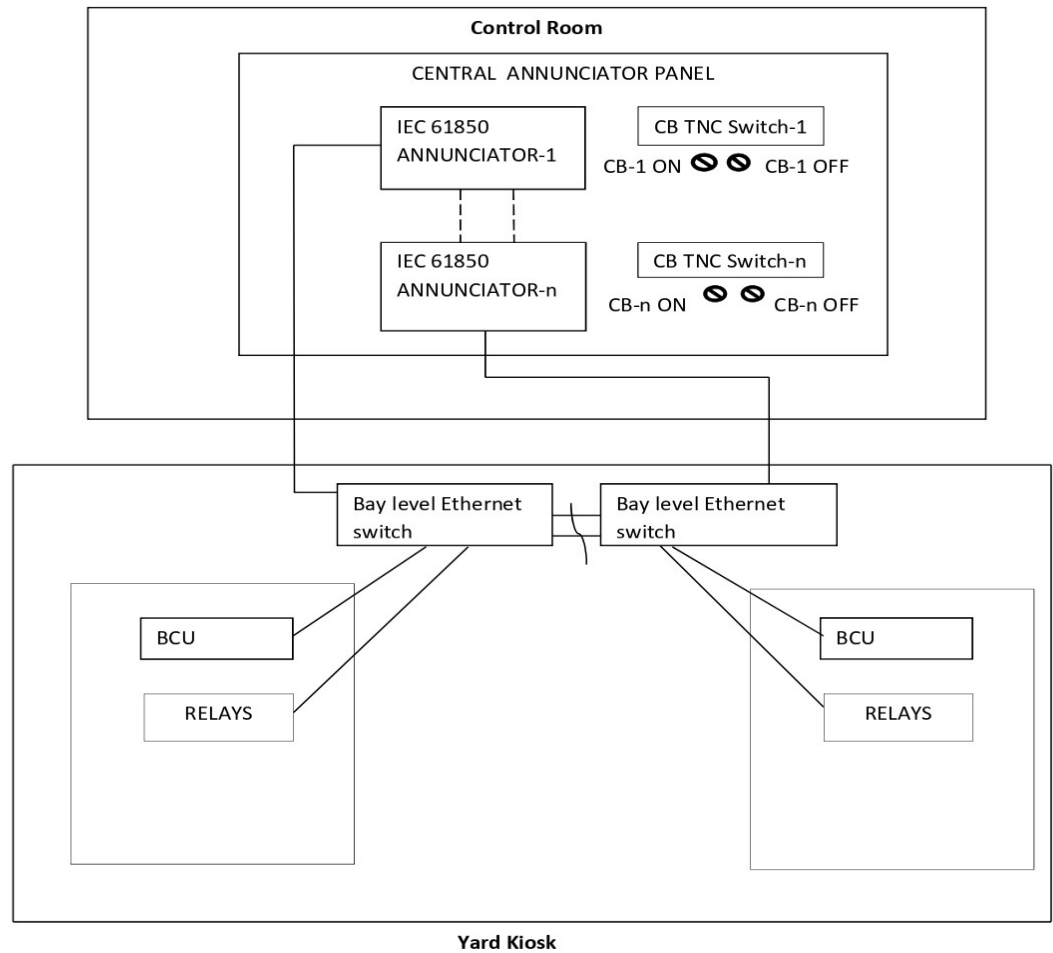
The list of type tests shall include the following
EMI/EMC:

- 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:



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 VDC 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, for 220 KV lines.
- Acquisition of alarm and fault record from protection relays
- Disturbance records for 220 KV lines.
- 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)
- OTI (for transformer)
- Tap position (for transformer only)
- iii) For bus coupler
 - 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) 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:

Sl. No.	Particulars	220 KV	110/66 KV	BC
1.	Line 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 TC1/TC2			
vi)	LBB optd			
vii)	Bus bar protection trip relay optd.			
viii)	Main bkr auto recloser operated			
ix)	A/R lockout			
x)	Direct trip sent			
xi)	Direct trip received			
xii)	Main-I/Backup blocking			
xiii)	Main-I/Backup Inter trip send			
xiv)	Main-I/Backup Inter trip received			
xv)	Fault Locator Faulty			
xvi)	Main VT Fuse fail			
xvii)	Main Protn trip			
xviii)	Back up protn trip			
xix)	Main PSB Alrm			
xx)	Main softrip			
xxi)	Main R-Phase trip			
xxii)	Main Y-Phase trip			
xxiii)	Main B-phase trip			
xxiv)	Main Start			
xxv)	Main Carrier aided trip			
xxvi)	Main fault in reverse direction			
xxvii)	Main Zone-2 trip			

xxviii)	Main Zone-3 trip			
xxix)	Main weak ends infeed			
xxx)	Main fault in reverse direction			
xxxi)	Back-up o/c optd			
xxxii)	Back-up e/f optd			
xxxiii)	220 V DC-I/II source fail			
xxxiv)	Speech channel fail			
xxxv)	PLCC protection channel fail			
xxxvi)	PLCC protection channel fail			
xxxvii)	SF6 Gas Pressure Low			
Sl. No.	Particulars	220 KV	110/66 KV	BC
xxxvii	Spares – 4 Nos			
2.	Transformer bays: 100/150MVA Transformer			
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)	Over flux alarm (V)			
xi)	Over flux trip (V)			
xii)	HV Bus VT fuse (A)			
xiii)	MV Bus VT Fuse (A)			
xiv)	OTI Alarm/Trip			
xv)	PRD optd			
xvi)	Overload alarm			
xvii)	Bucholz trip			
xviii)	Bucholz Alarm			
xix)	OLTC oil surge relay alarm			
xx)	OLTC oil surge relay trip			
xxi)	Oil low alarm			
xxii)	Back-up o/c (HV) optd.			

xxiii)	Back-up e/f (HV) optd			
xxiv)	220 V DC-I/II source fail			
xxv)	Tap mismatch			
xxvi)	Back-up o/c (MV) optd			
xxvii)	Back-up e/f (MV) optd			
xxviii)	WTI Alaram/Trip			
xxix)	SF6 Gas Pressure low			
xxx)	Spares 4 Nos.			
3.	Transformer bays – for others:			
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			
Sl. No.	Particulars	220 KV	110/ 66 KV	BC
vi)	LBB optd.			
vii)	Bus bar protn. trip relay optd			
viii)	REF optd			
ix)	DIF optd			
x)	HV Bus VT fuse fail			
xi)	OTI Alarm / trip			
xii)	PRD optd			
xiii)	Bucholz trip			
xiv)	Bucholz alarm			
xv)	Oil low alarm			
xvi)	Back-up o/c HV optd			
xvii)	Back-up E/F HV optd			
xviii)	220 V DC-I/II source fail			
xix)	Back up o/c LV operated			
xx)	Back up E/F LV operated			
xxi)	SF6 Gas Pressure low			
xxii)	Spares 4 Nos.			
4.	Bus-bar 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 protection relay fail			
5.	Auxiliary system:			
i)	Incomer-I On/Off			
ii)	Incomer-II On/Off			
iii)	415 V Bus-I/II U/V			
iv)	415 V Bus coupler breaker on/off			
v)	DG set bkr on/off			
vi)	Alarm/trip signals as listed in Section: DG Set			
vii)	PLCC exchange fail			
viii)	Time sync. Signal absent			
ix)	Alarm/trip signals as listed in Section: Battery & Battery charger			
x)	220 V DC-I earth fault			
xi)	220 V DC-II earth fault			
xii)	Alarm/ Nitrogen trip signals as listed in Section: Fire protection system			

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.

ANNEXURE – RPP –TVM

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

ANNEXURE – RPP1 – SAS

RELAY & PROTECTION PANEL FOR 220 KV FEEDERS AND BUS COUPLER FOR STATIONS WITH SUBSTATION AUTOMATION SYSTEM.

(TYPE-2L – FOR 220 KV FEEDERS)

(TYPE-2BC – FOR 220 KV BUS COUPLER)

The SIMPLEX panel shall generally consist of following items:

Sl. No.	PARTICULARS	QUANTITIES	
		2L	2BC
A	<u>MEASUREMENT & CONTROL:</u>		
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. 3.2.2 - Measurements. 3.2.3 - event & alarm handling.	1 No.	1No.
2 (a)	AC 3 Phase, 2 element, Electronic Tri-Vector meter (TVM), Accuracy 0.2S with ABT & TOD features and shall conform to detailed specification furnished.	1 No.	1No.
(b)	Test Terminal block for TVM	1 No.	1No.
3.	Selector switch for control of 220KV CB & 220KV isolator from local, RemoteBay control unit and remote – SCADA	1 No.	1No.
4	Selector Switch with indication a) For bus coupler off – FDR1-FDR2...../TR1, TR2	-	1 No.
	b) For double bus arrangement, for selection of trip transfer scheme between Feeder/ Transformer and bus coupler with locking facility.	1 No.	1No.
	c) For selection line CVT & bus VT	1 No.	-
5	Indication & alarm As described in Annexure of specification	1 No.	1 No.
6	IEC 61850 Annunciator (12 window)	1 No	1 No

ANNEXURE – RPP1 – SAS
RELAY & PROTECTION PANEL FOR 220 KV FEEDERS AND BUS COUPLER FOR STATIONS
WITH SUBSTATION AUTOMATION SYSTEM.

Sl. No.	PARTICULARS	QUANTITIES	
		2L	2BC
	<u>RELAYS</u>		
1	Main Protection Relay: a) Numerical / digital distance scheme with fault locator, disturbance recorder, event recorder suitable for 3-ph / single phase tripping with other features as described in the detailed specifications, with test switch- Main-I protection b) Numerical / digital distance scheme with fault locator, disturbance recorder, event recorder suitable for 3-ph / single phase tripping with other features as described in the detailed specifications, with test switch- Main-II protection. Note: Main-II numerical distance protection relay shall be of make different from that of Main-I.	1 Set 1 Set	-
2	Back-up protection: a) Numerical directional over current potentially polarized IDMT relays without instantaneous elements. b) Numerical directional earth fault potentially polarized IDMT relays without instantaneous elements c) Numerical non-directional over current & earth fault IDMT relay with instantaneous element. d) Carrier receive relays, auxiliary relays, timers etc as per scheme requirements. e) Numerical under frequency relay with voltage protection feature. 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.	- - -- Lot -	-- -- 1 No. Lot 1set
3	Breaker Auxiliary Relays: a) Trip circuit supervision relay b) 3 Phase Tripping relay (1 for main-I, 1 for main-II/backup protection & 1 for bus-bar protection) c) Single phase tripping relay 3 for Main-I & 3 for Main-II d) DC supply monitoring relay e) Flag relays, auxiliary relays, timers etc., as per scheme requirement (breaker failure protection) f) Local breaker back up relays g) Auto reclose scheme with check synchronizing and dead line charging relay	6 Sets 1 Set 1 Set 2 Sets As required 1 No. 1 Set	6 Sets 1 Set - 2 Sets As required 1 No. --
4	Other devices: a) Test terminal block b) PVC circuit labels c) One label indicating manufacturers name, P.O. details, drawing reference number etc. d) Internally mounted equipments	As required 2 Nos. 1 No. 1 Set	As required 2 Nos. 1 No. 1 Set

ANNEXURE – RPP1 – SAS

RELAY & PROTECTION PANEL FOR 220 KV FEEDERS AND BUS COUPLER FOR STATIONS WITH SUBSTATION AUTOMATION SYSTEM.

NOTE:

1. Other accessories required for operation of the protective scheme including interconnections shall be included.
2. Numerical distance scheme shall be suitable for all line lengths. Any limitation shall be clearly specified.
3. The static devices in addition to name plate, shall have labels indicating the function that are part of that particular relays and their codes in the drawings.
4. Suitable interlock arrangements shall be provided for selection of PT voltages, so that there should not be paralleling of PT secondaries or energisation of PT secondary of a PT, which is not charged.
5. Suitable interlock arrangement shall also be provided to prevent local / remote electrical operation of bus selection isolator when the corresponding breakers are closed.

ANNEXURE – RPP1 –Cable – SAS

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

(TYPE-2L – FOR 220 KV CABLE FEEDERS)

The SIMPLEX panel shall generally consist of following items:

Sl. No.	PARTICULARS	QUANTITIES
		2L
A	<u>MEASUREMENT & CONTROL:</u>	
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. 3.2.2 - Measurements. 3.2.3 - event & alarm handling.	1 No.
2 (a)	AC 3 Phase, 2 element, Electronic Tri-Vector meter (TVM), Accuracy 0.2S with ABT & TOD features, DLMS compliant and shall conform to detailed specification furnished.	1 No.
(b)	Test Terminal block for TVM	1 No.
3.	Selector switch for control of 220KV CB & 220KV isolator from local, RemoteBay control unit and remote – SCADA	1 No.
4	Selector Switch with indication a) For bus coupler off – FDR1-FDR2...../TR1, TR2	-
	b) For double bus arrangement, for selection of trip transfer scheme between Feeder/ Transformer and bus coupler with locking facility.	1 No.
	c) For selection line CVT & bus VT	1 No.
5	Indication & alarm As described in Annexure of specification	1 No.
6	IEC 61850 Annunciator (12 window)	1 No

[illegible]

**ANNEXURE – RPP1 – CABLE-SAS
RELAY & PROTECTION PANEL FOR 220 KV CABLE FEEDERS FOR STATIONS
WITH SUBSTATION AUTOMATION SYSTEM.**

NOTE:

- 1. Refer Note of Annexure CRP-1 SAS wherever applicable.**

ANNEXURE – RPP2 – SAS

RELAY & PROTECTION PANEL FOR 100 MVA, 220/66/11 KV
STAR-STAR-DELTA, THREE WINDING POWER TRANSFORMER
OR
220/110/11 KV STAR-STAR-DELTA, AUTO-TRANSFORMERS FOR STATIONS WITH
SUBSTATION AUTOMATION SYSTEM.

(TYPE-2T6 & 2T1)

2T6 FOR 220/66/11 KV TRANSFORMERS

TYPE-2T1 FOR 220/110/11 KV AUTO-TRANSFORMERS

The SIMPLEX C & R panel shall generally consist of the following items:

Sl. No.	PARTICULARS	QUANTITIES	
		2T6	2T1
A	<u>MEASUREMENT & CONTROL:</u>		
1	Bay Control Intelligent Electronic Device for both HV & MV side As per Cl. No. 3.1.1.1 – Over view 3.1.1.2 – Control & Selection. 3.1.1.3 – Synchronisation & energizing check. 3.1.1.4 – Transformer Tap changer control 3.2 - System level function 3.2.1 - Status supervision. 3.2.2 - Measurements. 3.2.3 - event & alarm handling.	1 Set.	1 Set.
2 (a)	AC 3 Phase, 2 element, Electronic Tri-Vector meter (TVM), Accuracy 0.2S with ABT & TOD features, DLMS compliant and shall conform to detailed specification furnished on both HV side & LV side.	2 Nos.	2 Nos.
(b)	Test Terminal block for TVM	2 Nos.	2 Nos.
3.	Selector switch for control of 220KV and 110/66KV CB & 220KV and 110KV/66KV isolator from local, Remote Bay control unit and remote- SCADA	2 Nos.	2 Nos.
4 (a)	For double bus arrangement, for selection of trip transfer scheme between Feeder/ Transformer and bus coupler with locking facility.	1 No.	1No.
5	Indication & alarm As described in Annexure of specification	1 No.	1 No.
6	IEC 61850 Annunciator (24 window)	1 No.	1 No.

ANNEXURE – RPP2 – SAS

RELAY & PROTECTION PANEL FOR 100 MVA/150MVA, 220/66/11 KV
 STAR-STAR-DELTA, THREE WINDING POWER TRANSFORMER
 OR
 220/110/11 KV STAR-STAR-DELTA, AUTO-TRANSFORMERS FOR STATIONS WITH
 SUBSTATION AUTOMATION SYSTEM. (SCADA)

Sl. No.	PARTICULARS	QUANTITIES	
		2T6	2T1
B	<u>PROTECTION RELAYS:</u>		
1	Main Protection Relay:		
	a) Numerical triple pole high speed percentage bias differential relay with high set instantaneous element suitable for three winding transformers with fixed ratio ICT's.	1 Set	1 Set
	b) Over Flux relay.	1 No.	1 No.
	c) Restricted earth fault relay	2 Nos.	1 No.
	d) Over load relay	1 No.	1 No.

ANNEXURE – RPP2 – SAS

RELAY & PROTECTION PANEL FOR 100 MVA/150MVA, 220/66/11 KV
STAR-STAR-DELTA, THREE WINDING POWER TRANSFORMER
OR

220/110/11 KV STAR-STAR-DELTA, AUTO-TRANSFORMERS FOR STATIONS WITH
SUBSTATION AUTOMATION SYSTEM. (SCADA)

Sl. No.	PARTICULARS	QUANTITIES	
2	Back-up protection:	2T6	2T1
	a) Numerical directional over current & Earth fault potentially polarized IDMT relays with high set instantaneous elements (on HV side).	1 No.	1 No.
	b) Numerical directional over current & Earthfault potentially polarized IDMT relays with high set instantaneous elements (on MV side)	1 No.	1 Nos.
	c) Numerical non-directional over current IDMT relay with high set instantaneous elements (suitable for 1000/1 or 1515/1A Amps) for protection of tertiary winding due to circulating current in delta winding.	1 No.	1 No.
	d) Flag relays, auxiliary relays, timers etc., as per scheme requirement		
3	Breaker Auxiliary Relays:		
	a) Trip circuit supervision relay (HV side)	6 Sets	6 Sets
	b) Trip circuit supervision relay (MV side)	2 Sets	2 Sets
	c) i. Inter tripping relay (to trip both HV & MV side of the transformer ii. Tripping relay MV side iii. Tripping relay for Bus-bar	1 Set 1 Set 1 Set	1 Set 1 Set 1 Set
	d) DC supply monitoring relay	1 Set	1 Set
	e) Auxiliary relays for Bucholtz trip/alarm, winding temperature high trip/alarm, oil temperature high trip/alarm, oil surge relay trip, pressure relief device trip	As required	As required
	f) Flag relays, auxiliary relays, timers etc., as per scheme requirement	As required	As required
	g) Local breaker back up relays (breaker failure protection)	1 No.	1 No.

ANNEXURE – RPP2 – SAS

RELAY & PROTECTION FOR 100 MVA/150MVA, 220/66/11 KV
STAR-STAR-DELTA, THREE WINDING POWER TRANSFORMER
OR
220/110/11 KV STAR-STAR-DELTA, AUTO-TRANSFORMERS FOR STATIONS WITH
SUBSTATION AUTOMATION SYSTEM. (SCADA)

Sl. No.	PARTICULARS	QUANTITIES	
4	Other devices:	2T6	2T1
	a) Test terminal block	Asrequired	
	b) PVC circuit labels	2 Nos.	2 Nos.
	c) One label indicating manufacturers name, P.O. details, drawing reference number etc.	1 No.	1 No.
	d) Internally mounted equipments	1 Set	1 Set

NOTE:

2. Refer Note of Annexure CRP-1 SAS wherever applicable.

ANNEXURE – RPP-3 SAS

SIMPLEX TYPE PANEL FOR 220 KV BUS-BAR PROTECTION

TYPE-2 BBA

FOR SUBSTATION WITH SUBSTATION AUTOMATION SYSTEM (SCADA)

Sl. No.	PARTICULARS	QUANTITIES
1	PVC Circuit labels	2 Sets
2	Internal equipment and small wiring like cubicle	1 Set
3	Triple pole high speed percentage biased static / numerical relays	1 Set
4	Bus barCT secondary wiring 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	<p>DC fail indication.</p> <p>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.</p>	

ANNEXURE – RPP -4 – SAS

RELAY & PROTECTION PANEL FOR 110/66 KV FEEDERS

(TYPE-1L – FOR 110 KV FEEDER)

(TYPE 6L – FOR 66 KV FEEDER)

FOR STATION WITH SUBSTATION AUTOMATION

(SCADA)

The SIMPLEX panel shall generally consist of the following items:

Sl. No.	PARTICULARS	QUANTITIES	
		1L	6L
A	<u>MEASUREMENT & CONTROL:</u>		
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. 3.2.2 - Measurements. 3.2.3 - event & alarm handling.	1 No.	1No.
2 (a)	AC 3 Phase, 2 element, Electronic Tri-Vector meter (TVM), Accuracy 0.2S with ABT & TOD features, DLMS compliant and shall conform to detailed specification furnished.	1 No.	1No.
(b)	Test Terminal block for TVM	1 No.	1No.
3.	Selector switch for control of 110/66KV CB & 110/66KV isolator from local, RemoteBay control unit and remote – SCADA	1 No.	1No.
4	Selector Switch with indication a) For bus coupler off – FDR1-FDR2...../TR1, TR2	1 No.	1 No.
	b) For double bus arrangement, for selection of trip transfer scheme between Feeder/ Transformer and bus coupler with locking facility.	1 No.	1No.
	c) For selection line CVT & bus VT	-	-
5	IEC 61850 Annunciator (12 window)	1 No.	1 No.

ANNEXURE – RPP -4 – SAS

RELAY & PROTECTION PANEL FOR 110/66 KV FEEDERS

Sl. No.	PARTICULARS	QUANTITIES	
		1L	6L
B	RELAYS:		
1	Main Protection Relay: Numerical distance scheme suitable for 3 phase tripping with other features as described in the detailed specification.	1 Set	1 Set
2	Back-up protection:		
	a) Numerical directional over current & earth fault potentially polarized IDMT relays without instantaneous elements.	1 Nos.	1 Nos.
	b) Flag relays, auxiliary relays, timers etc., as per scheme requirement.	As required	As required
3	Breaker Auxiliary Relays:		
	a) Trip circuit supervision relay	2 Sets	2 Sets
	b) Tripping relay (1 for main 1 for backup protection)	1 Set	1 Set
	c) DC supply monitoring relay	1 Set	1 Set
	d) Flag relays, auxiliary relays, timers, etc., as per scheme requirement	As required	As required
4	Other devices:		
	a) Test terminal block	If required see note	
	b) PVC circuit labels	2 Nos.	2 Nos.
	c) Label indicating manufacturers name, P.O. details, drawing reference number etc.	1 No.	1 No.
	d) Internally mounted equipments	1 Set	1 Set

NOTE: Refer Note of Annexure CRP-1, wherever applicable.

ANNEXURE – RPP -4 - CABLES – SAS

RELAY & PROTECTION PANEL FOR 110/66 KV FEEDERS

(TYPE-1L – FOR 110 KV CABLE FEEDER)

(TYPE 6L – FOR 66 KV CABLE FEEDER)

FOR STATION WITH SUBSTATION AUTOMATION

(SCADA)

The SIMPLEX panel shall generally consist of the following items:

Sl. No.	PARTICULARS	QUANTITIES	
		1L	6L
A	<u>MEASUREMENT & CONTROL:</u>		
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. 3.2.2 - Measurements. 3.2.3 - event & alarm handling.	1 No.	1No.
2 (a)	AC 3 Phase, 2 element, Electronic Tri-Vector meter (TVM), Accuracy 0.2S with ABT & TOD features, DLMS compliant and shall conform to detailed specification furnished.	1 No.	1No.
(b)	Test Terminal block for TVM	1 No.	1No.
3.	Selector switch for control of 110/66KV CB & 110/66KV isolator from local, RemoteBay control unit and remote – SCADA	1 No.	1No.
4	Selector Switch with indication a) For bus coupler off – FDR1-FDR2...../TR1, TR2	1 No.	1 No.
	b) For double bus arrangement, for selection of trip transfer scheme between Feeder/ Transformer and bus coupler with locking facility.	1 No.	1No.
	c) For selection line CVT & bus VT	-	-
5	IEC 61850 Annunciator (12 window)	1No	1 No

ANNEXURE – RPP -4 - CABLES– SAS
RELAY & PROTECTION PANEL FOR 110/66 KV CABLE FEEDERS

Sl. No.	PARTICULARS	QUANTITIES	
		1L	6L
B	<u>RELAYS:</u>		
1	Main Protection Relay: Numerical current differential protection with protection unit based on phase segregated line differential principle and restrained dual bias operating characteristic as detailed in the specification. Note: Optic fibre 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). The Numerical current differential protection relays shall be suitable for line/cable length of minimum 50km.	1 Set	1 Set
2	Back-up protection:		
	c) Numerical directional over current and Earth fault potentially polarized IDMT relays without instantaneous elements.	1 Nos.	1Nos.
	d) Flag relays, auxiliary relays, timers etc., as per scheme requirement.	As required	As required
3	Breaker Auxiliary Relays:		
	e) Trip circuit supervision relay	2 Sets	2 Sets
	f) Tripping relay (1 for main 1 for backup protection)	1 Set	1 Set
	g) DC supply monitoring relay	1 Set	1 Set
	h) Flag relays, auxiliary relays, timers, etc., as per scheme requirement	As required	As required
4	Other devices:		
	e) Test terminal block	If required see note	
	f) PVC circuit labels	2 Nos.	2 Nos.
	g) Label indicating manufacturers name, P.O. details, drawing reference number etc.	1 No.	1 No.
	h) Internally mounted equipments	1 Set	1 Set

NOTE:

1. Refer Note of Annexure CRP-1 SAS wherever applicable.

ANNEXURE – RPP -5 – SAS

RELAY & PROTECTION PANEL FOR 110/33 KV 110/11 KV & 66/11 KV DELTA-STAR POWER TRANSFORMER

(TYPE-1T3 FOR 110/33 KV TRANSFORMER)

(TYPE-1T1 FOR 110/11 KV TRANSFORMER)

(TYPE-6T1 FOR 66/11 KV TRANSFORMER)

FOR STATION WITH SUBSTATION AUTOMATION SYSTEM

The SIMPLEX panel shall generally consist of the following items:

Sl. No.	PARTICULARS	QUANTITIES	
		1T3	1T1 / 6T1
A	<u>MEASUREMENT & CONTROL:</u>		
1	Bay Control Intelligent Electronic Device for both HV & LV side As per Cl. No. 3.1.1.1 – Over view 3.1.1.2 – Control & Selection. 3.1.1.3 – Synchronisation & energizing check. 3.1.1.4 – Transformer Tap changer control 3.2 - System level function 3.2.1 - Status supervision. 3.2.2 - Measurements. 3.2.3 - event & alarm handling.	1 set	1 set
	Note: For LV side IED, the features shall be suitable for 11KV switchgear with single bus & VCB. Protection shall also be covered in the IED.		
2 (a)	AC 3 Phase, 2 element, Electronic Tri-Vector meter (TVM), Accuracy 0.2S with ABT & TOD features, DLMS compliant and shall conform to detailed specification furnished on both HV side & IV side.	2 Nos.	2 Nos.
(b)	Test Terminal block for TVM	1 No.	1No.
3. (a)	Selector switch for control of 110KV/66KV CB & 110KV/66KV isolator from local, RemoteBay control unit and remote – SCADA	1 No.	1No.
4.	b) For double bus arrangement, for selection of trip transfer scheme between Feeder/ Transformer and bus coupler with locking facility.	1 No.	1No.
5	IEC 61850 Annunciator (24 window)	1No	1No

ANNEXURE – RPP -5 – SAS

RELAY & PROTECTION PANEL FOR 110/33 KV 110/11 KV & 66/11 KV DELTA-STAR POWER TRANSFORMER

Sl. No.	PARTICULARS	QUANTITIES	
		1T3	1T1 / 6T1
B	<u>PROTECTION RELAYS:</u>		
1	Main Protection Relay:		
	a) Numerical triple pole high speed percentage bias differential relay with high set instantaneous element suitable for two winding transformers with universal ratio ICT's.	1 Set	1 Set
	b) Restricted earth fault relay.	1 No.	1 No.
2	Back-up protection:		
	a) Numerical directional over current and earth fault potentially polarized IDMT relays with high set instantaneous elements (on HV side).	1 No.	1 No.
	b) Numerical directional over current and earth fault potentially polarized IDMT relays with high set instantaneous elements (on MV side)	1 Nos.	1 No
	c) Flag relays, auxiliary relays, timers etc., as per scheme requirement	As required	As required
3	Breaker Auxiliary Relays:		
	a) Trip circuit supervision relay (HV side)	2 Sets	2 Sets
	b) Trip circuit supervision relay (MV side)	2 Sets	2 Sets
	c) Inter tripping relay (to trip both HV & MV side of the transformer)	1 Set	1 Set
	d) DC supply monitoring relay	1 Set	1 Set
	e) Local breaker back up relays (breaker failure protection)	1 No.	1 No.
	f) Auxiliary relays for Bucholtz trip/alarm, oil temperature high trip/alarm, winding temperature high trip/alarm, etc., for HV & MV	As required	As required

ANNEXURE – RPP -5 – SAS

RELAY & PROTECTION PANEL FOR 110/33 KV 110/11 KV & 66/11 KV DELTA-STAR POWER TRANSFORMER

Sl.	PARTICULARS	QUANTITIES
-----	-------------	------------

No.		1T3	1T1 / 6T1
4	Other devices:		
	a) Test terminal block	If required see note	
	b) PVC circuit labels	2 Nos.	2 Nos.
	c) Label indicating manufacturers name, P.O. details, drawing reference number etc	1 No.	1 No.
	d) Internally mounted equipments	1 Set	1 Set

NOTE: Refer Note of Annexure CRP-1, wherever applicable.

ANNEXURE – RPP -6 – SAS

RELAY & PROTECTION PANEL FOR 110/66 KV BUS COUPLER
 (TYPE-1BC FOR 110 KV BUS COUPLER)
 (TYPE-6BC FOR 66 KV BUS COUPLER)
 FOR STATION WITH SUBSTATION AUTOMATION SYSTEM

The SIMPLEX panel shall generally consist of the following items:

Sl. No.	PARTICULARS	QUANTITIES	
		1BC	6BC
A	MEASUREMENT & CONTROL:		
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. 3.2.2 - Measurements. 3.2.3 - event & alarm handling.	1 No.	1No.
2 (a)	AC 3 Phase, 2 element, Electronic Tri-Vector meter (TVM), Accuracy 0.2S with ABT & TOD features, DLMS compliant and shall conform to detailed specification furnished.	1 No.	1No.
(b)	Test Terminal block for TVM	1 No.	1No.
3.	Selector switch for control of 110/66KV CB & 110/66KV isolator from local, RemoteBay control unit and remote – SCADA	1 No.	1No.
4	Selector Switch with indication a) For bus coupler off – FDR1-FDR2...../TR1, TR2	1 No.	1 No.
	b) For double bus arrangement, for selection of trip transfer scheme between Feeder/ Transformer and bus coupler with locking facility.	1 No.	1No.
5	IEC 61850 Annunciator (12 window)	1No	1No

ANNEXURE – RPP -6 – SAS

RELAY & PROTECTION PANEL FOR 110/66 KV BUS COUPLER

Sl. No.	PARTICULARS	QUANTITIES	
		1BC	6BC
B	<u>PROTECTION RELAYS:</u>		
1	Back-up protection:		
	a) Numerical non-directional over current and Earth fault IDMT relay with instantaneous element.	1 No.	1 No.
	c) Flag relays, auxiliary relay, timers etc., as per scheme requirement.	Lot	Lot
2	Auxiliary Relays:		
	a) Trip circuit supervision relay	2 Sets	2 Sets
	b) Tripping relay (1 for main & 1 for backup protection)	1 Set	1 Set
	c) DC supply monitoring relay	1 Set	1 Set
	d) Local breaker back up relays (breaker failure protection)	1 No.	1 No.
	e) Flag relays, auxiliary relay, timers etc., as per scheme requirement	Lot	Lot
3	Other devices:		
	a) Test terminal block	If required see note	
	b) PVC circuit labels	2 Nos.	2 Nos.
	c) One label indicating manufacturers name, P.O. details, drawing reference number etc	1 No.	1 No.
	d) Internally mounted equipments	1 Set	1 Set

NOTE: Refer Note of Annexure CRP-1, wherever applicable.

ANNEXURE – RPP -7 – SAS

RELAY & PROTECTION AND METERING PANEL FOR 33 & 11 KV FEEDERS

(TYPE-3L FOR 33 KV FEEDERS)

(TYPE-11L FOR 11 KV FEEDERS)

FOR STATION WITH SUBSTATION AUTOMATION SYSTEM

The SIMPLEX panel shall generally consist of the following items:

Sl. No.	PARTICULARS	QUANTITIES	
		3L	11L
A	MEASUREMENT & CONTROL:		
1	Bay Control Intelligent Electronic Device As per Cl. No. 3.1.1.1 – Over view 3.1.1.2 – Control & Selection. 3.2 - System level function 3.2.1 - Status supervision. 3.2.2 - Measurements. 3.2.3 - event & alarm handling.	1 No.	1No.
	Note: i. 2 Nos. Numerical non directional over current IDMT relay with instantaneous element and 1 No. numerical non – directional earth fault IDMT relay with instantaneous element shall be provided in the bay control IED itself. ii. For 33KV feeders, the features of IED shall be suitable for single bus with SF6 breaker, 2 isolators & CT's. For 11KV feeders the features of IED shall be suitable for single bus with vacuum circuit breakers. iii. The status indication of electromechanical 20CR & IEFr provided in the conventional 11KV switchgear is to be included in the IED. v. As the number of features of 33KV /11KV feeders is limited, 2 feeders may be accommodated in one bay control IED.		
2 (a)	AC 3 Phase, 2 element, Electronic Tri-Vector meter (TVM), Accuracy 0.2S with ABT & TOD features, DLMS compliant and shall conform to detailed specification furnished.	1 No.	1No.
(b)	Test Terminal block for TVM	1 No.	1No.
3	IEC 61850 Annunciator (12 window)	1 No	1 No
B.	Back up protection included in the IED Refer Note (i) Under item A(i)		

ANNEXURE – RPP-7 – SAS

RELAY & PROTECTION PANEL FOR 33 KV FEEDERS

(TYPE-3L FOR 33 KV FEEDERS)

(TYPE-11L FOR 11 KV FEEDERS)

FOR STATION WITH SUBSTATION AUTOMATION SYSTEM

The SIMPLEX panel shall generally consist of the following items:

Sl. No.	PARTICULARS	QUANTITIES	
1	Auxiliary Relays:		
	a) Trip circuit supervision relay	2 Sets	1 Set
	b) Tripping relays	1 Set	1 Set
	c) DC supply monitoring relay	1 Set	1 Set
	d) Flag relays, auxiliary relay, timers etc., as per scheme requirement	Lot	Lot
2	Other devices:		
	a) Test terminal block	If required see note	
	b) PVC circuit labels	2 Nos.	2 Nos.
	c) One label indicating manufacturers name, P.O. details, drawing reference number etc	1 No.	1 No.
	d) Internally mounted equipments	1 Set	1 Set

ANNEXURE –SAS

SCHEDULE OF REQUIREMENT FOR SUB-STATION AUTOMATION SYSTEM IN 220KV STATIONS

Particulars

- 1) Station Human Machine Interface
- 2) Hot Stand by Station HMI.
- 3) Redundant managed switched Earth net Local area Network communication infrastructure including optic fibre cable etc., with hot stand by (**to RCC & RSCC**)
- 4) Gate way (PC based) for remote control via industrial grade hardware through IEC 60870-5-104 protocol.
- 5) Peripheral equipment line printer display unit key Board mouse etc.,
- 6) system software and Hardware for reliable operation of SAS in conformity with Technical specification.
- 7) Other accessories required for reliable operation of SAS as per Technical specification.
- 8) DR workstation.
- 9) EMS workstation with DLMS accessories.
- 10) Furniture's.
- 11) For all numerical relays conforming to IEC 61850 Ed1 & Ed2 (Site selectable) protocol necessary ICD, CID,PICS, MICS, PIXIT documents in soft copy.

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 220KV / 110KV / 66KV Lines:	
A	Type of distance measuring element	
	a. Starting unit	
	i. Type of scheme	
	b, No. of measuring element or comparator with details	

Sl. No.	Description	
	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.	<u>Facilities available for Fault Locator</u>	
	a. Name and type reference of manufacturer	
	b. Rating and setting available	
	c. Rated V A burden	
	d. Power consumption voltage and current element	

Sl. No.	Description	
	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)VoltageRange	
6	Other Parameters for which accuracy is guaranteed	
	a. Reference Temperature	
	b. Standard Reference Frequency (Hz)	
	c. Accuracy Guaranteed for	
	d. FrequencyRange	
	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. TemperatureRange	
	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. IntegrationPeriodRange	
	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.	Particulars	

No.		
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) CommunicationPort	
	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 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	
	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	

Item	Particulars	Purchaser's Requirement	Tenderer's Response	Reference Doc.
	Annunciator for each Bay			
1	Number of Windows	24		
2	Size of Each window	34X 69 mm (min)		
3	Window Colour Site selectable	Red/Yellow		
4	Auxiliary Supply	88 - 250 V DC		
5	Standby Supply	240 V AC		
	Communication			
6	IEC 61850 Client	Both Ed 1 and 2 supported		
7	Messaging	MMS and Goose		
8	Window configuration	To any MMS tag		
9	Window mapping	To multiple MMS tags if required		
10	Configuration port	Serial		

11	Window status change triggered by	both data change and polling		
12	Sequence of Event records	Last event memory		
13	IEC 61850 port	Ethernet /100 Mbps		
14	Engineering	Able to import CID/ICD files		
15	Max Nodes per device	500		
16	Loss of communication	Should be mapped to any window		
	General			
17	Self Supervision alarm	Should be mapped to any window		
18	Hooter	To be driven by serial port with group selection for Trip and No Trip alarms		

