

SECTION 1

SCOPE, SPECIFIC TECHNICAL REQUIREMENTS AND QUANTITIES

1.0 SCOPE

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of 400 kV / 110kV Protection panels with substation automation system. In case of any discrepancies between the requirements mentioned in this section and those specified in the following sections of this specification, the specifications given herein shall prevail and shall be treated as binding requirements.

The fitment and equipments offered shall be of approved make of TANTRANSCO or its subsequent approval from TANTRANSCO shall be bidder's responsibility with no commercial implications to BHEL. If any of the make offered by the bidder is not acceptable to M/s TANTRANSCO, the bidder has to supply alternate TANTRANSCO approved make, meeting the specification, with no commercial implications to BHEL.

All auxiliary relays, timers, counters, aux CTs, switches etc required for completeness of the scheme and good engineering are deemed to be included in the offer and no claim whatsoever shall be entertained at contract stage.

The specification comprise of following sections:

- Section-1: Scope, Specific Technical Requirements and Bill of Quantities.
- Section-2: Equipment Specification.
- Section-3: General Technical Requirements.
- Section-4: Guaranteed Technical particulars (GTP)
- Section-5: Enclosures to Specification

In case of any conflict between various sections, order of precedence shall be in the same order as listed above.

1.1 THE EQUIPMENT IS REQUIRED FOR THE FOLLOWING PROJECT.

Name of the Customer : M/s Tamil Nadu Transmission Corporation Limited

Name of the Project : 400/110kV S/S at Thappagundu

1.2 SPECIFIC TECHNICAL PARAMETERS

As per Single Line Diagram and Section- 2 of the specification

In addition, following points to be noted by the bidder:

- i) The scope for relay setting shall be as follows:
 - a) Conducting the relay setting calculations and determination of the recommended relay settings shall be in bidder's scope. The relay settings shall be submitted in the OEM's format along with supporting calculations for approval of TANTRANSCO during contract stage.
 - b) Co-ordination with the customer for all the inputs pertaining to protection relay settings shall be in BHEL scope.
- ii) Wherever bidder offers any spare/ item/ fitment in lieu of the same being "Built-in feature" of any relay/ fitment or the same being "Not applicable" is subject to approval by TANTRANSCO. No price implication will be entertained by BHEL at contract stage if any separate item is insisted by TANTRANSCO to meet the contract requirement.
- iii) Bidder to note that the GTP, Make & type of fitments, Bill of material of the offered Control & Relay Panels and their mandatory spares are subject to TANTRANSCO approval at the contract stage. No price implications will be entertained by BHEL at contract stage.
- iv) ABT energy meters are to be provided in 400KV & 110 KV feeder bays and transformer bays. Specification: Class 0.2S, ABT meter, DLMS Compliant (Category B), equipped with optical RS 232 port for CMI Download, RS 485 port equipped with open protocol (MODBUS) and DLMS protocol with protocol user selectable among DLMS and Open protocol (MODBUS). The energy meter real time data should integrated with the SAS. This paragraph shall be read in conjunction with clause No. 3 given in Section-2 of the specification for Energy Meters

1.3 BILL OF QUANTITIES

S. No.	Description	Unit	Quantity
1	400 KV feeder relay panel	No	2
2	400/110 KV Auto transformer relay panel	No	4
3	400 KV Bus Reactor relay panel	No	1
4	400 KV Tie breaker panel for lines	No	1
5	400 KV Tie breaker panel for Transformer / Reactor	No	3
6	400 KV Bus bar protection relay panel	No	1
7	110 KV Bus bar protection relay panel	No	1
8	110 KV Feeder relay panel with Under- frequency Relay	No	1

9	110 KV Feeder relay panel without Under- frequency Relay	No.	7
10	110 KV Bus coupler breaker relay panel	No	1
11	Synchronizing panel	No	2
12	Substation Automation System (SAS)comprising of following	Lot	1
12.1	Bay Control Unit for Substation Auxiliary system (with 64 Digital Inputs, 24 Digital outputs and 16 Analog Inputs (110V/1A/ 4-20 mA)	Lot	1
12.2	Industrial grade computer for station HMI (Complete with computer,KB,Mouse,500GB HDD, 29" TFT Monitor, All relevant software for applications, operating system)	Nos	2
12.3	Engineering work station (Complete with Industrial grade computer, KB Mouse, 500GB HDD,29" TFT Monitor, All relevant Software, operating system)	No.	1
12.4	Metering PC (Complete with Industrial grade computer,KB,Mouse,500GB HDD, 29" TFT Monitor, All relevant software for applications, operating system)	No.	1
12.5	Gateway Panel (Complete with panel, gateway device, Hooter-2nos for substation urgent & non-urgent alarms)	No.	1
12.6	Communication equipment (Complete with MODEMs, Lightning arrestor for MODEM, media interface device etc for gateway redundant interface to LDC)	sets	2
12.7	Ethernet Switch (20% spare ports in each switch)	Lot	1
12.8	General printer (A3 Color LASER Jet Printer)	No.	1
12.9	Report printer (A4 Color LASER Jet Printer)	No.	1
12.10	LAN accessories (Includes all cables and associated cable ducts, media converters etc for LAN)	Lot	1
12.11	Time synchronization system (GPS with all accessories, Antenna, cables, software etc)	Set	1
12.12	Configuration tools for SAS equipments (Includes Laptop computer, relevant software tools, accessories for configuration of SAS devices, protection panel devices.)	Set	1
12.13	Numeric relay testing kit with all associated software (suitable for testing of numeric relays) of reputed make with IEC61850 software for GOOSE	Set	1

	subscription & publishing, rugged carry case and necessary accessories. (OMICRON CMC356 /MEGGAR MPRTS 3P 8430 / PONOVO PW636i / Equivalent or better). Includes laptop computer dedicated for testing kit.				
12.14	Relevant manuals as per SA (Substation Automation) specification.	Lot	1		
12.15	Furniture: Chair suitable for operator-revolving type	Nos	3		
12.16	Furniture: Tables for SAS operator – 2Nos; Table for Engg. WS & Metering PC : 2nos.	Lot	1		
12.17	Furniture: Tables with drawers suitable for housing all the drawings & manuals of the SAS and protection system.	Lot	1		
12.18	UPS (VA rating should be 150% of load to supply for 2 Hours. Load includes SAS servers, SAS LAN devices, Engineering work station.)	No.	1		
12.19	Armoured Fiber Optic Cable for integration of SAS and Bus bar protection system.	m	1000		
13	<p>Installation, Testing & commissioning of complete SAS for 400KV/110KV SS (Comprising 24 Electrical bays)</p> <p>Services include the following:</p> <p>a) Testing & commissioning of main protection relays including configuration and protection relay setting calculations.- (Refer note-3)</p> <p>b) Testing, commissioning & relay setting of bus-bar protection & SAS including termination of network / optical cables (complete with supply of end connectors, tees etc. as required). (Refer note 3)</p> <p>c) Testing, commissioning & parameter setting of ABT Metering System and integration with SAS including termination of network / optical cables (complete with supply of end connectors, tees etc. as required). (Refer note 8)</p> <p>d) Arranging all necessary tools & tackles including 3-phase automatic relay test kit and equipment for testing of BCU, Protection relays, communication infrastructure shall be bidder's responsibility.</p> <p>e) Splicing & termination of FO cables (armoured & patch-cord)</p>			Bays	24
14	Training for SAS as per Clause XIII of section-2 of Technical specification document			Lot	1

Note:

1. If any additional item as per the specification for Substation Automation System is required to be supplied for completion of the system over and above the items indicated

above, the same shall be indicated clearly in the offer. Otherwise, the same shall be deemed to be included in the offer.

2. Unit rates of items from S. No. 12.1 to 12.19 to be indicated in the price bid.
3. Relay setting to be furnished in OEM's format.
4. 24 Electrical bays comprises: 2 x 400kV Feeders, 4 x 400KV Tie breakers, 4x 400KV HV, 1 x 400KV Bus reactor, 4X 110KV LV, 8x 110kV Feeders, 1x 110kv Tie breaker.
5. All relay panels shall have BCU mounted on it. Prices of BCU to be considered in the main Relay panel supply.
6. Standard Relay Panel Accessories to be supplied with each Control and Relay Panel as per Clause XI of Section -2 of Technical specification document. Prices to be included in the main supply of panels
7. Bidder to estimate the actual lengths of the Fiber optic cable. Payment for Fiber optic cable shall be made on pro-rata basis.
8. ABT meters shall be mounted in the respective relay panels as per BOQ given in Section-2 of the specification. All ABT meters shall be integrated with the Metering PC as well as SAS as per specification.
9. The commissioning of Switchyard shall be in stages. Bidder to quote accordingly. Total value of item S. No. 13 shall be minimum 5% of the sum total of the value of items from S. No. 1 to 12 together.

1.4 TYPE TESTS

All the tests as per relevant IS/IEC shall be carried out and reports shall be submitted. The Type Test for offered equipments/materials used for this project should have been conducted in any approved Government/Govt. recognized laboratories conforming to latest IS/IEC. The above type test certificates should accompany the drawings of the materials equipments, duly signed under seal by the Institution, who have issued the type test certificate.

The above type test should have been conducted not earlier than five (5) years as on the date of technical bid opening, which is 05/4/2013 for Anikadavu & 10/4/2013 for Thappagundu substations.

The original type test certificates shall be furnished for verification.

Non furnishing of type test certificates by the tenderers, will be liable for rejection.

1.5 DRAWINGS and SCHEME

- a. The documentation requirements detailed under Section-2 & 3 shall be submitted to BHEL at various stages of contract. Softcopy of the drawings and schemes are to be submitted at contract stage.
- b. Protection Key and Metering SLD shall be the first document for submission.
- c. Preparation of AS- BUILT drawings is also in the scope of the bidder.

1.6 DOCUMENTS REQUIRED WITH OFFER

- a) Clause wise confirmation/ comments.
- b) Bill of Material.
- c) Un priced schedule of Unit Prices
- d) Filled up Guaranteed Technical Particulars
- e) Catalogue and Technical Leaflets for the offered Equipments

1.7 INSPECTION AND TESTING

Factory acceptance tests (FAT), Inspection, routine tests & Quality assurance shall be as per approved Quality Plan by TANTRANSCO.

1.8 QUALITY PLAN

Bidder to follow valid TANTRANSCO approved Quality Plan as per TANTRANSCO procedure. In case the bidder doesn't have approved QP, it will be the bidder's responsibility to get its QP approved directly from the ultimate customer.

1.9 TECHNICAL QUALIFYING REQUIREMENT

The qualified manufacturer should have manufactured, Type tested and supplied at least 50% of the required quantity of the Control and Relay Panels including SAS based on IEC 61850 standard for 420KV, 245kV & 132 kV switchyards of Electricity Boards/Power Utilities in India in any one year during the last five years. The same should have been in satisfactory operation for a minimum period of two years as on date of technical bid opening, which is 05/4/13 for Anikadavu & 10/4/13 for Thappagundu substations.

Further the qualified manufacturer should also have type tested the Control and Relays panels including Relays and SAS equipments in a period of not less than 5 years as on date of technical bid opening, **which is** 05/4/13 for Anikadavu & 10/4/13 for Thappagundu substations, from Government / Government recognized laboratories confirming to latest IS/IEC only.

SECTION 2

EQUIPMENT SPECIFICATION

As per TAN TRANSCO SPECIFICATION ENCLOSED HERE IN

SECTION – 22
SAS, CONTROL AND RELAY PANELS

SECTION-I
TECHNICAL SPECIFICATION FOR PROTECTON RELAY PANELS

1. General

This specification requires the design, manufacture, supply, installation, testing and commissioning of SAS, 400KV & 110KV relay panels and other associated equipments. All material and works towards field interface of relay panels to the switchgears, CT's, PT's, power supply equipment, communication equipment etc are in the scope of the bidder. The equipments shall be capable of working satisfactorily in the intended environmental conditions.

The manufacturer of relay panels and SAS equipments offered by the bidder is subject to approval of TANTRASNCO.

2. Cabinet for Relay Panel:

a) Construction:

Free standing simplex type, Metal enclosed with swing frame to house the devices and an outer glass door. The gland and plate assembly shall be vermin proof. The panel shall be designed for wiring access from front of the relay panel Cable entries to the panel shall be from the bottom. The design of the interior of the panel shall allow sufficient access to the terminals of all devices for removal and repair. The design shall ensure that the heat generated by various apparatus mounted in the panel shall not affect the performance of any of the devices.

Dimension	: Depth x width x height : 800 x 800 x 2312 (or more including base frame) in mm
Degree of protection	: IP-31 as per IEC 60529 / IS 12063
Tests	: All type tests and routine tests prescribed in IS/IEC 60947 Low-voltage Switchgear and Control gear standards shall be performed on the complete panel assembly.

Thickness of metal : 3mm for planes housing the devices and for bottom plates.
2mm for all other sides.

Swing frame :

Play of Swing frame : 120 degree or above capable of opening in the opposite direction to glass door.

No of hinges : 3nos (minimum)

Door stopper : 1 No.

Protective Glass door : Splinter proof and transparent tempered glass of minimum thickness 3mm.

Bottom plates : Knock slots shall be provided in the bottom plates for facilitating cable entry at site.

b) Painting :

- i) All sheet steel work shall be phosphated in accordance with IS-6005
- ii) Oil, grease, dirt, swart, rust and scale shall be removed by adopting proper cleansing procedure.
- iii) After phosphating and thorough rinsing, the phosphate coating shall be sealed with application of two coats of ready mixed stoved type zinc chromate primer. The first coat shall be flash dried while the second coat shall be stoved.
- iv) After application of primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving
- v) The colour of the panel shall match with the existing panel colour of subject station and normally of following choice for new station.
Exterior - stoved enamel grey
Interior - stoved enamel white
Bus frame - stoved enamel black
Finish - glossy surface treatment shall be done as per BIS.

c) Accessories :

- A Door Stopper shall be provided with each door to hold it in the open position at an angle/angles as specified for each type of panel.
- Door handle shall be provided with padlocking facility.
- Each cabinet is to be provided with removable type lifting eyes or lifting beams installed on the top.
- Adequate ventilation openings in the form of louvers shall be provided. The ventilation louvers shall be vermin proof and shall be provided with removable filters or removable wire mesh to minimize ingress of dust.
- Labels to be provided at front and rear of the panel for each device.
Name plate to be provided on the top of each panel on front ,large and bold name plates shall be provided for circuit/ feeder designation
- Name plate and labels shall be made of non rusting metal or 3 ply lamincoid.
Name plate shall be black with white engraving lettering.
Typical label size : Width: 1.5cm; length : as per the length of the inscription;
the letter size : 0.75cm.
- Panels shall have base frame with smooth bearing surface, anti vibration strips/ pad made of shock absorbing materials shall be placed between panels and base frame.
- All doors, removable covers shall be gasketed all around with neoprene gaskets.
- Necessary cable gland should be fitted. Cable gland plates fitted on the bottom shall be connected to the earthing of panel/station through a flexible braided copper conductor rigidly.
- Each panel shall be provided with space heater rated for 230V single phase A.C. supply with controlling thermostat.
- All equipments in the panel shall be mounted and completely wired to the terminal blocks ready for external connection. The spare contacts shall also be

wired upto the terminal block.

- Each panel shall be provided with the interior fluorescent lights of sufficient illumination capacity controlled by door limit switch.
- A 240V single phase, 3 pin A.C. socket 15/5A with switch – 1 No.
- Accessories required for fixing the panel such as foundation bolts and nuts shall be provided along with a panel.
- DC voltage of the panels:- As per station DC supply voltage.

d) Circuit distribution and isolation :

- i) Each relay panel shall be provided with necessary arrangements for receiving, isolating and fusing of AC and DC supplies for various control of signaling, lighting and space heaters.
- ii) The incoming and sub circuit shall be separately provided with switch fuse units, selection main and sub circuit fuse rating shall be such as to ensure selective clearance of sub circuit faults.
- iii) Potential circuit for metering and relaying shall be protected by fuses.
- iv) All fuses shall be of HRC cartridge type conforming to IS 13703 mounted on plug in type fuse bases. All accessible live connection of fuse base shall be adequately shrouded.
- v) Fuse shall have operation indications for indicating blown fuse condition.
- vi) Fuse carrier shall have imprints of fuse rating and voltage.
- vii) Removable links should be provided at the output of each relay for trip output and reclose output. Adequate space shall be left between fuse units when arranged adjacently.

e. Panel wiring:

- i) Wire type :

- Single core multi strand copper conductor wires with PVC insulation of **FRLS** and shall be flexible and flame, vermin, & rodent proof. 1100V grade for CT,PT circuits. 600V/1100V Grade for other circuits.
- i) Flexible wires shall be used for wiring of devices on moving parts such as swinging panels or panel door.
 - ii) Wire size :
 - 4 Sq.mm for Auxiliary AC supply circuits.
 - 2.5 Sq.mm for CT circuits and earthing circuits.
 - 1.5 sq.mm for all other circuits.
 - iii) Panel wiring shall be securely supported, neatly arranged, readily accessible and connected to equipment terminals and terminal blocks. Wiring gutters and troughs shall be used for this purpose. All wiring shall be made without splices
 - iv) Cables/wires shall be uniformly bunched and tied by means of PVC belts and carried in PVC carrying troughs. The position of the PVC carrying troughs and having bunch of wires shall not give any hindrance for fixing or removing relay casing, switches etc.
 - v) Wire termination shall be made with solder less crimping type and tinned copper lugs, which firmly grip the conductor. Insulated sleeves shall be provided at the wire terminations.
 - vi) Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire.
 - vii) The wire number shown on the wiring shall be in accordance with IS 5578.
 - viii) All wires directly connected to trip circuit breaker or device shall be distinguished by addition of red colour unlettered ferrule.
 - ix) Interconnection to adjacent panels shall be brought to a separate set of terminal blocks located near to the slots or holes to be provided at the top of the panel. Arrangements shall be made for easy connections to adja-

cent panels at site and wires for this purpose shall be provided and bunched inside the panel.

- x) Bus wires shall run at the top the panels. The terminal blocks for the wires shall be with isolating links.
- xi) The terminal blocks used shall be minimum 600V (For other circuits) / 1000V (for CT & PT circuits) grade and have 10A continuous rating, moulded piece, complete with insulated barriers, stud type terminals washers nuts and lock nuts suitable for operation with a tubular box spanner or screw driver.
- xii) Terminal blocks shall be arranged in vertical formation at an inclined angle with sufficient space between terminal blocks with minimum of 150mm for easy wiring.
- xiii) Terminal blocks shall include a white fibre marking stripe with clear plastic, slip on/clip on terminal covers. Marking on terminal strips shall correspond to wire number and terminal number on the wiring diagrams.
- xiv) There shall be minimum clearance of 250mm between the first row of terminal blocks and the associated cable and plate or panel side wall.
- xv) At least 20% of total terminal shall be provided as spare for further connections and these spare terminals shall be uniformly distributed on all terminal blocks.
- xvi) Wiring is preferable with the following colour code.
 - PT supply : Red, yellow, blue for phase and black for neutral.
 - CT circuits : Red, yellow, blue for phase and black for neutral.
 - DC circuit : Grey for both positive and negative.
 - 230V AC circuits : Black for both phase and neutral.
 - Earthing : Green.
- xvii) Lugs : Solder less crimping type, Tinned copper lug. Ring type (Generally for termination on devices).

f. Earthing

- i) All panels shall be equipped with bus securely fixed along the inside base of the panels. When several panels are mounted adjoining to each other, the earth bus shall be made continuous and necessary connectors and clamps for this purpose shall be included in the scope of supply.
- ii) The size of the earth bus shall be made of 25mmx6mm tinned copper flat.
- iii) The earth of the substation will be 40mm diameter MS rods, provision shall be made on the earth bus bars of the end panels for connecting to the earth grid. Necessary terminal clamps and connectors shall be included in the scope of supply.
- iv) All metal case of the relays, instruments and other panel mounted devices shall be connected to the earth bus by independent copper wires of size not less than 2.5 sq.mm. The colour code of the earthing wire shall be green. Earthing wire shall be connected on the terminals with suitable clamp connectors and soldering shall not be permitted.

3. Energy meters :

The energy meter shall comply with IEC 60687 / IS 14697 standard. Electronic tri-vector meters shall be with facility for separate registering of KWH, KVAH and KVARH consumption and also to record export/import and demands and their input quantities. The accuracy of the meter shall be 0.2 class (Revenue certifiable metering) and metering function should be based on true rms. The meter should be equipped with Flash/NVRAM for storing the meter parameters and measurements. The meter shall have communication facility with open protocol. It shall record and indicate the measured parameters for a frequency variation of +/- 5 % and for A.C auxiliary supply variation from -40% to +10% and shall have facility to communicate online parameters as well as download stored data. The meters are to be integrated with the SAS for real time data access and with remote configuration facility.

4. ANNUNCIATORS:

- i) The annunciations fascia shall be provided with flasher, hooters and bell for separate indication of tripping alarm/non-tripping alarms. All the panels shall have the inter connection for accepting the alarm but the reset shall be from the individual panel.

- ii)** Each annunciations fascia/window shall be provided with LED.
- iii)** Trip and non-trip discrimination shall be made in the fascia. For example all trip fascia shall have red colour and non trip fascia white colour.

5. General requirements for Numeric type protection relays

- 1) Technology shall be based on numeric type.
- 2) Equipped with Event recorder. Events storage shall be sufficient for the application and with a time stamp resolution of 1ms.
- 3) Equipped with disturbance recorder. Trigger criteria and record length for disturbance recording should be user configurable. Disturbance record storage shall be sufficient for the application.
- 4) Equipped with fault recorder. Trigger criteria and record length for fault recording should be user configurable. Fault record storage shall be sufficient for the application. The sampling rate of fault records shall be 64 samples/cycle.
- 5) Equipped with Ethernet ports for Bay level LAN interface.
- 6) Support SNTP for time synchronization. Time stamping of events shall be of resolution of 1ms.
- 7) Support IEC 61850 protocol with type test certification/report for compliance with relevant parts of IEC 61850. The compliance shall include :
 - dii) Model implementation conformance statement (MICS)
 - diii) Protocol implementation conformance statement (PICS)
- 8) Equipped with communication port (USB or RS232 or 10Base-T Ethernet port) for relay configuration, Data and records retrieval. It shall be possible to carry out firmware updates of the numeric relay through internet connectivity free of cost.
- 9) Equipped with self monitoring feature during start up and always while in service. A relay fail alarm should be available in dry contact type alarm output. A relay healthy indication shall be provided. The numeric relay shall be provided with diagnostic tools with which it shall be possible to identify and display all the defective modules of the relay.
- 10) Provided with the necessary software tools for complete configuration of the protection relay, record retrieval, data retrieval. All firmware updates to the numeric relays shall be feasible to be effected with download of files from the manufacturer's website free of cost.
- 11) Suitable to operate with the auxiliary DC supply voltage available in the sub-Station (Nominal aux supply Voltage is 110V DC or 220V DC as per station DC supply voltage.)
- 12) Provision for display of alarms with LED/ LCD/Graphic display. The LEDs shall be programmable to any of the alarms and inputs.
- 13) Support multiple relay settings for protection. The numeric relay should be provided with a facility for settings file comparison. Facility should be provided to view the abstract of adopted settings features of the relay.
- 14) All configuration files of the protection relay shall be stored in a non-volatile

memory and shall not be lost on absence of dc supply.

15) The relays should be suitable for testing with universally acceptable testing kit.

16) The relay should be equipped with field configurable opto isolated Digital inputs and potential free digital outputs as required for the specific application. **Numeric relays with non-programmable Inputs and non-programmable outputs are not acceptable.**

17) All relays shall have screw type terminations for wiring terminations, if any other type of termination is offered necessary crimping tools – 1set should be supplied free of cost with each panel housing special type of termination lugs.

18) Relay casings shall have a degree of protection of IP 50 for relay enclosure, IP54 for relay facia as per IEC 60529 or equivalent.

19) Thermal with stand capabilities:

3x In - Continuously

100x In - 1 Second

40x In for 3 second

20) - For trip rated contacts :

Make and carry continuously : 6 A , 300V.

Make and carry for 0.2 secs : 30A.

Breaking capacity for DC : 75W.

Breaking capacity for DC (when L/R is within 40 m sec) : 30 W.

- For alarm contacts:

Make and carry continuously : 4A DC/AC

Make and carry for 0.2 secs : 30A DC , 300V.

Operating time shall be less than 10ms for output contacts.

21) The numerical relay shall conform to the of the following standards with latest amendments:

- IS 8686 in general with impulse Impulse Voltage Withstand Test and High Frequency Disturbance Test as per Class III of this standard.
- IS 3231 (Relevant parts) / IEC 60255
- IEC 60255-22-2 : ESD
- IEC 60255-22-3 : Radiation susceptibility test
- IEC 60255-22-4 : Fast transient interference
- IEC 60255-21-2 : Shock test
- IEC 60255-21-1 : Vibration test
- IEC 60255- 11 : Alternating component (Ripple) in DC auxiliary energizing quantity.

- Environmental performance requirements :
IEC 60255-1 : Operating temperature range
IEC 60255-1 : Storage temperature range
IEC 60068-2-30 : Humidity

6. Electro-mechanical Relays:

- i) All relays shall conform to IS: 3231
- ii) Unless otherwise specified all auxiliary relays and timers shall be supplied in non-drawout cases / plug in type modular cases.

7. RELEVANT REFERENCE STANDARDS:

IS/IEC 60947 Low-voltage Switchgear and Control gear

IS – 3231 electrical relays for power system protection

IS – 8686 static protective relays

IEC 60529 Degrees of protection procured by enclosures (IP code 31).

IS – 1248 & IS – 2419 indicating instruments

IS – 0722 energy meters, control switches (LV switching devices for control and auxiliary circuits)

IEC 60687 /IS 14697 AC static transformer operated watt-hour and Var-hour meters.

IS – 0337,0337-1 -do-

IS – 0297(part 1-3) Dimensions for the mechanical structures of the 482.6mm (19”)series

IS – 6875 control switches (LV switching devices for control and aux.circuits)

IS – 0005 Colour for ready mix paints

IS – 1554(part –I) PVC insulated cables upto and including 1000 volts

IS –3842(part I-VII) application guide for protection

IS –6005 code of practice for phosphating iron and steel

IES –602555-1-0 electrical relays –all-or-nothing elec. relays.

IEC – 60255-3,5,6,7,8,10,11,12,13,16 electrical relays for various specifications

IEC – 60255-21-2,3

IEC – 60255-22-1,2,3,4 electrical relays – vibration and disturbance etc.

IEC – 60255-23 electrical relays – contact performance

IEC 61850-3 EMI Immunity and environmental compliance(Electrical utility substations)

IEC 61850 All applicable parts of this standard certified by KEMA/ reputed laboratory. Including type test certification/report for :

div) Model implementation conformance statement (MICS)

dv)Protocol implementation conformance statement (PICS)

Note : For standards other than IS mentioned above, the equivalent or better IS standards may be complied.

8. 400 KV LINE PROTECTION:

MAIN-I & MAIN –II DISTANCE PROTECTION:

The numeric distance protection relays shall be comply with the following requirements.

1. The numerical distance protection relays shall comply with the specification for general requirements for numerical protection relay as furnished in this document.
2. The numeric relays shall be equipped with sufficient digital output contacts for trip outputs, alarms, spare and for the protection scheme implementation.
3. The numeric relay shall be suitable for operating with Nominal PT input of 110V~ phase to phase, 63.5V ~ phase to ground, CT input of 1A and 5A (user selectable).
4. Fault sensing algorithm of Main-1 and Main-2 should be different. How it differs shall be explained.
5. Equipped with the following built in protection functions:
 - √ 21 : Distance protection
 - a. The distance protection relay shall perform for sub-cycle distance protection.
 - b. There shall be a minimum of 3 forward and 1 reverse selectable distance protection zones.
 - c. Have six independent loop measurements system to cater phase to phase and phase to ground faults
 - d. Polygonal characteristics for phase to phase fault and polygonal characteristics for phase to earth fault. In case of polygonal characteristics X and R or Z and R should be independently settable.
 - e. have an impedance setting range of 0.01 – 120 ohm

- f. have a requisite independent continuously variable time setting with range 0-3 sec
- g. Have a resetting time of less than 40 millisecc.
- h. have facility for zero-sequence compensation for earth fault on all zones of measuring element
- i. suitable for single and three phase tripping
- j. Have cross polarization, assure 100% directional sensitivity for unbalance fault and memory for balanced faults.
- k. Have built in fault locator with following features.
 - a) Shall display the fault location either in percentage of line length or in actual distance in kilometer based on reactance setting.
 - b) Shall have an accuracy of +/-3% or better and watch dog output.

√ 98 : Fuse failure detection for single,two and three phases

The scheme shall incorporate necessary precaution in measurement to block the distance protection. However, during blocking period the relay shall have over current protection facility for fault detection.

√ 50/27 : SOTF

√ 25 : synchro check function

√ 50BF : LBB Function

√ 79: Built in auto reclose function with single shot, single phase reclose with adjustable dead time setting of 0.1sec to 1sec, and with adjustable reclaim time of 1 to 250sec.

√ 27/59 : Under voltage/ over voltage protection element with rate of change of voltage protection element. This protection element should have two independent stages.

√ 50N/51N IDMT directional earth fault relay with adjustable setting range of 10 to 80% with characteristic curve for normal inverse, very inverse and extremely inverse of both IEC and IEEE curves.

√ DR : Disturbance recorder with minimum 8 analog and 12 digital inputs and with minimum memory capacity to store at least 8 disturbance records with

each record of minimum 10 cycles. The sampling of analog inputs shall be at least 16 per cycle. Shall have features to adjust pre fault and post fault time.

√ Event recorder shall be able to store at least 1000 time tagged events. The resolution of event recorder shall be at least 1 millisecond.

√ Load encroachment discrimination facility to prevent false tripping due to encroachment of heavy loads.

6. The distance protection function shall be provided with the following functionalities,

features:

√ 68 : power swing blocking protection

The power swing shall be detected by rate of change of impedance with suitable characteristics. The blocking shall have continuously adjustable time delay with setting range of not less than 2sec or shall have feature to block the tripping as long as it exists. The relay shall have feature to unblock during fault. It shall be explained how blocking is effected during power swing for phase to earth fault, phase to phase faults and three phase faults. In each case the relay shall have feature to unblock during fault and with facility to block each distance zone independently.

√ 85 : Communication aided schemes PUTT, POTT, Blocking, weak infeed and current reversal logic.

√ 46BC : Broken conductor detection

7. Provided with metering function of class 1.0 accuracy or better and user programmable display.

8. Equipped with sufficient numbers (minimum is 16 nos) of programmable of opto isolated input and sufficient numbers (minimum is 36 nos) of programmable potential free outputs with wetting voltage for digital inputs to be field programmable to 48V / 110V / 220V DC.

9. 110KV LINE PROTECTION:

A. MAIN DISTANCE PROTECTION:

The numeric distance protection relays shall be comply with the following requirements.

1. The numerical distance protection relays shall comply with the specification for

general requirements for numerical protection relay as furnished in this document.

2. The numeric relays shall be equipped with sufficient digital output contacts for trip outputs, alarms, spare and for the protection scheme implementation.

3. The numeric relay shall be suitable for operating with Nominal PT input of 110V \sim phase to phase, 63.5V \sim phase to ground, CT input of 1A and 5A (user selectable).

4. Equipped with the following built in protection functions:

√ 21 : Distance protection

- a. The distance protection relay shall perform for sub-cycle distance protection.
- b. There shall be a minimum of 3 forward and 1 reverse selectable distance protection zones.
- c. Have six independent loop measurements system to cater phase to phase and phase to ground faults
- d. Polygonal characteristics for phase to phase fault and polygonal characteristics for phase to earth fault. In case of polygonal characteristics X and R or Z and R should be independently settable.
- e. have an impedance setting range of 0.01 – 120 ohm
- f. have a requisite independent continuously variable time setting with range 0-3 sec
- g. Have a resetting time of less than 40 millisec.
- h. have facility for zero-sequence compensation for earth fault on all zones of measuring element
- i. suitable for three phase tripping
- j. Have cross polarization, assure 100% directional sensitivity for unbalance fault and memory for balanced faults.
- k. Have built in fault locator with following features.
 - a) Shall display the fault location either in percentage of line length

or in actual distance in kilometer based on reactance setting.

b) Shall have an accuracy of +/-3% or better and watch dog output.

√ 98 : Fuse failure detection for single,two and three phases

The scheme shall incorporate necessary precaution in measurement to block the distance protection. However, during blocking period the relay shall have over current protection facility for fault detection.

√ 50/27 : SOTF

√ 25 : synchro check function

√ 50BF : LBB Function

√ 79: Built in auto reclose function with single shot, single phase reclose with adjustable dead time setting of 0.1sec to 1sec, and with adjustable reclaim time of 1 to 250sec.

√ 27/59 : Under voltage/ over voltage protection element with rate of change of voltage protection element. This protection element should have two independent stages.

√ 50N/51N IDMT directional earth fault relay with adjustable setting range of 10 to 80% with characteristic curve for normal inverse, very inverse and extremely inverse of both IEC and IEEE curves.

√ DR : Disturbance recorder with minimum 8 analog and 12 digital inputs and with minimum memory capacity to store at least 8 disturbance records with each record of minimum 10 cycles. The sampling of analog inputs shall be at least 16 per cycle. Shall have features to adjust pre fault and post fault time.

√ Event recorder shall be able to store at least 1000 time tagged events. The resolution of event recorder shall be at least 1 millisecond.

√ Load encroachment discrimination facility to prevent false tripping due to encroachment of heavy loads.

5. The distance protection function shall be provided with the following functionalities,

features:

√ 68 : power swing blocking protection

The power swing shall be detected by rate of change of impedance with suitable characteristics. The blocking shall have continuously adjustable time delay with setting range of not less than 2sec or shall have feature to block the tripping as long as it exists. The relay shall have feature to

unblock during fault. It shall be explained how blocking is effected during power swing for phase to earth fault, phase to phase faults and three phase faults. In each case the relay shall have feature to unblock during fault and with facility to block each distance zone independently.

√ 85 : Communication aided schemes PUTT, POTT, Blocking, weak infeed and current reversal logic.

√ 46BC : Broken conductor detection

6. Provided with metering function of class 1.0 accuracy or better and user programmable display.
7. Equipped with sufficient numbers (minimum is 14 nos) of programmable of opto isolated input and sufficient numbers (minimum is 24 nos) of programmable potential free outputs with wetting voltage for digital inputs to be field programmable to 48V / 110V / 220V DC.

B. BACK-UP PROTECTION FOR 110KV FEEDERS

: DIRECTIONAL O/C & E/F RELAY:

The relays shall be of numerical type

1. The numerical distance protection relays shall comply with the specification for general requirements for numerical protection relay as furnished in this document.
2. The numeric relays shall be equipped with sufficient digital output potential free contacts for trip outputs, alarms and for the protection scheme implementation.
3. The numeric relay shall be suitable for operating with Nominal PT input of 110V~ phase to phase, 63.5V ~ phase to ground, CT input of 1A and 5A (user selectable).
4. Features and characteristics.

Current settings :

O/C Phase fault setting : 20 to 200 % of rated current in at least 1% steps

E/F setting : 20% to 80 % of rated current in at least 1% steps.

Time multiplier : 0.05 to 1.0 in steps of 0.01 for phase fault and earth fault settings.

Definite Time Delay : 0.05 to 20 Sec. in steps of 0.01 sec.

Drop out to pick up ratio : > 95%.

Inverse Characteristic : Normal Inverse (3 Sec, 1.3 Sec), Very Inverse & Extremely Inverse of IEC curves. (Curves should be Selectable at site)

Characteristic curves and settings shall be separately selectable for phase fault and earth fault.

High set Instantaneous Unit :

O/C : 50 % to 2500 % of rated current in steps of 50% or lesser step size.

E/F : 50 % to 500 % of rated current in steps of 50% or lesser step size.

Current settings o/c – 50 to 200% & E/F – 10 to 80% in convenient steps

Time multiplier settings 0 to 1 with a resolution of 0.01sec.

Have built in IDMT directional O/C and E/F relay with characteristic curve for normal inverse, very inverse, extremely inverse of both IEC and IEEE curves

Directional element

P.T voltage – 110 V A.C

Phase fault : 0-35deg

E/F fault : – 90 deg to 90 deg. Current lagging

The relay shall be equipped with in built 50LBB function.

5. Relay shall be provided with Event record & Fault record as stated below:

Storage and display of at least 100 event records with date and time stamp.

Storage and display of at least 16 fault records comprising information of Fault element (R/Y/B/Earth) , Type of fault, Value of fault in true rms Amps.

6. Relay shall be provided with LED Indications for :

i) Protection healthy or In service

ii) Pickup

iii) Trip operated

iv) High set operated

v) Phase O/C operated

vi) Earth O/C operated

Note : Individual indication of hand reset type shall be provided for each O/C, Earth fault element & each high set element.

10. BUS-BAR PROTECTION for 400 KV / 110KV BUS:

Bus-Bar protection scheme shall

1. The numerical busbar protection relays shall comply with the specification for general requirements for numerical protection relay as furnished in this document.
2. Bus bar protection relay shall be of low impedance numerical type.
3. have operating time of 15millisec at 5times setting value for all type of fault.
4. operate selectively for each busbar.
5. be stable for through fault condition upto 50KA fault level.
6. incorporate check zone feature for each phase and clear zone indication. The check zone shall be without any switching. Also check zone shall not over stabilize during internal fault due to unequal source & load distribution.
7. shall include one overall check zone protection in addition to single/multiple zones specified.
8. incorporate continuous supervision of CT secondaries against any possible open circuit and if it occurs, shall render the relevant zone of protection inoperative after a time delay and initiate an alarm. However facility to unblock CT supervision in case of actual fault occurring in the bus shall be provided.
9. be phase segregated type with separate relay for each phase and provide independent zone of protection. If bus section is provided, then each side of the bus section shall have separate set of bus bar protection scheme. The bus section breaker and bus coupler breakers shall be covered by overlapping bus bar protection scheme of respective buses.
10. be transient-free in operation.
11. includes continuous DC supply supervision.
12. include provision for protection IN/OUT for each zone and check zone.
13. The numeric relay shall be suitable for operating with CT inputs of 1A and 5A (user selectable).
14. the relay must have rejection and shall not operate on second and third harmonics. Second harmonic rejection ratio 2:1 minimum, third harmonic rejection ratio 40 :1 minimum.

15. the high speed tripping relays (96) for tripping each feeders on actuation of bus bar protection shall be on respective feeder relay panels and necessary provision for running the tripping bus wires to actuate these relays shall be made. The protection scheme shall be wired in such a way that both check zone and bus sectionalizing zone schemes shall operate to isolate the respective faulty bus bar for internal fault condition.
16. The relay should be equipped completely for supporting three numbers spare circuits in addition to the circuits for feeders/ bays in the single line diagram.
17. The bus bar protection relay should support various bus architectures selectable by means of the relay configuration (Single bus bar, Double bus bar, Breaker and a half bus bar, two section bus bar with a bus tie, Double bus bar with transfer bus and tie breaker) for its bus bar protection.
18. The relay shall incorporate dynamic bus replica and provide necessary end zone fault protection depending on the bus bar protection CT's location.
19. The relay shall facilitate through relay configuration tools as well as through user interface keypad/controls the following requirements:
 - Adopting multiple CT ratios of different bays
 - CT polarity selection
 - Bay IN/OUT selection
 - Bus differential enable or disable etc
 - IN/OUT selection for each zone and check zone.
20. Facility to monitor the bus differential currents and bus restraint current for each zones shall be supported in the relay display as well as through configuration tools.
21. The bus bar protection of respective bus sections shall trip respective set of bus bar lockout relays and shall initiate BF of respective CB. The bus bar protection scheme of each bus section shall be developed such that one lockout relay shall be provided with each circuit breaker.
22. The bus bar protection relay shall be provided with built in breaker fail (50BF) / LBB protection for all the connected circuits.

11. TRANSFORMER PROTECTION:

a) BIAS DIFFERENTIAL PROTECTION RELAY FOR TWO WINDING TRANSFORMER PROTECTION:

The numerical differential protection relays shall be comply with the following requirements.

1. The numerical differential protection relays shall comply with the specification for general requirements for numerical protection relay as furnished in this document.
2. The numeric relay shall be suitable for operating with CT inputs of 1A and 5A (user selectable).
4. Differential protection features and characteristics:
 - i. Based on low impedance differential principle. Three phase with faulty phase identification.
 - ii. Shall have instantaneous high set feature with facility to adjust 5 to 20 times normal current.
 - iii. Shall have second harmonic restraint feature with second harmonic content in the range of 15 to 35% .Transformer inrush restraint functionality shall be provided.Inrush and CT saturation shall not influence the differential function.
 - iv.Facility to set transformer vector group and CT ratio selection/ correction through relay configuration software tools.
 - v. Basic bias setting 20 to 40% in steps 1%.
 - vi. Operating current setting range 15 to 30%.
 - vii. have operating time not greater than 35ms at 3 times normal current.
 - viii. Maximum operating time for instantaneous operation: 25ms +/-4% of set value.
 - ix. The differential protection shall have adjustable characteristics with adaptive differential feature to maintain stability in case of through faults.
 - x. The protection relay shall be equipped with unrestrained differential protection element for fast tripping on heavy internal faults.
 - xi. Facility to view the transformer differential current and bias current directly from the Relay display as well as through configuration software.
5. Shall have inbuilt restricted earth fault protection inbuilt over fluxing protection.
6. The protection relay shall be equipped with built in Over excitation protection (ANSI 24).
7. The protection relay shall be equipped with built in thermal overload protection.
8. The disturbance recording functions should be integrated in the relay module. The disturbance recorder shall have facility to record at least 4 numbers of digital signals apart from digital signal from the relay and currents in HV&LV winding.Recording memory capacity: 5secs.

b) BACKUP NON-DIRECTIONAL OVER CURRENT PROTECTION WITH HIGH SET INSTANTANEOUS FOR HV:

Specification same as that required for numerical DIRECTIONAL O/C &E/F RELAY but without directional feature. However the phase and ground Overcurrent functions shall incorporate a harmonic restraint feature.

c) BACKUP NON-DIRECTIONAL OVER CURRENT RELAY FOR LV:

Specification same as that required for numerical DIRECTIONAL O/C &E/F RELAY but without directional feature.

12. MISCELLANEOUS PROTECTION

12.1 D.C. Supply Supervision Relay.

The relay shall monitor continuously D.C. Supply to Protection System. The de-energization of this relay will indicate the DC Supply failure. Auxiliary supply for the relay is 220V DC. The relay shall have a time delay on drop off of not less than 100 milli second. The relay shall be provided with operation indicators (Reverse flag) self reset. Sufficient number of contacts potential free may be provided. Separate relays for dual source are to be provided.

12.2 Trip Circuit Supervision Relays.

The relays shall supervise the healthiness of trip circuit continuously (Both pre-closing and post-closing conditions of the circuit breakers). The relay shall be capable of monitoring the healthiness of each phase trip coil and associated circuits of the circuit breaker during " ON and OFF " conditions. The relay shall work on 220V dc with allowable margin as the case may be. The relay shall have adequate contacts for providing connection to alarm and event logger, self reset. The relay shall have a " time delay on drop off of not less than 200 milli seconds " and provided with Operation indicators. The short circuiting of any series resistance provided in this relay or short circuiting the coil of the relay should not energize the trip coil of the breaker.

12.3 Tripping (Master) Relay :

- For tripping of feeder / transformer breakers in a station on operation of protective relays and for interlock purposes. The relay shall be voltage rated for station DC supply with allowable margin of variation, be instantaneous (Operating time not exceed 10 milli seconds).
- Reset within 20 milli seconds.
- Hand and electrical reset type

- Have adequate contacts to meet the requirement of scheme, other functions like autoreclose relay, LBB relay as well as to cater to associated equipments like SER, DR etc., to be provided with operation element/ coil.

12.4 Under Frequency Relay :

Comply with the general requirements for numeric type relay furnished in this technical specification document.

* The relay shall be equipped with separate protection elements for under frequency protection and for frequency gradient protection (f+df/dt i.e Frequency supervised df/dt protection).

* The relay shall be highly reliable and immune to transient and surges.

The relay shall have a discrete (digital) selection unit with built in timer and tripping relay to activate tripping.

* The relay shall be equipped with built in VT supervision function and under voltage blocking function.

Under frequency protection function (81U)		
1	No of Stages	4 Stages
2	Frequency range	45 Hertz to 55 Hertz
3	Frequency steps	In 0.01 HZ
4	Timers	4 Timers. i.e One for each stage independently programmable settings
5	Timer setting	Programmable between 0 to 5 sec in step of 0.01 sec
6	Operating time	Within 100ms

Frequency supervised df/dt protection (81RF)		
1	No of Stages	3 Stages (first stage is for alarm, next two stages for tripping)
2	Settings range	0.1 HZ/Sec to 1 HZ/Sec in steps of 0.1HZ/Sec
	Operational accuracy	5 milli Hz./sec
3	Measuring cycles	Programmable between 2 to 10 cycles
4	Operating time	Within 100ms

* Operating Voltage : 50 to 100% of nominal voltage with provision for selection. Nominal voltage is 110V AC.

Facility for under voltage blocking shall be provided with programmable range for voltage setting.

* It shall be possible to assign each of the trip outputs reserved for feeders to any of the three stages of under frequency protection function as well as f+df/dt protection.

* Necessary LED indications for operation, parameter selection etc., need be provided.

* The relay shall be equipped with sufficient quantity of opto-isolated digital inputs for facilitating external blocking of under frequency as well df/dt protection elements for each feeder. Necessary isolation links should be provided to facilitate manual isolation of under 81U and 81RF protection feeder wise.

* The relay shall be equipped with sufficient opto-isolated digital inputs and potential free digital outputs to accommodate feeders all the feeders plus 3 spare feeders for future use.

12.5 Check Synchronizing relay:-

Synchro check function should be part of the main relay.

The synchronism and energizing check functions shall feature:

52.1. Settable voltage, phase angle, and frequency difference.

52.2. Energizing for dead line - live bus, live line - dead bus or dead line– dead bus with no synchro-check function.

52.3. Synchronising between live line and live bus with synchro-check function.

The relays equipped with synchronism and energizing check shall comply with the requirements as mentioned above.

13. Line differential relay for 400 KV / 110KV Line protection

i. Comply with the general requirements for numeric type relay furnished in this technical specification document.

ii. Longitudinal differential protection shall be based on current. It shall be numerical phase segregated type protection scheme (summation CT type scheme is not acceptable) for application at each end of the line. The protection shall be designed to detect all kinds of poly-phase and ground faults. Its operation shall compare currents on a per phase basis.

- The protection shall be designed for fast operation and be suitable for protection of lines.

- The relays when applied at both ends of the line must operate simultaneously to clear a fault rapidly whether fault current is fed from one end or both.

- The relays should be designed to ensure time synchronization with the remote end relay when same model relay is between put in service at the remote end of the line with direct optic fibre connectivity of up to 10km distance or as required for longer line at site for implementation of line protection. The relay must be compatible to operate with the remote end relay for implementation of line protection.

- The relay shall have display for indicating/display phase, differential and bias current magnitudes.

- The maximum operating time of the relay in respect of line differential protection shall be 20ms.

- The relay shall have direct inter-trip/permissive inter-trip facilities selectable.

87L : Current differential protection

21: Distance protection

50/51 : Non-directional phase over current protection

50N/51N : Non-directional stand by earth fault protection

68 : Power swing blocking

2. The relay shall be equipped with one channel of fibre optic communication port's for relay to relay communication for implementation of line differential protection. Fiber optic patch cable of 5m or sufficient length -2 sets to connect the relay port to the fiber optic patch panel shall be provided for each relay. Exact length of this FO cable shall be ascertained at site, 1 set of FO patch cable is required as spare for each site.
3. The relay shall have the built in distance protection functionality as specified for distance protection relay for line protection.

SECTION-II

TECHNICAL SPECIFICATION FOR SUB-STATION AUTOMATION SYSTEM (SAS)

1. GENERAL :

This specification provides for complete Design & Engineering, Manufacture, FAT (Factory acceptance test), packing, shipment, insurance, transport and delivery to site, installation, testing and commissioning with SAT (Site acceptance test) of the substation automation system completely as described in the following sections to control and monitor the 400 KV and 110 KV bays and the auto transformer equipments at the Thappagundu 400KV/110KV substation. All material and works towards field interface of SAS to the switchgears, CT's, PT's, power supply equipment, communication equipment etc are in the scope of the bidder. The details of equipments to be controlled are given in the single line diagram.

The substation automation system shall be installed to control and monitor all the substation equipments from Local Control room as well as from the remote load dispatch centre/ Master.

The SAS shall be based on a decentralized architecture and on a concept of bay-oriented, distributed intelligence. Functions shall be decentralised, 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. station and bay level. The database sizing shall be sufficient to accommodate for current Single line diagram and future expansions.

At bay level, the IEDs shall provide all bay level functions regarding control, monitoring and protection, inputs for status indication and outputs for commands. The IEDs should be directly connected to the switchgear without any need for additional interposition of transducers.

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

3.3. All the numerical IEDs must be fully IEC 61850 compliant and must have the following features.

3.4. Peer-to-peer communication using GOOSE messages (IEC 61850) for interlocking.

- 3.5. Interoperability with third party IEC 61850 compliant devices
- 3.6. Generate XML file for integration/engineering with vendor independent SCADA systems.
- 3.7. Should be directly connected to the inter bay bus on IEC 61850 without the use of any gateways. Connections of bay protection IEDs to the IEC 61850 bus through the bay control units are not acceptable.

The sub-station configuration language shall be based on XML format shall be defined for system configuration and the same shall be furnished for system integration and end user.

Failure of one set of fiber shall not affect the normal operation of the SAS. However, it shall be alarmed in SAS. Each fiber optic cable shall have adequate spare fibers.

At station level, the entire station shall be controlled and supervised from the station HMI. It shall also be possible to control and monitor the bay from the bay level equipment at all times, accordingly a graphic user interface (GUI) display shall be provided in each bay control unit. The GUI display in the BCU shall display the status of the bay devices (breakers, isolators, switches etc) in real time along with the related measurands. All alarms related to the respective bay shall be displayed in the BCU through its LED's or in its GUI display as an alarm list/scroll. A TNC switch shall be provided for each breaker in the respective relay panel of the bay for facilitating manual operation for facilitating operation in emergency condition. The BCU's shall be located in the respective relay panel itself and Multiple BCU's shall not be housed in a single panel.

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. 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 realized at bay level, e.g. alarm list or event list related to the entire substation etc.

All the data cabling & other interconnections shall be through fibre optic cables wherever possible except for power supply.

Communication with the remote control centers State Sub-load Dispatch Centre through Gateway on IEC 60870 – 5 – 101/104 of SCADA/EMS system through PLCC Modem's/Fibre optic interface equipment as applicable. This interface shall support communication to the remote control centre on IEC 60870 – 5 – 101/104 through redundant communication ports. TAN TRANSCO Engineers shall be co-ordinated for integration. The data should be made available for the polling

schedule of the SCADA/EMS system at State Sub-load Dispatch control centre. Any support required for completing the task shall be in bidders scope.

2. FUNCTIONAL REQUIREMENTS :

- a) Control of all equipments mentioned in the Single Line diagram.
- b) Supervisory function (i.e.) Data Acquisition, Processing, Monitoring, Analysis and Diagnostic,
- c) Data Exchange
- d) Report Generation and Printing.
- e) The updating times on the operator station under normal and calm conditions in the substation shall be as follows:

Function	Typical values
α Exchange of display (first reaction)	< 1 s
α Presentation of a binary change in the process display	< 0.5 s
α Presentation of an analogue change in the process display	< 1 s
α From order to process output	< 0.5 s
α From order to updating the display	< 1.5 s

3) CONTROL:

Basic Functions :

- a) To execute commands from both operator work stations HMI.
- b) Select before execute commands.
- c) Operation of all 400 KV and 110 KV Circuit breakers and all the associated motorized Isolators through output contacts of corresponding BCUs.
- d) Operation of On load Tap Changer: Manual Operation from HMIs through BCU is envisaged.
- e) Provide interlocking of different switchgear/isolators for their correct and safe operation.
- f) Monitoring of Circuit breakers, Isolators and Earth Switch contacts (status)

4) OTHER FUNCTIONS:

- a) Switching sequences.
- b) Time synchronizing through GPS.
- c) Monitoring of DC system.
- d) Monitoring of fire-protection system.
- e) Monitoring of DG operation.
- f) Changing relay settings of all numerical relays from Engg./DR works station with suitable software.
- g) Storage of data.

- h) Collection of disturbance record files from various relays and analysis of the same from Engg/DR works station with suitable software.
- i) Auto re closure selection and monitoring.
- j) Bus PT change-over.
- k) Carrier IN/OUT selection.
- l) Synchro check provision.

5) INTERLOCKING:

The interlocking function provision through logic gates prevents unsafe operation of equipments such as breakers, isolators and earthing switches for all switching operation within a bay or station. An override function at Bay level shall be provided, which can be enabled to by-pass the interlocking function via a key/password, in cases of maintenance or emergency situations. This override function should be accessed with higher level password security.

6) SUPERVISORY FUNCTION: DATE ACQUISITION, PROCESSING MONITORING, ANALYSIS AND DIAGNOSTICS.

The status of each switchgear, e.g., circuit breaker, isolator, transformer tap changer etc., shall be continuously acquired through polling sequences. ie.,

- Polling on request
- Automatic Polling (Every 5sec, 10sec,....)
- Polling by exception (change of digital status)

Every detected change of position shall be immediately visible on the screen in the single-line diagram, recorded in the event list, Alarms shall be initiated in cases when spontaneous position changes have taken place.

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

7) DATA ACQUISITION, PROCESSING AND MONITORING:

Conventional interlock through hardware wiring is to be provided in addition to the software interlock. The BCU shall be located in the relay panel itself. The main and redundant station HMI should be located in the operator table. The distance between the BCU and the HMI will vary according to site conditions during execution. Bay control shall be provided to each bay and the number of bays to be provided in each substation as per SLD is furnished in the bill of materials.

The SA system shall acquire data (analog and digital inputs) from 1) Numerical relays Electronic Energy meters (to be made available in all the feeders, transformers both HV & LV sides). 2) OLTC, Battery charger etc.,. Data for the system shall be acquired as hard wired input for all station equipments stated in the single line diagram.

Automatic Disturbance File Transfer

All recorded data from the IEDs with integrated disturbance recorder systems shall be automatically uploaded to a station HMI database. A dedicated computer as relay engineer's console (EWS) shall be offered for analysis of records additionally.

DATA REQUIRED:

KW, KVA, V,I, PF, kWh, kVah and kVarh from electronic energy meters (four quadrant type) , bus voltage and frequency for the 400KV and 110KV system shall be measured and communicated on Modbus or standard IEC protocol to SAS and values shall be obtained and displayed in both HMIs.

Provision shall also be available for extracting these measurements from the relays and BCUs in addition to following protection function data (not exhaustive).

- a. For each 400KV feeders
 - main I distance relay tripping
 - main II distance relay tripping
 - LBB relay actuation
 - Dc fail for source 1 & 2
 - Fuse failure
 - Auto reclose
 - Carrier send
 - Carrier received

Fault reports including zone,phase, Fault I,V & Location in k.m

b. For each 110KV feeders

main distance relay tripping

LBB relay actuation

Dc fail for source 1 & 2

Fuse failure

Fault reports including zone,phase, Fault I,V & Location in k.m

c. For each transformer(400KV/110KV) separately

differential relay tripping

over current relay for HV tripping

over current relay for LV tripping

master relays(1 & 2 separately)

LBB relay actuation

Dc fail for source 1 & 2

Bucholz relay alarm

Bucholz relay trip indication

Oil/winding temperature alarm

PRD acted

Fault I& V

d. For each breaker

Status ON/OFF

Air/gas pressure low

Air/gas pressure lockout

Pole discrepancy actuation

TSR (common for all trip coil per circuit breaker)

e. Isolator ON/OFF

f. earth switch On/Off

g. Others

Bus bar protection actuation for 400KV and 110KV buses. CT circuit supervision for above bus bar protection(common for each voltage). In case the bus bar protection relays provided with communication port the zone operation and CT supervision function shall be acquired on the communication interface or DI.

The measured values shall be displayed locally, on the HMI, Threshold limit values shall be selectable for alarm actuation.

Basic monitoring functions are:

- 35.0.Switchgear status indication
- 36.0.Measurements (U, P, Q, F)
- 37.0.Event list
- 38.0.Alarm list
- 39.0.Status and display of DC system
- 40.0.Status of display of fire protection system
- 41.0.Acquisition of alarm and fault record from protection relays
- 42.0.Disturbance records
- 43.0.Trend curves

8) DATA EXCHANGE TO REMOTE CONTROL CENTRE

All data, records etc as available from all the SAS devices including protection relays and meters shall be exchanged with Remote control centre through the gateway equipment with out the aid of Station HMI servers. The gate way equipment shall be equipped with sufficient memory for data, records etc and shall support IEC 61850 protocol towards the SAS and IEC 60870 – 5 – 101/104 towards the remote control centre.

9) REPORT GENERATION:

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

Following shall be Automatically monitored:

- Status
- Events, alarms
- Limit values.

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

- i. Hourly voltage and frequency curves.
- ii. Trend curves for MW & MVAR.
- iii. Printouts of the maximum and minimum.
- iv. Printout on demand for MW, MVAR, Current, Voltage on each feeder and transformer tap position, status of pumps and fans for transformer.
- v. Printout on demand system frequency and average frequency.
- vi. Daily, weekly and monthly reports are required. The SA

system shall be capable of delivering the same.

10) BAY CONTROL UNIT

Communication Port : Ethernet port with support for IEC 61850 protocol, SNTP.

Inputs : Sufficient opto-isolated inputs with opto-isolation.

Outputs : Sufficient potential free outputs.

All inputs and outputs must be user programmable and BCU without this facility will not be acceptable.

The IEDs should be directly connected to the switchgear without any need for additional interposition of transducers. The bay control units shall be equipped with I/O modules inherently in the unit without external I/O modules for interfacing with the process inputs and outputs, However, all the commands extending for control of switchgear shall be routed through suitable trip/ aux Relays. The Bay control IED should be provided with sufficient number of **programmable I/O's**.

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 bay control unit shall be fed from redundant DC power supplies, this may be implemented with redundant power supply modules in the BCU or with automatic DC source selection with a suitable auxiliary relay."

Functions for BCU:

52.4. Control mode selection

52.5. Select-before-execute principle

52.6. Command supervision:

52.7. Interlocking and blocking

52.8. Double command

52.9. Synchrocheck, voltage selection

52.10. Run Time Command cancellation

52.11. Operation counters for circuit breakers and pumps

52.12. Hydraulic pump/ Air compressor runtime supervision

52.13. Operating pressure supervision through digital contacts only

52.14. Breaker position indication per phase

52.15. Alarm annunciation

52.16. Measurement and display of Vrms, Irms, HZ, W, Var for each phase and for 3phase

52.17. Local HMI (local guided, emergency mode) with Graphic display

52.18. Interface to the station HMI.

52.19. Data storage for at least 200 events

52.20. Capability to implement bay level interlocks

The update rate for measurement and display of digital inputs , analog inputs and the control command execution scheme shall be of satisfactory performance as applied for sub-station applications.

Synchronism and energizing check

The synchronism and energizing check functions shall feature:

52.21. Settable voltage, phase angle, and frequency difference.

52.22. Energizing for dead line - live bus, live line - dead bus or dead line– dead bus with no synchro-check function.

52.23. Synchronising between live line and live bus with synchro-check function.

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 bay control unit shall be fed from redundant DC power supplies which may implemented with redundant power supply modules in the BCU or with automatic DC source selection with a suitable auxiliary relay." The GUI display in the BCU shall display the status of the bay devices (breakers, isolators, switches etc) in real time along with the related measurands. All alarms related to the respective bay shall be displayed in the BCU through its LED's or in its GUI display as an alarm list/scroll.

The BCU shall conform to the specification stipulated under General requirements for Numeric type protection relays in this tender specification. The BCU should be compatible to interoperate and integrate with the IEC 61850 based SAS in TANTRASNCO sub-stations.

11) TIME SYNCHRONISATION

The Time synchronization equipment shall receive the co-ordinate Universal Time (UTC) transmitted through Geo Positioning Satellite System (GPS) and synchronize equipments to the Indian Standard Time in substation. The times synchronization of all the relevant SAS equipments shall be realized using the SNTP protocol through the SAS LAN.

Time synchronization equipment shall include antenna & its mounting facility, all special cables and processing equipment etc.

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

It shall be compatible for synchronization of all the SAS equipments through the SAS LAN Event Loggers, Disturbance recorders and SCADA at a substation through Ethernet realized through optic fiber bus.

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

Equipment shall meet the requirement of IEC 60255 for storage and operation. The system shall be able to track the satellites to ensure no interruption of synchronization signal. The output signal from each port shall be programmable at site for either one hour, half hour, minute or second pulse, as per requirement. The equipment shall have a periodic time correction facility of one-second periodicity. Equipment shall have real time digital display in hour, minute, second (24 hour mode) and have a separate time display unit (100 mm display high) at a suitable height in the control room.

12) **HMI FUNCTIONS:**

PRESENTATION AND DIALOGUES

GENERAL

The Local HMI for Operation & Engineers console 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 soft-keys through keyboard. The HMI shall provide the operator with access to alarm and events displayed on the screen. Besides these lists on the screen, there shall be a print out of hard copies of alarm or events.

Following standard display shall be available from the HMI:

- * Single line diagram showing the switchgear status and measured vales.
 - * Control dialogues.
- * Measured values
 - * Alarms list.
 - * Events list.
 - * System status.
 - * A/R selection
 - * PT selection/ CT selection (one and half breaker scheme)
 - * Carrier status
 - * Tripping selection

13) SYSTEM SUPERVISION DISPLAY:

The SA system shall be comprehensively self-monitored and faults will be immediately indicated to the operator before they develop into serious situation. Such faults are recorded as faults in a system supervision display. The display shall cover the status of the entire substation including all switchgear, Numerical relays and communication links. Dynamic colouring of single line diagram with load, power factor voltage. Bay view to zoom all the parameter.

14) EVENT LIST

The event list shall contain events with time tag (universal time synchronization with GPS) , which are important for the control and monitoring of the substation. The date and time has to be displayed for events. The events shall be registered in a chronological events list in which the type of event and its time of occurrence are indicated. It shall be possible to store all event in the HMI. The information shall be obtainable also from printed event log.

15) ALARM LIST:

Fault and error 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 table, and shall constitute an evaluation of all station alarm however alarm and visual must be provided on receiving alarm. It shall contain unacknowledged alarms and persisting faults. Date and time of occurrence shall be indicated. Historical data sizing for storing Data for 35 days shall be available in the SA system. The capacity of the server is to be designed accordingly. Also necessary hardware and software to copy and store data from server should be provided. The data collected shall not be lost due to overflow. Whenever overflow is likely to occur, the data shall be archived into storage media like CD so that there is no change of losing historical data.

16) RIGHTS:

40.local HMI: shall be able to get data from all the equipments for monitoring and control.

Engineering/DR work station: shall have the facility for relay setting and analysis of faults by acquiring disturbance recorder data from Numerical relays.

The alarm list consists of a summary display of the present alarm situation. Each alarm shall be reported on one line that contain.

5.1.0.1.1. The alarm date and time.

- 5.1.0.1.2. The name of device in alarming state.
- 5.1.0.1.3. A descriptive text.
- 5.1.0.1.4. The acknowledgement state.

The operator shall be able to acknowledge alarms, which shall be either audible or only displayed on the monitor. Acknowledged alarms shall be marked at the list. Filters for selection of a certain type or group of alarm shall be available as for events.

17) SYSTEM TESTING:

The supplier shall submit a test specification for factory acceptance test (FAT) and commissioning tests of the station automation system for approval. If the complete system consists of parts from various suppliers or some parts are already installed on the site, the FAT shall be sub-system tests. In such a case, the complete system test shall be performed on site together with the site acceptance test (SAT).

18) EXTENDABILITY IN FUTURE:

Offered substation automation system shall be suitable for extension in future for additional bays. During such requirement, all the drawings and configurations, alarm/event list etc. displayed shall be designed in the such a manner that its extension shall be easily performed by the Engineers authorized. During such event, normal operation of the existing substation shall be unaffected and system shall not require a complete shutdown.

19) RELIABILITY AND AVAILABILITY:

The bidder shall select & design & supply the SAS for the overall availability of **99.98%** with the following understanding.

The SA system shall be designed to satisfy the very high demands for reliability and availability concerning.

- 1.1.0.1.1. Solid_mechanical and electrical design
- 1.1.0.1.2. Security against electrical interference (EMI).
- 1.1.0.1.3. High quality components and TAN TRANSCOs.
- 1.1.0.1.4. Modular, well-tested hardware.
- 1.1.0.1.5. Thoroughly developed and tested modular software.
- 1.1.0.1.6. Easy-to-understand programming language for application programming.
- 1.1.0.1.7. Detailed graphical documentation and application software.

- 1.1.0.1.8. Built-in supervision and diagnostic function.
- 1.1.0.1.9. Panel design appropriate to the harsh electrical environment and ambient conditions.
- 1.1.0.1.10. Panel grounding immune against transient ground potential rise.

20) Documentation:

The following documentation to be provided for the system in the course of the project shall be consistent, CAD supported, and of similar look/feel:

- List of Drawings.
- Substation automation system architecture.
- Block Diagram.
- Guaranteed technical parameters,
- List of Signal-Analogue/Digital.
- Schematic diagrams.
- List of Apparatus.
- List of Labels.
- Logic Diagram.
- Test schedule and reports of FAT/SAT
- Product Manuals'
- Operator's Manual.
- Listing of software and loadable in CD ROM.

3 sets of CD ROM containing all the as built documents/drawing shall be provided.

Also the final documentation shall provide:

- The System specification description (SSD) file that outlines this substation automation project.
- IED capability description file (ICD) that describes the available functions logical nodes and services available from IED.
- Substation capability description file (SCD) that describes the relationship among the IEDs in the substation automation system and their information exchange structure.
- Configured IED description file (CID) that is final file to download into IED to enable its configuration.

21) HMI SERVER's:

The HMI server functionality and operator work station facilities may be integrated in the station HMI (Main) as well as in the redundant station HMI.

All Station HMI computer hardware (including computers, displays, and other computer peripheral equipment) shall be industrial grade substation-hardened computer hardware equipment which is suitable for, and will be fully operational in each substation where the Station HMI computer hardware equipment will be installed. The gateway equipment shall be rackmount housed in a IP31 compliant cabinet with protective glass door. Necessary Keyboard, mouse and monitor extender interface with cables shall be provided for facilitating operation from the operator workplace. Cabinet design shall ensure to be equipped with the standard accessories specified for relay cabinets. Each server shall be equipped with at least one (1) CD/DVD RW drive to allow transfer of data and other software from the Hard Disk(s) to removable CD/DVD media.

All computers including HMI servers, Work stations etc shall be provided with comprehensive anti-virus protection and cyber protection as appropriate.

Station HMI computer hardware shall be preferably a totally Solid State Hard Disk (to provide maintenance-free operation of the Hard Disk) be used as the main storage device for the Station HMI operating system, Station HMI databases, and other Station HMI software. Alternatively to a totally Solid State Hard Disk for the Station HMI computer hardware, for each HMI server two (2) mechanical Hard Disks with full **RAID 5** data backup abilities (so that each mechanical Hard Disk in the Station HMI computer hardware will contain an identical image at all times).

One remote client facility for Station HMI access with relevant original licenses and software shall be provided.

The redundant station HMI server shall operate in hot standby mode and vice versa in case of a switcher over. The real time data base of the main and redundant HMI servers shall be synchronized at all times with out loss of real time data in case of a switchover.

22) Engineering Work station

The engineering work station should be provided in a industrial grade PC.

The engineering work station should be equipped for :

- Data retrieval and analysis of recorded data from SAS devices including disturbance records, fault records, event records etc
- Remote configuration of SAS IED's, Numerical protection relays, Digital Energy meters etc. All relevant software tools is to be provided for this purpose.

- Client access facility to station HMI with all the relevant softwares.

The engineering works station shall be provided with a simple Network Management System (NMS) software for following management functions of Ethernet switches, SAS devices supporting SNMP.

- 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 shall be easy to use, user friendly and menu based.

The Engineering work station shall be provided with comprehensive anti-virus protection and cyber protection as appropriate.

Each server shall be equipped with at least one (1) CD/DVD RW drive to allow transfer of data and other software from the Hard Disk(s) to removable CD/DVD media.

Engineering WS computer hardware shall be preferably a totally Solid State Hard Disk (to provide maintenance-free operation of the Hard Disk) be used as the main storage device for the operating system, Station HMI databases, and other Station HMI software. Alternatively to a totally Solid State Hard Disk, two (2) mechanical Hard Disks with full **RAID 5** data backup abilities (so that each mechanical Hard Disk in the Station HMI computer hardware will contain an identical image at all times).

The engineering workstation shall be rack mount housed in a IP31 compliant cabinet with protective glass door. Necessary Keyboard, mouse and monitor extender interface with cables shall be provided for facilitating operation from the operator workplace. Cabinet design shall ensure to be equipped with the standard accessories specified for relay cabinets.

23) Metering PC

An industrial grade computer complete with operating system, 500GB hard disk, key board, mouse, 29 inch colour TFT monitor, all relevant original software and tools for viewing in real time and generating reports relevant to metering data. The metering data from the meters shall be integrated in to the station HMI servers in real time through the SAS LAN and the same shall be available from the HMI server to the metering PC as a client. All HMI

servers shall be provided with comprehensive anti-virus protection and cyber protection as appropriate.

24) COMMUNICATION NETWORK:

All the SAS equipments that are to be integrated with the SAS should be provided with suitable communication ports to connect to the LAN and support IEC 61850 protocol. Digital energy meter may be integrated with the IEC 61850 inter bay bus suitably through data concentrators / media converters. Redundant LAN'S shall be provided at station level. At the bay level a self healing ring architecture shall be provided. The station LAN's shall be separate from the bay level LAN's. The ring LAN architecture shall have the RSTP or equivalent feature. The proposed LAN's shall be equipped with 802.1Q VLAN facility.

Alternate Communication architecture for SAS and bay level LAN's may be proposed if proven to provide better performance and reliability.

25) CAPACITY:

The system should be capable of handling upto 100 IEDs and 10,000 data points.

26) SEQUENCY OF EVENTS (SOE) FEATURE:

To analyze the chronology or sequence of events occurring in the power system, time tagging of data is required which should be achieved through SOE feature of SA. The server should have an internal clock with adequate stability. The Server time should be set from time synchronization messages received from GPS equipment to be supplied by bidder. The Server should maintain a clock and should time-stamp the digital status data. Any digital status input data point in the Server should be assignable as an SOE point. Each time a SOE status indication point changes the state, the Server should time-tag the change and store in SOE buffer within it. SOE shall be transferable to the Remote Control Centre through the IEC 60870-5-101 gateway. The time resolution for SOE should be 1 ms at point of acquisition.

27) ETHERNET SWITCHES:

The Ethernet switches used for creating the LAN network should meet the specification as laid down in the IEC 61850 standard and should be of managed type SNMP based. The Ethernet switches should comply to

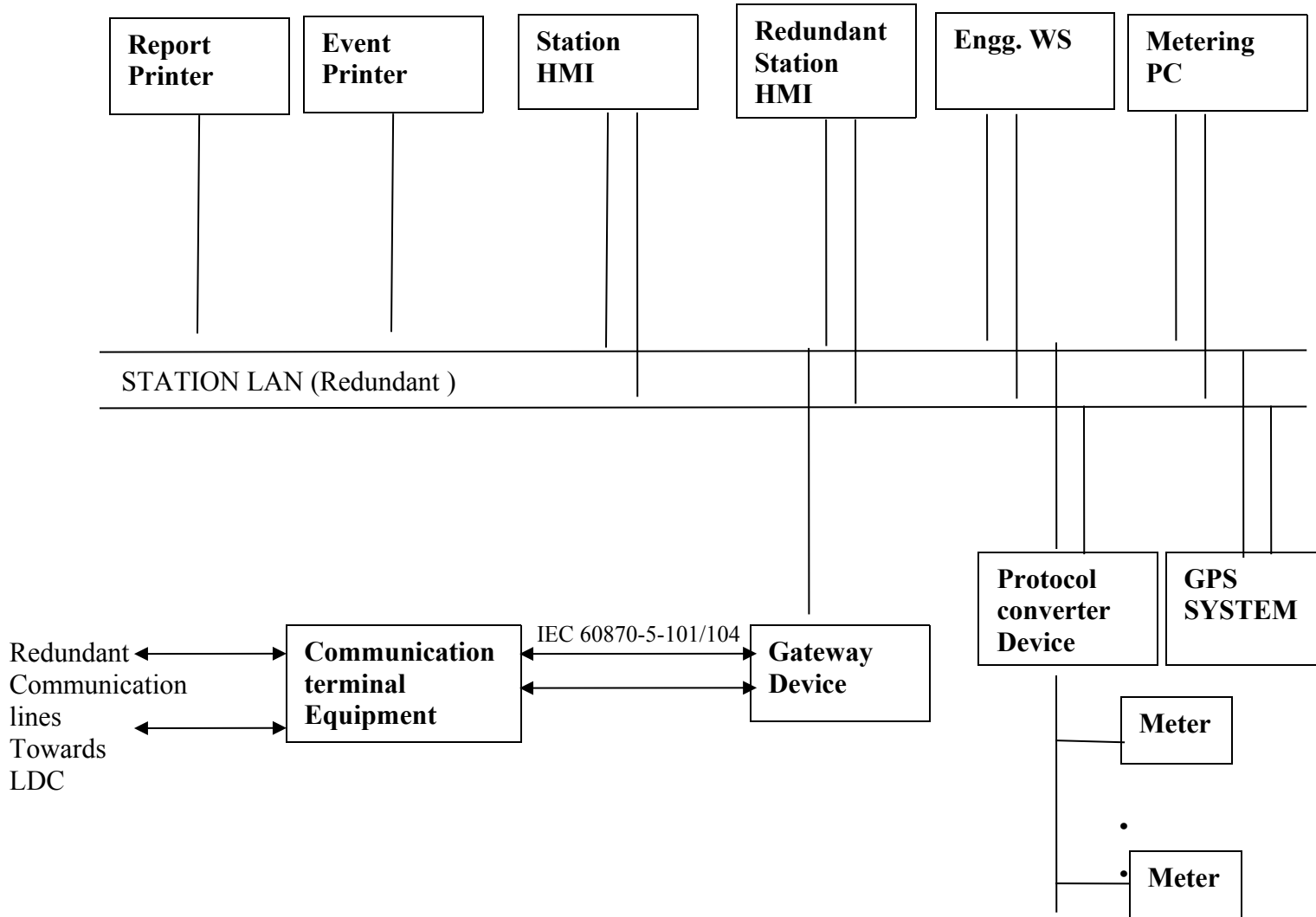
IEC 61850-3 standard/equivalent for EMI Immunity and environmental compliance pertaining with Electrical utility substations applications.

28) Gateway Equipment

The Gateway equipment shall conform to the following technical requirements:

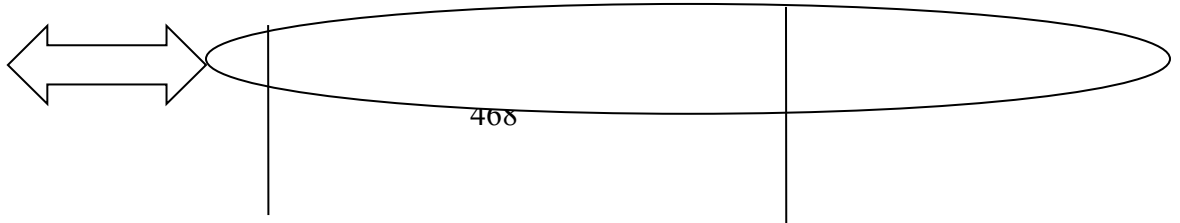
- The gateway equipment shall be based on embedded technology without moving parts.
- **The gateway equipment shall comply to IEC 60255** standards / Equivalent IS for EMC and Environmental compliances.
- Support IEC 61850 protocol, IEC 60870-5-101/104 protocol.
- **Perform the data concentration** by directly collecting data from the bay level devices and provide the same to the remote LDC/Master without the aid of the SAS HMI servers.
- The gateway device should be equipped with sufficient memories for firmware, Configuration data, Process data, records.
- Equipped with redundant communication ports for SAS interfaces as well as for remote LDC/Master interfaces.
- Gateway shall be equipped with redundant power supply modules and communication modules.
- Equipped to run high speed programmable logic control function that includes provision for implementing station level interlocks and automation logic as necessary.
- Necessary software with original license for Anti-virus protection with Relevant firewall should be provided for operating system based on MS windows.
- The gateway equipment shall be rackmount housed in a IP31 compliant cabinet with protective glass door. Cabinet design shall ensure to be equipped with the standard accessories specified for relay cabinets.

CONCEPTUAL DIAGRAM FOR SAS

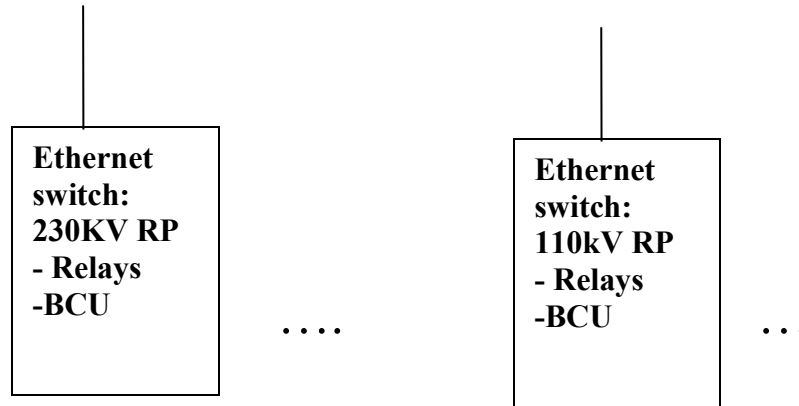


BAY LEVEL LAN (IEC 61580, RING TOPOLOGY)

To



Station LANs



29) UPS specification :

The UPS shall conform to applicable parts of IEC 62040/ Equivalent standards.

The UPS system shall include the following:

- UPS equipments supplying load at 0.8 lagging power factor,
- Maintenance free VRLA batteries for UPS system with backup duration,
- The UPS shall be designed for continuous-duty, on-line operation and shall be based on solid- state design technology to provide uninterrupted power supply for computersystem and associated items. The control of the UPS system shall be microprocessorbased providing monitoring and control of rectifier/charger, Inverter,static switches,firing and logic control.
- The UPS shall provide continuous regulated sine wave AC power to the connected loads.
- The UPS electronic equipment and associated circuitry & all devices shall be housed in freestanding enclosures/panels.
- In the event of a loss of AC source, the UPS equipment shall provide uninterrupted power to the specified loads from the output of the UPS inverter subsystems through its batteries.
- The UPS shall be suitable for operating with input of 230V AC (1-Phase) or 415 Volt AC(+10% to -15%; 3-phase,4-wire), 50 Hz (47.5 to 52.5 Hz) as well as 220VDC.
- The overall efficiency of the UPS, input to output, shall be a minimum of 90 percent with the batteries fully charged and operating at full load and unity

power factor.

- The UPS shall be provided with potential free contacts for its equipment faulty alarms.

SECTION-III

BILL OF MATERIALS FOR PROTECTION RELAY PANELS

I. 400 KV FEEDER RELAY PANEL

1.	Numerical distance protection relay for Main-1 protection as per Specification.	1 No
2.	Numerical distance protection relay for Main-2 protection as per Specification.	1 No
3.	Bay control unit	1 No
4.	Electronic Trivector meter (3-phase,4W,3E,4 Quadrant, class 0.2, with RS 485 port,110 V,1A)	1No.
5.	Single phase trip relay (with self-reset contacts)	6 Nos.
6.	Trip circuit supervision relay	6 Nos.
7.	DC supply supervision relay	3 Nos.
8.	5 element High burden Hand Reset with Flag Indication Relay for HV/LV breaker annunciation and transformer function annunciation with a minimum of 3 sets of N/O contacts and 1 set of N/O contact.	1 No
9.	Three phase Master Trip relay (self reset contacts, Hand reset flags)	2 Nos.
10.	P.T. selection scheme with bistable relays	1 Set
11.	Bus bar Tripping relay (96)	1 No
13.	Supervision relays for tripping and lockout relays	As required
14.	Selector switch (A/R IN/OUT, 4 Way,Stayput)	1 No.
15.	Selector switch (Carrier IN/OUT, 2Position, 4 Ways,Stay put)	2 Nos.
16.	Indicating lamp for carrier healthy common to both Main I & II	2 Nos.
17.	LBB Isolation link	2 Nos
18.	Auxiliary relay for circuit breaker alarms/trip (Typically :Loss of SF6, PD Trip, General Lockout, SF6 Lockout, 81X)	As required
19.	Trip transfer switch (3 Postion, Lockable type with removable key,sufficient ways)	1 No.
20.	Auxiliary relay for contact multiplication of trip transfer switch	1 No
21.	Auxiliary relay for Automatic DC source selection	1 No
22.	Synchronising socket 12 Pin	1 No
23.	Control switch (TNC) spring return type with pistol grip handle for Breaker	1 No.
24.	Auxiliary relays and timers to fullfill protection scheme	-As required
Standard relay panel accessories as stipulated in this specification		-As required
26.	Numerical over flux relay	1 No.
27.	Numerical 3-phase Under voltage protection relay (2 stage with separate timers programmable scheme logic. To be provided with necessary trip relays etc.)	1 No

Note :

1. Functions of supervision relays, trip relays, selector switches, auxiliary relays may be incorporated in a multifunction IED subject to design approval from TAN TRANSCO. Such scheme should be designed such that a single point of failure in the multifunction IED should not cause simultaneous failures of Main-I and main-II protection scheme. The IED should conform to the Specification for the general requirements for numeric relay and equipped with redundant power supply modules.
2. Under voltage relay shall be provided in one of the line protection panel only.
3. Fault sensing algorithm of Main-1 and Main-2 should be different. How it differs shall be explained.

II. 400 KV TIE BREAKER PANEL FOR LINES / TRANSFORMERS:

- | | |
|--|-------------|
| 1. Bay Control unit | 1 No |
| 2. Numerical relay for LBB protection with built in timer and necessary I/Os. | 1 No |
| 3. Three phase trip relay with hand/Electrical reset contact and hand reset flag | 2 Nos |
| 4. Single phase trip relay with self reset contact | 6 Nos |
| 5. Trip Circuit Supervision relay (Pre close and Post close) | 6 Nos |
| 6. DC supervision relay | 2 Nos |
| 7. Five element high burden hand reset with flag indication relay for breaker annunciation with minimum of four set of NO contacts | 1 No |
| 8. Auxillary relays and timers required | As |
| 9. High speed trip relay (96) for busbar protection | 1 No |
| 10. Supervision relays for trip relays | As required |
| 11. TNC Control switch spring return type with pistol grip handle for Breaker | 1 No |
| 12. Auxiliary relay for circuit breaker alarms/trip
(Typically :Loss of SF6, PD Trip, General Lockout, SF6 Lockout, 81X) | As required |
| 13. LBB isolation link | 1 No. |
| 14. Relay for Automatic DC source selection | 1 no. |
| 15. Standard relay panel accessories as described in this technical specification document. | |

III BILL OF MATERIALS FOR 400KV BUS REACTOR PANEL :

- | | |
|--|----------|
| 1. Numerical Reactor differential protection relay (87R) | - 1 Each |
|--|----------|

2.	Numerical protection relay for (50/51, 50N/51N,64R,50Z,21R)	As required
3.	Bay control unit	1 No
4.	Flag relays for thermal imaging, MOG,WTI,OTI, Bucholz,PRV and staus indication.	As required.
8.	DC supervision relays	2 Nos
9.	Auxiliary relays and timers,trip relays etc. to fulfill protection & automation scheme.	- As required.
10.	High speed trip relay (96) for busbar protection	1 No
11.	Supervision relays for trip relays	As required
12.	TNC Control switch spring return type with pistol grip handle for Breaker	1 No
13.	Auxiliary relay for circuit breaker alarms/trip (Typically :Loss of SF6, PD Trip, General Lockout, SF6 Lockout, 81X)	As required
14.	LBB isolation link	1 No.
15.	Relay for Automatic DC source selection	1 no.
16.	Standard relay panel accessories as described in this technical specification document.	

IV.BOM FOR AUTO TRANSFORMER RELAY PANEL
(Applicable for 400kV/110 kV as well as 400kV/230kV)

1.	Electronic Trivector meter (3-phase,4W,3E,4 Quadrant, class 0.2, with RS 485 port,110 V,1A)	2Nos.
2.	Numerical biased differential protection for two winding Transformer with REF,LBB, over fluxing and synchro check Features	1 No
3.	Numerical non-directional over current protection relay with LBB and high set for HV side	1 No
4.	Numerical non-direction over current protection relay with LBB and high set for LV side	1 No
5.	Numerical impedance relay (21T) for backup protection for transformer	1 No
6.	Numerical protection relay for LBB protection with built in timer and sufficient inputs and outputs	2 Nos
7.	Bay control units for HV and LV	2 Nos
8.	TNC Control switch spring return type with pistol grip handle for Breaker	2 Nos
9.	Three Phase trip relay with hand reset contact and hand reset flag	2 Nos
10.	Trip transfer switch (Lockable type;Normal-Intermediate-Transfer positions, 24 Ways)(Applicable only for main and transfer bus type with TBC)	1 No.

11. Trip circuit supervision relay for HV and LV trip coils (pre close and post close)	As required
12. D.C. supply supervision relay	3 Nos
13. Five element high burden hand reset with flag indication relay for breaker communication with a minimum of 4 set of N/O contacts (for HV and LV)	2 Nos
14. Supervision relays for tripping and lockout relays	As required
15. Auxiliary relay for transformer alarms and trip (Typically : Bucholz alarm-3 Element, Oil flow alarm-3, WTI-3 Element, OTI-3 Element,Oil level alarm-3 Element, PRV Trip-3 Element, Bucholz trip-3 Element,OLTC Low oil Level- 3Element)	As required
16. Auxiliary relay for circuit breaker alarms/trip (Typically :Loss of SF6, PD Trip, General Lockout, SF6 Lockout, 81X)	As required
17. Auxiliary relays and timers to fulfill scheme	As required
18. P.T. selection scheme with bistable relays (for HV and LV)	2 Sets.
19. High Speed tripping relay (96) for B/B protection	2 Nos
20. LBB isolation link	2 Nos.
21. Standard relay panel accessories as stipulated in this specification	-As required
22. Relay for Automatic DC selection	1 no.
23. Transducer for Tap position indication (30-250VDC auxiliary supply, IEC 60688 compliant, Output 4-20mA)	1 no.
24. Digital Voltmeter (LED Display for Bus voltage)	1 No
25. Digital Frequency meter (LED Display)	1 No.
26. Selector switch (for voltmeter)	1 No.
27. Selector switch (for frequency meter)	1 No.
28. Indication lamps (for checking bus PT)	3 Nos.

Note :

1. Item no. 24 to 28 are applicable only if there is no 230KV transfer bus coupler breaker/230KV Bus coupler breaker in the single line diagram, In which case item no. 20 through 24 shall be provided in one of the transformer protection panel only.

2. Functions of supervision relays, trip relays,selector switches,auxiliary relays may be incorporated in a multifunction IED subject to design approval from TAN TRANSCO. Such scheme should be designed such that a single point of failure in the IED should not cause failure of the protection scheme. The IED should conform to the Specification for the general requirements for numeric relay and equipped with redundant power supply modules.

V. BILL OF MATERIALS FOR 400KV / 110KV BUS BAR PROTECTION RELAY PANEL :

- 1) Set of low impedance bus bar protection scheme of Numerical type for 1 Set

single/double zone with check zone for 400/110KV bus (as per single line diagram enclosed plus 3 numbers spare feeders)

- | | |
|--|--------------|
| 2) DC supervision relays | 2 Nos |
| 3) Bus bar cut IN/OUT switch Main and check zones. | As required |
| 4) Auxiliary relays for automatic DC source selection | As required |
| 5) Auxiliary relays and timers to fulfill scheme | As required |
| 6) 3 Phase trip relay (96) (shall be be a part of relay panel of the respective panels) | As required |
| 7) Supervision relay for B/B protection
trip relays (shall be a part of relay panel of the respective panels) | As required |
| 8) Standard relay panel accessories as stipulated in this specification | -As required |

VI. BILL OF MATERIALS FOR 110 KV BUS COUPLER RELAY PANEL/ / 110KV BUS SECTION BREAKER RELAY PANEL /110KV BUS COUPLER RELAY PANEL:

- | | |
|--|--------------|
| 1) Numerical non directional over current and earth fault relay with LBB 1No
and synchro check | |
| 2) Bay control unit | 1No |
| 3) TNC Switch | 1 No. |
| 4) 3 Phase trip relay with hand reset contact and hand reset Flag | 2Nos |
| 5) Trip Circuit supervision relay
(quantity applicable as per 1-ph or 3-ph breaker) | 2nos/6 Nos |
| 6) DC supervision relays | 2Nos |
| 7) Five element high burden hand reset with flag indication relay
for breaker annunciation with a minimum of four set of N/O contact) | 1No |
| 8) Supervision relay for Main,Backup and B/B protection Trip relays | 3Nos |
| 9) Auxiliary relays and timers to fulfill scheme | As required |
| 10) High Speed tripping relay (96) for B/B protection | 1No |
| 11) Digital Voltmeter (LED Display for Bus voltage) | 2 Nos. |
| 13) Digital Frequency meter (LED Display) | 2 Nos. |
| 14) Selector switch (for voltmeter) | 2 Nos. |
| 15) Selector switch (for frequency meter) | 2 Nos. |
| 16) Indication lamps (for checking bus PT) | 6 Nos. |
| 17) LBB isolation link | 1 No. |
| 18) Relay for Automatic DC source selection | 1 no. |
| 19) Standard relay panel accessories as stipulated in this specification | -As required |

Note :

1. Functions of supervision relays, trip relays,selector switches,auxiliary relays may be incorporated in a multifunction IED subject to approval of TAN TRANSCO design approval. Such scheme should be designed such that a single point of failure in the IED should not cause protection failure. The IED should conform to the Specification for the general requirements for numeric relay and equipped with redundant power supply modules.

VII. BOM FOR 110 KV Feeder Relay Panel

- | | |
|---|------------------|
| 1) Electronic Trivector meter
(3-phase,4W,3E,4 Quadrant, class 0.2, with RS 485 port,110 V,1A) | 1No. |
| 2) Numerical distance protection relay for Main protection as per
No | Specification. 1 |
| 3) Numerical directional O/C & E/F relay with LBB for back up protection as
per specification. | 1 No |
| 4) Bay control Unit | 1No |
| 5) TNC Switch | 1 No. |
| 6) Three phase trip relay with hand reset contact and hand reset flag | 2 Nos |
| 7) Trip Circuit Supervision relay (pre close and post close)
(quantity applicable as per 1-ph or 3-ph breaker) | 2nos/6 Nos |
| 8) D.C. Supervision relay | 2 Nos |
| 9) Five element high burden hand reset with flag indication relay for
breaker annunciation with a minimum of four set of N/O contact | 1No. |
| 10) Selector switch (A/R IN/OUT, 4 Way,Stayput) | 1No. |
| 11) Supervision relays for tripping and lockout relays | As required |
| 12) P.T. selection scheme with bi-stable relay | 1 Set |
| 13) Highly Speed tripping relay(96) for B/B protection | 1 No |
| 14) Remote access block switch (For numeric relay) | 1 No. |
| 15) LBB isolation link | 1 No |
| 16) Auxiliary relays and timers to fulfill scheme
required | As |
| 17. Trip transfer switch
(Lockable type;Normal-Intermediate-Transfer positions, 24 Ways)
(Applicable where transfer breaker is available) | 1 No. |
| 18. Standard relay panel accessories as stipulated in this specification | -As required |

Note :

1. Functions of supervision relays, trip relays,selector switches,auxiliary relays may be incorporated in a multifunction IED subject to approval of TAN TRANSCO design approval. Such scheme should be designed such that a single point of failure in the IED should not cause simultaneous failures of Main and backup protection scheme. The IED should conform to the Specification for the general requirements for numeric relay and equipped with redundant power supply modules.

VIII. BOM FOR 110 KV Feeder Relay Panel with line differential protection

1) Electronic Trivector meter (3-phase,4W,3E,4 Quadrant, class 0.2, with RS 485 port,110 V,1A)	1No.
2) Numerical line differential relay with built in distance protection for Main-1 protection. (Distance protection as per specification)	1 No
3) Numerical line differential relay with built in distance protection for Main-2 protection. (Distance protection as per specification)	1 No
Manufacturer should be different from Main-2.	
4) Bay control Unit	1No
5) TNC Switch	1 No.
6) Three phase trip relay with hand reset contact and hand reset flag	2 Nos
7) Trip Circuit Supervision relay (pre close and post close) (quantity applicable as per 1-ph or 3-ph breaker)	2nos/6 Nos
8) D.C. Supervision relay	2 Nos
9) Five element high burden hand reset with flag indication relay for breaker annunciation with a minimum of four set of N/O contact	1No.
10) Selector switch (A/R IN/OUT, 4 Way,Stayput)	1No.
11) Supervision relays for tripping and lockout relays	As required
12) P.T. selection scheme with bistable relay	1 Set
13) Highly Speed tripping relay(96) for B/B protection	1 No
14) Remote access block switch (For numeric relay)	1 No.
15) LBB isolation link	1 No
16) Auxiliary relays and timers to fulfill scheme required	As
17) Fiber optic cables for interface between 87-L relay to fiber optic patch panel	As required.*
18) Trip transfer switch (Lockable type;Normal-Intermediate-Transfer positions, 24 Ways) (Applicable where transfer breaker is available)	1 No.
19. Standard relay panel accessories as stipulated in this specification	-As required

Note :

1. Functions of supervision relays, trip relays,selector switches,auxiliary relays may be incorporated in a multifunction IED subject to approval of TAN TRANSCO design approval. Such scheme should be designed such that a single point of failure in the IED should not cause simultaneous failures of Main and backup protection scheme. The IED should conform to the Specification for the general requirements for numeric relay and equipped with redundant power supply modules.

2. * Direct Link between 87-L to 87-L relays is preferred through fiber optic cables using

IEEE 37.94 standard. Alternatively media converter is to be provided for Fiber optic to G.703 converter and necessary interface cables compatible for remote end link.

IX. BOM FOR 110 KV Feeder Relay Panel with UF relay

- | | |
|--|------------------|
| 1) Electronic Trivector meter
(3-phase,4W,3E,4 Quadrant, class 0.2, with RS 485 port,110 V,1A) | 1No. |
| 2) Numerical distance protection relay for Main protection as per
No | Specification. 1 |
| 3) Numerical directional O/C & E/F relay with LBB for back up protection as
per specification. | 1 No |
| 4) Bay control Unit | 1No |
| 5) TNC Switch | 1 No. |
| 6) Three phase trip relay with hand reset contact and hand reset flag | 2 Nos |
| 7) Trip Circuit Supervision relay (pre close and post close)
(quantity applicable as per 1-ph or 3-ph breaker) | 2nos/6 Nos |
| 8) D.C. Supervision relay | 2 Nos |
| 9) Five element high burden hand reset with flag indication relay for
breaker annunciation with a minimum of four set of N/O contact | 1No. |
| 10) Auxiliary relays and timers to fulfill scheme | As required |
| 11) Supervision relays for tripping and lockout relays | As required |
| 12) P.T. selection scheme with bistable relay | 1 Set |
| 13) Highly Speed tripping relay(96) for B/B protection | 1 No |
| 14) Remote access block switch (For numeric relay) | 1 No. |
| 15) Numerical under frequency protection relay as per specification | 1 No. |
| 16) LBB isolation link | 1 No. |
| 17) 3-phase Master Trip relay for (81RF) under frequency scheme: As required+3 nos.
(Hand & Electrical reset contacts, Hand reset flags. 1 no per feeder plus 3nos
spare for future feeders) | |
| 18) 3-phase Master Trip relay for f+df/dt scheme : As required+3 nos.
(Hand & Electrical reset contacts, Hand reset flags. 1 no per feeder plus 3nos
spare for future feeders) | |
| 19) Isolation link for each feeder for under frequency scheme | : As required |
| 20) Auxiliary relays and timers to fulfill scheme | As required |
| 21) Trip transfer switch
(Lockable type;Normal-Intermediate-Transfer positions, 24 Ways)
(Applicable where transfer breaker is available) | 1 No. |
| 22. Numerical 3-phase Under voltage protection relay
(2 stage with separate timers programmable scheme logic. To be provided with
necessary trip relays etc.) | 1 No |
| 23.Standard relay panel accessories as stipulated in this specification | -As required |

Note :

1. Functions of supervision relays, trip relays, selector switches, auxiliary relays may be incorporated in a multifunction IED subject to approval of TAN TRANSCO design approval. Such scheme should be designed such that a single point of failure in the IED should not cause simultaneous failures of Main and backup protection scheme. The IED should conform to the Specification for the general requirements for numeric relay and equipped with redundant power supply modules.

X. Synchronising Bracket/ Trolley

1. Circuit Label	1 Each.
2. Voltmeter	2 Nos.
3. Frequency Meter (45-55 HZ)	2 Nos.
4. Synchroscope	1 No.
5. Synchroscope selector switch	1 No.
6. Check synchronizer IN/OUT selector switch	1 No.
7. Numerical Check synchronizing relay	1 No.
8. Auxiliary relays, Auxiliary VTs, Gurad relay, synchronizing socket & plug	: As required
9. Indication lamp for synchronising indication	1 No.
8. Panel Standard accessories	As required

Note : The synchronism and energizing check functions of the relay shall feature:

- 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.
- Synchronising between live line and live bus with synchro-check function.

XI. Standard relay panel accessories:

All the Control & Relay panels shall have the following

1. Cubicle illumination Lamp (CFL) with door switch	- 1 Set.
2. Space heater with thermostat and ON/OFF switch	- 1 Set.
3. 5A&15A, 3-Pin socket with pin and ON/OFF switch	- 1 Set.
4. Test terminal block for relay testing	- As required
5. Test plug	- As required
6. Cable glands (Not Applicable)	
7. Terminal blocks	As required+20% Spares
8. Wires for CT, Earthing (2.5 Sq.mm, Multi strand, 1100V Grade, PVC Insulated, FRLS)	As required
9. Wires for VT, Alarms, status, Control	As required

(1.5 Sq.mm, Multi strand, 600v/1100V Grade,PVC Insulated, FRLS)

10. 25*6mm Tinned copper bar	As required
11. Cabinet (Free standing, self supported, with swing frame for devices and outer glass door.)	1 Each
12. Labels for devices (Inside and outside the panel)	- 2 Sets
13. Lable for panel designation	- 2 Nos
14. Fuses and links for DC and AC circuits	As required
15. DC fail test/accept button	- 2 Each
16. AC bell for DC fail alarm	- 1 no
17. DC Hooter for non-Trip alarms	- 1No
18. Synchronising socket (12 Pin) (Applicable for interface with synchronising trolley)	- 1 No. 1 No.

General: The following items are included under the scope of supply for relay panels and for SAS equipments

1. Manuals (hard copy & soft copy)	3 Sets.
2. As built drawings (hard copy & soft copy)	5 Sets.

XII. BOM FOR SAS

Sl. No	Description	Unit	Qty
1	Industrial grade computer for station HMI (Complete with computer,KB,Mouse,500GB HDD, 29" TFT Monitor, All relevant software for applications, operating system)	Nos.	2
2	Engineering work station (Complete with Industrial grade computer, KB,Mouse, 500GB HDD,29" TFT Monitor, All relevant softwares, operating system)	No.	1
3	Metering PC (Complete with Industrial grade computer,KB,Mouse,500GB HDD,29" TFT Monitor, All relevant software for applications, operating system)	No.	1
4	Gateway Panel (Complete with panel, gateway device, Hooter-2nos for substation urgent & non-urgent alarms)	No.	1
5	Communication equipment (Complete with MODEMs,Lightning arrestor for MODEM,media interface device etc for gateway redundant interface to LDC)	sets	2
6	Bay Control Unit	Nos.	As required. (Refer note below.)
7	Ethernet Switch (20% spare ports in each switch)	Nos.	As required.
8	General printer (A3 Colour LASER Jet Printer)	No.	1
9	Report printer (A4 Colour LASER Jet Printer)	No.	1
10	LAN accessories (Includes all cables and associated cable ducts, media converters etc for LAN)	Lot	1
11	Time synchronization system (GPS with all accessories,Antenna, cables,software etc)	Set	1
12	Configuration tools for SAS equipments (Includes Laptop computer,relevant software tools, accessories for configuration of SAS devices, protection panel devices.)	Set	1
13	Numeric relay testing kit with all associated software (suitable for testing of numeric relays) of reputed make with IEC61850 software for GOOSE subscription & publishing, rugged carry case and necessary accessories. (OMICRON CMC356 /MEGGAR MPRTS 3P 8430 / PONOVO PW636i / Equivalent or better). Includes laptop computer dedicated for testing kit.	Set	1
14	Relevant manuals as per SA specification.	Lot	1
15	Furniture : Chair suitable for operator-revolving type	Nos.	3
16	Furniture : Tables for SAS operator – 2Nos; Table for Engg WS & Metering PC : 2nos.	Lot	1
17	Furniture : Tables with drawers suitable for housing all the drawings & manuals of the SAS and protection system.	Lot	1
18	UPS (VA rating should be 150% of load to supply for 2 Hours. Load includes SAS servers, SAS LAN devices, Engineering work station.)	No.	1

Note:

1.Refer enclosed Single line diagram for verifying the total quantity of BCU's, Quantity of BCU's offered should be sufficient to meet the requirement of the Single line diagram. Dedicated BCU should be provided for each of the 400KV bay's as well as each of each of the 110KV bays.

2.IED/ BCU with graphic display of sufficient I/O capacity shall be offered for common alarms in the sub-station.

3. Media type (PLCC or Fibre optic media or leased line) for gateway interface to the remote load dispatch centre would be known during project execution.

XIII. TRAINING SCOPE

Training shall be imparted at works and at site as described below.

a) Training at works :

Minimum one week training for two batches of boards engineers at the manufacturers works with lectures and hands on training on complete SAS & protection relays. This training shall be imparted prior to commissioning of SAS & protection system with at least 7 trainees per batch. All relevant training material, tools and equipments shall be provided for each trainee towards this training. The training shall cover the technology, principle of operation, functions etc of the protection relays and SAS devices. Training content should be furnished to TANTRANSCO for obtaining concurrence prior to training schedule.

Composition of batch shall be (5 trainees of TANTRANSCO + 2 trainees of BHEL)

b) Training at site (Applicable for each sub-station):

Comprehensive hands on training of TAN TRANSCO engineers at site should be imparted as follows:

4. For 1 batch of at least 7 engineers oriented for operations of SAS & protection system. This training shall be imparted after commissioning of SAS.
5. For 1 batch of at least 7 engineers oriented for Testing, commissioning & maintenance of complete SAS & protection relays. This training shall be imparted after installation of SAS & protection system. This training should be implemented to enable the trainees to configure, trouble shoot all the SAS devices including numeric relays,BCU etc and prepare the trainees to use all the configuration tools for all of the SAS devices.

All expenses of the training instructor for executing the training at site is in the bidder's scope.

Delviery receipt signed by the trainees deputed should be furnished towards completion of training at works and at

site. Training scope is included under the commissioning of SAS.

ANNEXURE
BILL OF QUANTITIES FOR RELAY PANELS & SAS FOR
THAPPUKUNDU 400kV/110 kV SS

S.no	Description of Material	Unit	Qty
1	Relay panel for 400kV feeder protection	Nos.	2
2	Relay panel for 400kV tie breaker for 400 kV lines	Nos.	1
3	Relay panel for 400kV tie breaker for Auto transformers/Reactor	Nos.	3
4	Relay panel for 400kV/110kV Auto transformers	Nos.	4
5	Relay panel for 400kV Bus Reactor	No.	1
6	Relay panel for 400kV Bus bar protection	No.	1
7	Relay panel for 110kV feeder protection with UF relay	No.	1
8	Relay panel for 110kV feeder protection relay	Nos.	7
9	Relay panel for 110kV Tie breaker/ Transfer breaker protection	No.	1
10	Relay panel for 110kV Bus bar protection	No.	1
11	Synchronizing trolley	No.	2
12	Sub-station Automation system (Complete as per BOM for SAS; Comprising 24 Electrical bays. Includes Relay test kit)	Lot	1
13	Installation, Testing & commissioning of complete SAS for 400KV/110KV SS (Comprising 24 Electrical bays; inclusive of training)	Lot	1

Note :

1. All relay panels are with SAS.
2. 24 Electrical bays comprises : 2 x 400kV Feeders, 4 x 400KV Tie breakers, 4x 400KV HV, 1 x 400KV Bus reactor, 4X 110KV LV, 8x 110kV Feeders, 1x 110kv Tie breaker.

SECTION-V: GURANTEED TECHNICAL PARTICULARS

18 GUARANTEED TECHNICAL PARTICULARS FOR DISTANCE PROTECTION NUMERICAL RELAY:

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

is allowed for tripping in case of fault when there is PT fuse failure.

18. Power swing blocking
 - a) Detection method :
 - b) Blocking time :
 - c) Details of combination of Zones that can be blocked. :
19.
 - a) Details of trip contacts :
 - b) Details of additional contacts provided. :
20. Details of Auto reclose relay:
 - a) Dead time setting :
 - b) Reclaim time setting :
 - c) Synchro check facility :
 - d) Facility to initiate from main-2 :
21. Details of IDMT directional earth fault relay. :
 - a) Setting range :
 - b) Characteristic curve at 10 times of set value. :
22. Characteristic angle range of distance relay. :
23. Details of Disturbance recorder :
 - a) No. of Analog input :
 - b) No. of Digital input :
 - c) Memory capacity to store records:
 - d) Facility to down load and analys the recording. :
24. Details of fault locator :
 - a) Whether in built :
 - b) Whether accurate for all operating conditions. :
25. Communication ports details (Media & protocol):
26. Details of software needed for setting, down loading, fault analysis and programmable logic control. :
27. Whether self diagnostic feature is provided. :
28. Whether time Synchronising facility is available. :
29. Type tests complied (List out) :

**19 GUARANTEED TECHNICAL PARTICULARS FOR Transformer
Biased Differential Relay:**

S.no	Description	Guaranteed Specification
1	Make & Model	
3	Current Rating: Continuous	
4	Current Rating 1 sec	
	Operating time at 3 times normal current:	
5	Operating time for instantaneous operation:	
6	Bias setting range with steps	
7	Availability of faulty phase identification	
8	Availability of instantaneous High set feature with current setting range	
9	Range of second harmonic restrain feature available.	
10	Transformer vector group and CT ratio selection/corrections through software.	
11	LBB Protection Setting range:	
12	LBB Protection : Time range	
13	Auxiliary supply operating range	
14	Max Digital Input (Equipped)	
15	Max Digital Input (Feasible)	
16	Max Digital output (Equipped)	
17	Max Digital Output (Feasible)	
18	Rating of control output relays provided	
19	Max. Single indications	
20	Functionalities supported:	
a)	SOE (Mention resolution, record length)	
b)	Disturbance record (Mention resolution, record length, Sampling rate)	
c)	Fault recorder (Resolution, storage capacity)	
d)	Self diagnostics (Equipped?)	
33	Time synchronisation interface equipped (Mention media, standard supported)	
34	Type tests Standards complied (List out)	

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

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

IV. GUARANTEED TECHNICAL PARTICULARS FOR BUS BAR PROTECTION RELAY:

S.no	Description	Guaranteed Specification
1	Make & Model	
2	Architecture (Centralised / Distributed)	
3	Max operating time at 5 times setting	
4	CT Supervision facility	
5	Dynamic bus replica facility	
6	Phase segregated type?	
7	Current or voltage setting	
8	Availability of faulty phase indication	
9	Availability of Check feature	
10	Rated voltage and current	
11	Resetting value	
12	Does the relay give 100% security and reliability under all operating conditions and upto applicable fault level	
13	Second harmonic rejection ratio	
14	Third harmonic rejection ratio	
15	Phase current slope adjustment	
16	Phase differential current threshold	
17	Residual current slope adjustment	
18	Residual differential current threshold	
19	Dead zone protection	
20	Accuracy	
21	Pickup	
22	Auxiliary supply operating range	
23	Max Digital Input (Equipped)	
24	Max Digital Input (Feasible)	
25	Max Digital output (Equipped)	
26	Max Digital Output (Feasible)	
27	Rating of control output relays provided	
28	Max. Single indications	
29	Functionalities supported:	
a)	SOE (Mention resolution, record length)	
b)	Disturbance record (Mention resolution, record length, Sampling rate)	
c)	Fault recorder (Resolution, storage capacity)	
d)	Self diagnostics (Equipped?)	
33	Time synchronisation interface equipped (Mention media, standard supported)	
34	Type tests Standards complied (List out)	

V. GUARANTEED TECHNICAL PARTICULARS FOR UNDER FREQUENCY RELAY:

S.no	Description	Guaranteed Specification
1	Make & Model	
2	Frequency setting range & accuracy	
3	Rate of change of frequency setting range with step & accuracy	
4	DC power supply operating voltage range	
5	Operating time	
6	Type tests complied (List out)	

VI. GUARANTEED TECHNICAL PARTICULARS FOR BAY CONTROL UNIT:

S.no	Description	Guaranteed Specification
1	Make & Model	
2	Auxiliary supply operating range	
3	Max Digital Input (Equipped)	
4	Max Digital Input (Feasible)	
5	Max Digital output (Equipped)	
6	Max Digital Output (Feasible)	
7	Rating of control output relays provided	
8	Max. Single indications	
9	Functionalities supported:	
a)	SOE (Mention resolution, record length)	
b)	Disturbance recorder (Mention resolution, record length, Sampling rate)	
c)	Metering - Four quadrant measurement?	
d)	Fault recorder (Resolution, storage capacity)	
e)	Self diagnostics (Equipped?)	
10	Operating system	
11	Data transmission speed supported	
12	Communication ports (Mention media, speed & protocol)	
13	Communication port for device configuration (Mention media)	
14	Time synchronisation interface equipped (Mention media, standard supported)	
15	Time to update the Digital event (Status change of Digital inputs etc) in the graphic display of BCU.	
16	Time to update the Analog measurand (Status change of Digital inputs etc) in the graphic display of BCU.	
17	Provision of sufficient protection in the BCU to protect from natural hazards viz lightning & thunder systems.	
18	Provision of Electrical isolation between all the functional boards and field connections.	
19	Operating temperature range	
20	Relative humidity -Operating range	
21	List out the type test standards complied by the BCU	

VII. GUARANTEED TECHNICAL PARTICULARS FOR GATEWAY EQUIPMENT:

S.no	Description	Guaranteed Specification
1	Make & Model No.	
2	Operating system	
3	Processing platform : (Embedded technology? Processing capacity etc)	
i	Memory for data (Type and capacity)	
ii	Memory for programm (Type and capacity)	
iii	Facility for programmable logic functionality	
iv	Maximum digital Input/Output Capabilities	
	Note :Mention for programme, data/records etc with type i.e non-voltaile/Flash etc.)	
4	Availability of communication ports (Mention media, protocol, data transmission speed)	
i	Towards Master Station's	
ii	Towards SAS LAN/Bay level LAN	
iii	For HMI interface(KB,Mouse,Monitor interface	
iv	Other ports (specify)	
5	Type tests Standards complied (List out)	

VIII. GUARANTEED TECHNICAL PARTICULARS FOR RELAY CABINETS

S.no	Description	Guaranteed Specification
1	Make & Model	
2	Cabinet dimension	
3	Thickness of cabinet	
a)	Weight bearing sides	
b)	Other sides	
4	Swing frame play in deg	
5	Outer Glass door thickness	
6	Degree of protection (IP ?)	
7	Paint shade	
a)	Exterior	
b)	Interior	
c)	Paint standard (IS-5?)	
8	Type tests complied (List out)	

IX. GUARANTEED TECHNICAL PARTICULARS FOR HMI Server & Engg. WS

S.no	Description	Guaranteed Specification	
		For HMI Server	For Engg. WS
1	Make & Model		
2	Power supply operating voltage range		
3	Processor		
4	RAM (Type & capacity)		
5	HDD (Type & capacity)		
6	DVD (Type & capacity)		
7	I/O Ports (Type & quantity)		
8	Clock speed & Bus speed		
9	Operating system		
10	Mounting (Rack mount?)		
11	Degree of protection (IP?) of computer hardware unit		
12	Operating temperature range		
13	Operating humidity range		
14	Vibration protection (Mention standard complied)		
15	Shock protection (Mention standard complied)		
16	Type tests complied (List out)		

SECTION-VIII : DEVIATION FROM TECHNICAL SPECIFICATION

All technical deviations from the specification shall be filled in by the Tenderer , clause by clause, in the Schedule.

SECTION NO	CLAUSE NO	DEVIATION

The tenderer hereby confirms that the above mentioned are the only deviations from the Technical Specification and the tender conforms to the specification in all other respects. Even for Nil deviation, this schedule is to be duly filled in and enclosed in the offer cover.

BIDDER SEAL

DATE

SIGNATURE

DESIGNATION

BIDDER NAME

SECTION-IX : STATEMENT OF TYPE TEST PARTICULARS

Sl.No.	Material and Name of Test	Name of Lab	Date of Test
1			
2			
3			
.			
.			

NOTE:

The above type tests should have been conducted in any reputed Laboratory within five (5) years from the date of Tender Opening.

BIDDER SEAL

DATE

SIGNATURE

DESIGNATION

BIDDER NAME

SECTION – 3

GENERAL TECHNICAL REQUIREMENTS

3.0 Foreword

The provision under this section is intended to supplement general requirements for the materials, equipment and services covered under other sections.

3.1 PROJECT INFORMATION AND SYSTEM PARAMETERS

- a) Customer : M/s Tamil Nadu Transmission Corporation Limited
- b) Project Title : 400/110 KV Substation at Thappagundu & 400/230/110 KV Substation at Anikadavu
- c) Transport facilities : Road/Rail
- d) Site location : THAPPAGUNDU IN THENI DISTRICT, MADURAI REGION & ANIKADAVU IN TIRUPPUR DISTRICT, COIMBATORE REGION

The following system parameters shall prevail:

Nominal system voltage	400 kV	230kV	110 kV
Highest system voltage	420 kV	245kV	132 kV
Frequency	50 Hz	50 Hz	50 Hz
Minimum creepage	25mm/kV	25mm/kV	25mm/kV
System Earthing	Effectively Earthed	Effectively Earthed	Effectively Earthed

SITE CONDITIONS

3.1.1 Ambient Temperature

- a) Ambient air temp. (max.) : 50 deg C
- B) Max Temp. for design : 50 deg C
- b) Ambient air temp. (min.) : 20 deg C
- c) Max, Daily average ambient air temp. : 45 deg C
- d) Max. yearly average ambient air temp. : 32 deg C

3.1.2 Max. humidity : 100% Max.

3.1.3 Average thunder storm days per annum : 50

3.1.4 Average rainy days per annum : 90

3.1.5 Average Annual rainfall : 1000 mm

- 3.1.6 No. of months during which tropical monsoon condition prevail: 5
- 3.1.7 Max, wind Pressure : 150kg/sqmm
- 3.1.8 Max wind speed : 39m/s
- 3.1.8 Altitude above MSL : 1000 m

However for design purpose, ambient temperature should be considered as 50° C and relative humidity as 100%.

AUXILIARY POWER SUPPLY

3 phase AC Supply	415V, 3 phase 4 wire 50 Hz, neutral grounded AC supply -15% to +10%
1 phase AC supply	240V, single phase, 50 Hz neutral grounded AC supply
DC supply	220, 2 wire DC supply + 10% to -15% 48V, 2 wire DC supply

3.2 GENERAL REQUIREMENT

3.2.0 ALL THE EQUIPMENTS /MATERIALS TO BE SUPPLIED SHOULD BE IN ACCORDANCE WITH RELEVANT LATEST / AMMENDED ISS /IEC, WHETHER IT HAS BEEN SPECIFICALLY MENTIONED IN THE SPECIFICATION OR NOT”.

3.2.1 The supplier shall also furnish drawings for the following:

All EQUIPMENTS and type of clamps, fitting hardware, insulators, bus bar. These designs/ drawing shall be got approved by the BHEL/TANTRANSCO before commencing the manufacture / construction / erection and are to be as per latest IS.

3.2.1 GENERAL:

- 3.2.1.1 The bidders shall be fully responsible for providing all equipment, materials system and services specified or otherwise which are required to complete the construction and successful commissioning of the substation in all respects.
- 3.2.1.2 Any other items not specifically mentioned in the specification but which are required for erection of materials/equipments under the scope of work, testing and commissioning are deemed to be included in the scope of the specification unless specifically excluded.
- 3.2.1.3 All items shall be supplied as per schedule and as specified in the relevant Indian standard of latest revision. The Technical specification of the main materials/equipments is furnished. The Technical specification contained herein for the materials are for the guidance of the tenderer.

- 3.2.1.4 The Tenderers are requested to procure the equipments/materials/component only from reputed /qualified manufacturer as per Technical requirement stipulated in Section - I of Technical specifications. Approval of make of item shall be taken up by vendor from TANTRANSCO himself.

3.3 SPECIFIC REQUIREMENT

- 3.3.1** The Supplier shall furnish make/manufacturer, catalogues, engineering data, and technical information, design documents, drawings etc., fully in conformity with the technical specification and get approval from competent authority before commencement of any work.

- 3.3.2** All steel materials, other than materials for earthing should be of galvanized if not specified.

3.4 SPECIFIC TECHNICAL REQUIREMENTS: / Drawing submission

The successful bidder shall submit all drawings and documents as per clause no. 3.29 along with the list of drawings within 7 days after placement of order to BHEL.

3.5 STANDARD:

The goods supplied under this contract shall conform to the standards mentioned in the Technical Specifications and when no applicable standard is mentioned, to the standard specified by the Institution of Central / State Government or internationally recognized Institutions shall be applicable and such standards shall be the latest issued by the concerned institution.

3.6 TEST CERTIFICATE:

Copies of all test certificates relating to material to be procured by the Supplier for the works shall be forwarded to BHEL.

3.7 Inspection clause :

- 3.7.1** The BHEL/TANTRANSCO or his representative shall have the right to inspect and/or test the goods /works to confirm their conformity to the supplier. BHEL/TANTRANSCO shall notify the supplier in writing of the identity of any representatives authorized for these purposes.

The inspections and tests may be conducted on the premises of the supplier or his Sub vendor at the point of delivery and /or at the goods' final destination. Where tests are conducted in the premises of Supplier, all reasonable facility and assistance including access to drawings and production data shall be furnished at no charge to the BHEL.

Should any inspected or tested goods fail to conform to specifications, the BHEL/TANTRANSCO may reject them and the supplier shall either replace the rejected goods or make all alterations necessary to meet specification requirements free of cost to the BHEL/TANTRANSCO within one week of intimation.

The BHEL/TANTRANSCO's right to inspect, test and where necessary reject the goods after the goods; arrival at the site, shall in no way be limited or waived by reason of the goods having been previously inspected. Tested and passed by the BHEL/TANTRANSCO or his representative prior to the goods dispatch.

3.7.2 Not less than 15 (Fifteen) days advance intimation shall be given about the quantity of materials that will be ready for inspection by the officers of TANTRANSCO/ BHEL/Third agency authorized by the Corporation. The materials should not be dispatched without instruction from the Corporation.

3.8 GUARANTEE:

3.8.1 The supplier shall guarantee that the goods under the Contract are new, unused of the most recent or current models and incorporated all recent improvements in design and materials unless provided otherwise in the Contract. The supplier shall further guarantee that the goods supplied under this Contract shall have no defects arising from design, materials or workmanship, installation and erection, if that may develop under normal use of the supplied goods. The supplier shall also guarantee the performance of the works executed by him including the performance of all the materials/goods supplied by him.

3.8.2 BHEL shall promptly notify supplier in writing of any claims arising under guarantee in respect of goods. Upon receipt of such notice, the supplier shall, with all reasonable speed, repair or replace the defective works or parts thereof, free of cost at site. All the expenses towards transportation of defective parts to supplier's works and of repaired/replaced parts to site shall be borne by the Supplier.

3.8.3 If the Supplier, having been notified, fails to remedy the defects within 14 days, the BHEL will proceed to take such remedial action as may be necessary, at the supplier's risk and expenses. All expenses in this regard will be recovered from Supplier.

3.9 PRE COMMISSIONING TESTING :(if applicable)

On completion of erection of equipments and before charging each item of equipments shall be thoroughly cleaned and inspected jointly by the TANTRANSCO and the BHEL for correctness and completeness of installation and acceptability for charging leading to initial pre commissioning test. The pre commissioning testing to be carried all equipments in the presence of Board Engineers. Necessary tools, testing kits are to be arranged by the Supplier.

3.10 PACKING:

3.10.1 The supplier shall provide such packing of the goods as is required to prevent their damage or deterioration during transit to their final destination as indicated in the Contract. The packing shall be sufficient to withstand, without limitation, rough handling during transit to their final destination as indicated in the Contract and exposure to extreme temperatures, salt and precipitation etc., during transport and open storage. Packing case size and weights shall be taken into consideration wherever appropriate, the remoteness of the 'goods' final destination and absence of heavy mechanized handling facilities, at all points in transit.

3.10.2 The packing, marking and documentation within and outside the package shall comply strictly with such special requirements as shall be expressly provided for in the Contract or in any subsequent instructions issued by BHEL.

3.11 COLOUR SCHEME AND CODES FOR PIPE SERVICE/PANELS

The supplier shall propose a color scheme for those equipment/Items for which the colour scheme has not been specified in the specification for the approval of BHEL/TANTRANSCO. The decision of BHEL/TANTRANSCO shall be final. The scheme shall include:

Finishing colour of Indoor equipment

Finishing colour of Outdoor equipment.

Finish colour of all cubicles.

Finishing colour of various auxiliary system equipment including piping

Finishing colour of various building items.

All the steel works shall be thoroughly cleaned of rust , scale , oil , grease, dirt and scarf by pickling , emulsion cleaning , etc. The sheet steel shall be phosphated /oven dried and then painted with two coats of zinc rich primer paints . After application of the primer, two coats of finished synthetic enamel paint shall be applied. The colour of the finished coats inside shall be glossy white and exterior of the treated sheet steel shall be shade 631 of IS 5 /RAL 7032 for all switchboard /MCC/distribution board , control panels etc.

Sufficient quantities of touch paint shall be furnished for application at site. All the indoor cubicles shall be the same as exterior surface and for other miscellaneous items, colour scheme will be approved by the BHEL/TANTRANSCO.

3.12 SURFACE FINISH

All interiors and exteriors of tanks, control cubicles and other metal parts shall be thoroughly cleaned to remove all rust, scales, corrosion, greases or other adhering foreign matter. All steel surfaces in contact with insulating oil as far as accessible, shall be painted with not less than two coats of heat resistant, oil insoluble, insulating paints.

All metal surfaces exposed to atmosphere shall be given two primer coats of zinc chromate and two coats of epoxy paint with epoxy base thinner. All metal parts not accessible for painting shall be made of corrosion resisting material. All machine finished or bright surfaces shall be coated with a suitable preventive compound and suitably wrapped or otherwise protected. All paints shall be carefully selected to withstand tropical heat and extremes of weather within the limit specified. The paint shall not scale off or wrinkle or be removed by abrasion due to normal handling.

3.13 PROTECTION

All coated surfaces shall be protected against abrasion, impact, discoloration and any other damages. All exposed threaded portions shall be suitably protected with either a metallic or a non-metallic protecting device. All ends of all valves, pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

All equipment accessories and wiring shall have fungus protection, involving special treatment of insulation and metal against fungus, insects and corrosion. The parts which are likely to get rusted, due to exposure to weather should also be properly treated and protected in a suitable manner. Screens of corrosion resistant material shall be furnished on all ventilating louvers to prevent entry of insects.

3.14 FUNGI-STATIC VARNISH

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on the parts, which may be subjected or predisposed to the formation of fungi due to the presence or deposit of nutrient substances. The varnish shall not be applied to any surface of part where the treatment will interface with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application to the varnish.

3.15 GALVANIZING

All nuts and pins shall be adequately locked. Nuts, bolts and pins used inside the transformer and tap-changer compartment where gaskets are not used shall be provided with spring washers or locknuts. Where galvanizing is specified, it shall be applied by the hot dipped process or by electro-galvanizing process and for all parts, other than steel wires, shall consist of a thickness of zinc coating equivalent to not less than 610 gm of zinc per square metre of surface. The zinc coating shall be smooth, of uniform thickness and free from defects.

3.16 DEGREE OF PROTECTION

The supplier shall propose following Degree of protection for those equipment/Items for which the degree of protection has not been specified in the specification for the approval of BHEL/TANTRANSCO. The decision of BHEL/TANTRANSCO shall be final. The enclosures of the Control Cabinets, Junction boxes and Marshalling boxes panels etc to be installed shall be provided with degree of protection as detailed here under:

- a) Installed outdoor: IP-55

- b) Installed indoor in air conditioned area: IP-42
- c) Installed in covered area IP:52
- d) For LT switchgear (AC & DC distribution Boards): IP-54

The degree of protection shall be in accordance with IS:13947, (Part-1)/IEC-947(Part-1). Type test report/or degree of protection test on each type of the box shall be submitted for approval.

3.17 RATING PLATES, NAME PLATES AND LABELS

Type or serial number together with details of the loading conditions under which the item of the substation in question has designed to operate and such diagram plates as may be required by the BHEL/TANTRANSCO. The rating plate for each equipment shall be according to IEC requirements.

Alternately two separate plates one with Hindi and other with English inscriptions may be provided.

During approvals drawings of Rating/name plates/lables shall also be submitted.

3.18 EARTHING

Circuit breakers, LA, Isolator, CVT, CT, BPI shall be provided with two grounding pads suitable for connection to galvanized steel flat. Control panels, Relay panel, outdoor marshalling boxes, Junction boxes, Lighting panels and distribution board shall be provided with two grounding pads, for connection to galvanized steel flat. The two pads shall be provided, one each at the middle of the two opposite sides of the bottom frame of the equipment. Earthing of hinged door shall be done by using a separate earth wire.

3.19 TERMINAL BLOCKS AND WIRING

Control and instrument leads from the switchboards or from other equipment will be brought to terminal boxes or control cabinets in conduits. All Inter-phase and external connections to equipment or to control cubicles will be made through terminal blocks.

Terminal blocks shall be 1100 V grade and have continuous rating to carry the maximum expected current on the terminals. Those shall be of moulded piece complete with insulated barriers stud type terminals, washers, nuts and lock nuts. Screw clamp, overall insulated, insertion type, rail mounted terminals can be used in place of stud type terminals. But preferably the terminal blocks shall be non-disconnecting stud type equivalent to Elmex type CATM4, Phoenix cage clamp type of Wedge or equivalent. The Insulating material of terminal block shall be nylon 6.6 which shall be free of halogens, fluorocarbons etc.

Terminal block for current transformer and voltage transformer secondary leads shall be provided with test links and isolating facilities. The current transformer secondary leads shall also be provided with short circuiting and earthing facilities.

The terminal shall be that maximum contact area is achieved when a cable is terminated. The terminal shall have a locking characteristic to prevent cable from escaping from the terminal clamp unless it is done intentionally. The conducting part in contact with cable shall preferably be tinned or silver plated however Nickel plated copper or zinc plated steel shall also be acceptable. The terminal blocks shall be of extensible design. The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.

The terminal blocks shall be fully enclosed with removable covers of transparent, non deteriorating type plastic material. Insulating barriers shall be provided between the terminal blocks. These barriers shall not hinder the operator from carrying out the wiring without removing the barriers.

Unless otherwise specified terminal blocks shall be suitable for connecting the following conductors on each side.

All circuits except CT circuits :	Minimum of 2 nos. of 2.5 sq.mm,copper flexible.
All CT circuits :	Minimum of 4 nos. of 2.5 sq.mm, copper flexible..

The arrangements shall be in such a manner so that it is possible to safely connect or disconnect terminals on live circuits and replace fuse links when the cabinet is live. At least 20 % spare terminals shall be provided on each panel/cubicle/box and these spare terminals shall be uniformly distributed on all terminals rows.

There shall be a minimum clearance of 250mm between the first bottom row of terminal block and the associated cable gland plate. Also the clearance between two rows of terminal blocks shall be a minimum of 150 mm. The Supplier shall furnish all wire, conduits and terminals for the necessary inter-phase electrical connection (where applicable) as well as between phases and common terminal boxes or control cabinets.

All input and output terminals of each control cubicle shall be tested for surge withstand capability in accordance with the relevant IEC Publications, in both longitudinal and transverse modes. The supplier shall also provide all necessary filtering, surge protection, interface relays and any other measures necessary to achieve an impulse withstand level at the cable interfaces of the equipment.

TB sizes for incoming power supply shall be informed/confirmed during drawing approval stage.

TBs should be suitable for cable sizes all cable sizes.

3.20 CONTROL CABINETS, JUNCTION BOXES, TERMINALS BOXES AND MARSHALLING BOXES FOR OUTDOOR EQUIPMENTS

All types of boxes, cabinets etc. shall generally conform to and be tested in accordance with IS-5039, IS-8623 or IEC-439, as applicable and the clause given below.

Control cabinet, Junction boxes, Marshalling boxes & Terminal boxes shall be made of sheet steel. Sheet steel used shall be at least 3.0 mm thick cold rolled or 3 mm hot rolled. The box shall be properly braced to prevent wobbling. There shall be sufficient reinforcement to provide level surfaces, resistance to vibrations and rigidity during transportation and installation. Cabinet/boxes shall be free standing floor mounting type, wall mounting type or pedestal mounting type as per requirements.

Cabinet /boxes shall be provided with double hinged doors with padlocking arrangements. The distance between two hinges shall be adequate to ensure uniform sealing pressure against atmosphere. The quality of gaskets shall be such that it does not get damaged/cracked during the operation of the equipment.

All door, removable covers and plates shall be gasketed all around with suitably profiled Neoprene gaskets. The gasket shall be tested in accordance with approved quality plan. The quality of gasket shall be such that it does not get damaged /cracked during the years of the equipment or its major overhaul whichever is earlier. All gasketed surfaces shall be smooth, straight and reinforced if necessary to minimize distortion and to make a tight seal. Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass.

All boxes/cabinets shall be designed for the entry of cables from bottom by means of weather proof and dust-proof connections. Boxes and cabinets shall be designed with generous clearances to avoid interference between the wiring entering from below and any terminal blocks or accessories mounted within the box or cabinet. Suitable cable gland plate projecting atleast 150 mm above from the base of the Marshalling Kiosk/box shall be provided for this purpose along with the proper blanking plates. Necessary number of cable glands shall be supplied and fitted on this gland. The gland shall project atleast 25mm above gland plate to prevent entry of moisture in cable crutch. Gland plate shall have provision for some future glands to be provided later, if required

3.21 SPACE HEATERS

The heater shall be suitable for continuous operation at 240 V AC supply voltage and shall be provided with on – off switch and fuse shall be provided for heater.

One or more adequately rated, thermostatically connected heaters shall be supplied to prevent condensation in any compartment.

3.22 DELIVERY OF GOODS AND DOCUMENTS RELATED THERETO:

Delivery of goods shall be made by the supplier in accordance with the terms specified by the BHEL in its schedule of requirements.

3.23 INCIDENTAL SERVICES:

The Supplier is required to provide any or all the services broadly outlined in the Technical specification. Any other minor incidental service related to the scope of work like providing necessary assistance whether specifically mentioned or not must be carried out by the

Supplier at his own cost. All tools, Tackles Plant etc., required for completion of above works shall be brought by the Supplier.

3.24 DISCREPANCIES BETWEEN DRAWING AND SPECIFICATION:

Should there be any discrepancy between the specifications and/or schedule of prices and/or drawings or any inconsistency, error or omission in either of them, reference must be made to the BHEL/TANTRANSCO for an explanation and the Supplier will be held responsible for any errors that may occur in the work through neglect of this precaution. The explanation of the BHEL/TANTRANSCO shall be final and binding on the Supplier.

3.25 APPROVAL PROCEDURE

The scheduled dates for the submission of drawings as well as for, any data/information to be furnished by the Employer would be as per the following schedule. The supplier shall also submit required no. of copies as mentioned in this specification of all drawings/design documents/test reports for approval by the Employer. The following schedule shall be followed generally for approval.

i.	First Submission	7 days after LOI/PO
ii.	Approval/comments/by employer on Initial submission	Reasonable time
iii.	Resubmission	Within 7 days (whenever from date of comments required) Including both ways postal time.
iv.	Approval or comments	Within 2 weeks of receipt of resubmission.
v.	Furnishing of distribution copies	2 weeks from the date of last approval.

Note: The supplier may please note that all resubmissions must incorporate, all comments given in the submission by the Employer failing which the submission of documents is likely to be returned. Every revision shall be a revision number, date and subject, in a revision block provided in the drawing, clearly marking the changes incorporated.

The title block of drawings shall contain the following information incorporated in all contract drawings. Please refer enclosed sheet for details of Title block.

3.26 TITLE BLOCK

Following Title Blocks to be used in drawings at the time of drawing approvals

For Thappagundu

Customer	M/s Tamil Nadu Transmission Corporation Limited
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Project:	400/110 KV Substation at Thappagundu
Contractor	BHEL

For Anikadavu

Customer	M/s Tamil Nadu Transmission Corporation Limited
Project:	400/230-110 KV Substation at Anikadavu
Contractor	BHEL

3.27 DOCUMENTS TO BE SUBMITTED ALONGWITH OFFER

- 1) Drawings
- 2) Guaranteed Technical Particulars
- 3) Type Test Reports
- 4) List of Part Supplies with rating

Drawings & Documents submitted at the time of offer shall be subject to review at contract stage.

3.28 DOCUMENTATION SCHEDULE

Following Documentation schedule to be followed per project.

S. No.	DESCRIPTION	TENDER STAGE	CONTRACT STAGE FOR APPROVAL	FINAL DOCUMENTATION	
				Prints	CDs
1	Drawings and Data Sheets	1	7	10	5
2	Drawings "As Built "	-	-	10	
3	Type Test Reports	1	7	10	
4	Erection Manuals	-	7	10	
5	Operation and Maintenance Manuals	-	7	10	
6	Manufacturing Quality Plan	-	7	10	
7	Field Quality Plan	-	7	10	
8	Inspection Test Reports	-	7	10	

Note: Drawings will also be submitted in CD/DVD in Latest AUTOCAD-2004 or Later version or any other CAD package along with conversion files for all major items.

Final Documentation shall be submitted in bound volumes with details of Customer & Project etc. written on top.

APPENDIX-A

SCHEDULE OF TECHNICAL DEVIATION

The following are the deviations/variations/exceptions from the specification:

SECTION	CLAUSE NO. / PAGE NO.	STATEMENT OF DEVIATION / VARIATIONS / EXCEPTIONS

In case, this schedule is not submitted, it will be presumed that the equipment /material to be supplied under this contract is deemed to be in compliance with the specification.

If there is NIL deviation, even then the format to be filled as **NIL DEVIATION**

Note: Continuation sheets of like size and format may be used as per the Bidder's Requirement and shall be annexed to this schedule.

Place

Signature of the authorized representative of

Date

Bidder's name

Designation

Company seal

APPENDIX-B

BIDDER'S UNDERTAKING FOR TYPE TEST REPORTS

Bidder shall take type test report, MQP, and drawing approval from TANTRANSCO without any commercial / delivery implication to BHEL. In case type test reports are not acceptable to customer due to any technical reason, the same shall be conducted free of cost.

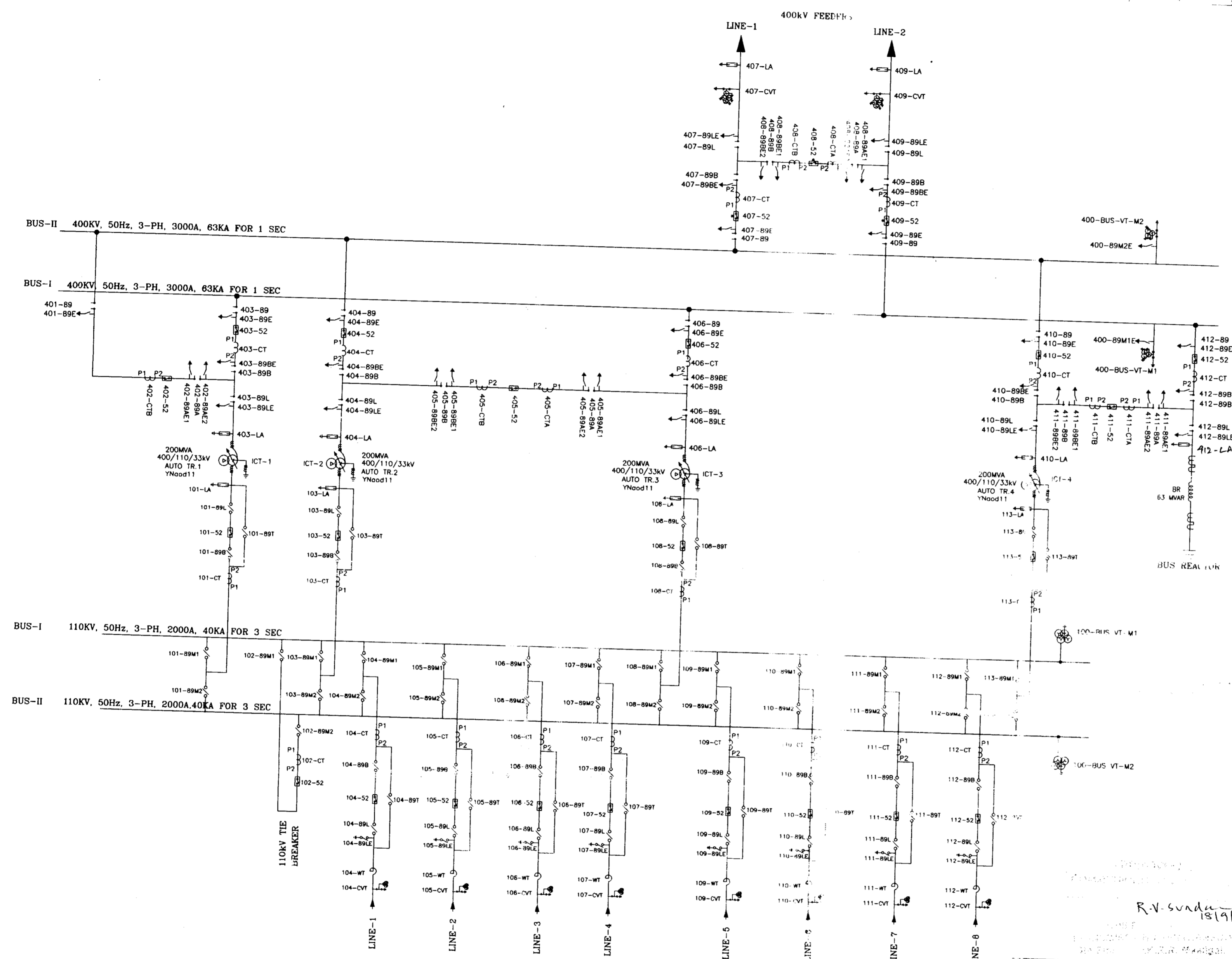
Place Signature of the authorized representative of

Bidder 'name-----

Date

Designation-----

Company seal -----



400kV MAIN EQUIPMENTS BILL OF QUANTITY

S.L.	ITEM DESCRIPTION	SYMBOL	ABR	QTY.
1.	200 MVA, 3 PHASE 50Hz, 400 / 110 / 33 KV YNood11, ONAN/ONAF/ODAF, AUTO TRANSFORMER		ICT	04
2.	63 MVAR, 400KV REACTOR WITH GROUNDING TRANSFORMER		BR	01
3.	400 KV, 3150 A, 63 KA OUTDOOR SF6 CIRCUITBREAKER		52	08
4.	400 KV, 3150 A, 63 KA OUTDOOR SF6 CIRCUITBREAKER WITH PRE INSERTION RESISTOR (FOR OUT GOING LINES)		52	03
5.	400 KV, 3150 A, 63 KA, 5 CORE, 5 WIRE PHASE		WT	42
6.	590 KV LIGHTNING ARRESTER		LA	21
7.	400 KV 4400pF SINGLE PHASE CVT		CVT	12
8.	420 KV, 3150 A, 63KA ISOLATOR WITH DOUBLE EARTH SWITCH		89E1 89E2	07
9.	420 KV, 3150 A, 63 KA ISOLATOR WITH SINGLE EARTH SWITCH		89	22
10.	420 KV BUS EARTH SWITCH (SINGLE PHASE)		89E	06

110kV MAIN EQUIPMENTS BILL OF QUANTITY

S.L.	ITEM DESCRIPTION	SYMBOL	ABR	QTY.
11.	132 KV, 2000A, 40 KA OUTDOOR SF6 CIRCUITBREAKER		52	13
12.	132 KV, 2000 A, 40 KA, 5 CORE SINGLE PHASE CURRENT TRANSFORMER		CT	39
13.	132 KV, 2000 A, 40 KA ISOLATOR WITH SINGLE EARTH SWITCH		89E	05
14.	132 KV, 2000 A, 40 KA ISOLATOR WITHOUT EARTH SWITCH		89	54
15.	96 KV LIGHTNING ARRESTER		LA	12
16.	110 KV SINGLE PHASE 3 CORE BUS VT		VT	06
17.	110 KV 3200pF SINGLE PHASE CVT		CVT	08
18.	110 KV, 0.5 MH, 2000A WAVE TRAP		WT	08

MAIN SYSTEM PARAMETERS:-

NOMINAL VOLTAGE	400 kV	110 kV
HIGHEST SYSTEM VOLTAGE	420 kV	132 kV
BIL	1425 kVp	550 kVp
POWER FREQUENCY WITHSTAND VOLTAGE FOR 1MIN	630 kV	230 kV
CREEPAGE	10500 mm	3625 mm
SHORT CIRCUIT CAPABILITY	63kA/1s	40kA/3s

LEGEND FOR EQUIPMENT IDENTIFICATION
 XXX-ZZA
 EQUIPMENT SEQUENCE NO. IF ROD.
 EQUIPMENT ABBREVIATION
 BAY SEQUENCE NO.
 VOLTAGE LEVEL 4 FOR 400KV
 AND 1 FOR 110KV

NOTE:-
 1. CVT AND WAVE TRAP IN 110KV LINES SHALL BE PROVIDED IN ONE PHASE ONLY.
 PHASE ON WHICH WAVE TRAP AND CVT SHALL BE MOUNTED TO BE CONFIRMED BY TANTRANSCO.

ADDITIONAL INFORMATION
 W.O.No. 83003

STATUS OF DRAWING
 DISTRIBUTION OF PRINTS

आसक/परियोजना का नाम TAMILNADU TRANSMISSION CORP. LTD.
 NAME OF CUSTOMER/PROJECT
 400/110kV SUBSTATION AT THAPPAGUNDU

NAME OF CONSULTANT

भारत हेवी इलेक्ट्रिकल्स लिमिटेड
 भारत भारती इलेक्ट्रिकल्स लिमिटेड
 भारती भारती इलेक्ट्रिकल्स लिमिटेड
 BHARAT HEAVY ELECTRICALS LTD.
 TRANSMISSION PROJECTS DIVISION

रिजि. कोड / DEPT. CODE
 उगुपात / SCALE
 कर्ड कोड / CARD CODE

सिंगल लाइन डायग्राम फॉर 400/110kV SUBSTATION THAPPAGUNDU

ड्राइंग नं./DRAWING NO. TB-2-363-510-001
 पृष्ठ नं./SHEET No 01

REV.	DATE	ALTERED	CHECKED	APPROVED	REV.	DATE	ALTERED	CHECKED	APPROVED

R.V. Sundar
 18/11/11

CORE WISE DETAILS OF 420KV CURRENT TRANSFORMERS (3000-2000-1000-500/1-1-1-1-1A)

NO. OF CORES	APPLICATION	CURRENT RATIO	MIN. OUTPUT BURDEN (VA)	ACCURACY CLASS AS PER IEC-60044-1	MIN. KNEE POINT VOLTAGE (VK) (VOLTS)	MAX. CT. SEC. WINDING RESISTANCE (Ohms)	MAX. EXCITING CURRENT @ KNEE POINT VOLTAGE VK (MA)	REMARKS
CORE 1	MAIN-I PROTECTION	3000/1 2000/1 1000/1	-	PS	3000/1 2000/1 1000/1	15 10 5	20mA ON 3000/1 TAP 30mA ON 2000/1 TAP 60mA ON 1000/1 TAP	N.A
CORE 2	MAIN-II PROTECTION	3000/1 2000/1 1000/1	-	PS	3000/1 2000/1 1000/1	15 10 5	20mA ON 3000/1 TAP 30mA ON 2000/1 TAP 60mA ON 1000/1 TAP	N.A
CORE 3	METERING MAIN	3000/1 2000/1 1000/1 500/1	20 20 20 20	0.2 0.2 0.2 0.2	N.A	-	N.A.	ISF ≤ 5
CORE 4	BUS DIFF. MAIN	3000/1 2000/1 1000/1	-	PS	3000/1 2000/1 1000/1	15 10 5	20mA ON 3000/1 TAP 30mA ON 2000/1 TAP 60mA ON 1000/1 TAP	N.A
CORE 5	BUS DIFF. CHECK	3000/1 2000/1 1000/1	-	PS	3000/1 2000/1 1000/1	15 10 5	20mA ON 3000/1 TAP 30mA ON 2000/1 TAP 60mA ON 1000/1 TAP	N.A

CORE WISE DETAILS OF 132KV CURRENT TRANSFORMERS (2000-1200-800-400/1A (5Core))

NO. OF CORES	APPLICATION	CURRENT RATIO	MIN. OUTPUT BURDEN (VA)	ACCURACY CLASS AS PER IEC-60044-1	MIN. KNEE POINT VOLTAGE (VK) (VOLTS)	MAX. CT. SEC. WINDING RESISTANCE (Ohms)	MAX. EXCITING CURRENT @ KNEE POINT VOLTAGE VK (MA)	REMARKS
CORE 1	METERING	2000/1 1200/1 800/1 400/1	20 20 20 20	0.2 0.2 0.2 0.2	N.A	N.A.	N.A.	ISF ≤ 5
CORE 2	MAIN-I PROTECTION	2000/1 1200/1 800/1 400/1	N.A	PS	2000V @ 2000/1 A	12 OHMS @ 2000/1A	30 mA @ 2000/1 A	N.A
CORE 3	METERING-II MAIN <i>Basic up protection</i>	2000/1 1200/1 800/1 400/1	N.A	PS	2000V @ 2000/1 A	12 OHMS @ 2000/1A	30 mA @ 2000/1 A	NA
CORE 4	BUS DIFF. MAIN	2000/1 1200/1	-	PS	2000V @ 2000/1 A	12 OHMS @ 2000/1A	30 mA @ 2000/1 A	NA
CORE 5	BUS DIFF. CHECK	2000/1 1200/1	N.A	PS	2000V @ 2000/1 A	12 OHMS @ 2000/1A	30 mA @ 2000/1 A	NA

400KV CVT (LINE/BUS) DETAILS:-

WINDING NO.	RATED VOLTAGE	RATIO	RATED BURDEN	ACCURACY	PURPOSE
I	400KV / $\sqrt{3}$	110V / $\sqrt{3}$	100VA	3P	PROTECTION
II	400KV / $\sqrt{3}$	110V / $\sqrt{3}$	100VA	3P	PROTECTION
III	400KV / $\sqrt{3}$	110V / $\sqrt{3}$	100VA	0.2	METERING

110KV LINE CVT / BUS-VT DETAILS:-

WINDING NO.	RATED VOLTAGE	RATIO	RATED BURDEN	ACCURACY	PURPOSE
I	110KV / $\sqrt{3}$	110V / $\sqrt{3}$	100VA	3P	PROTECTION
II	110KV / $\sqrt{3}$	110V / $\sqrt{3}$	100VA	3P	PROTECTION
III	110KV / $\sqrt{3}$	110V / $\sqrt{3}$	100VA	0.2	METERING

NOTE:-

- THE ACCURACY OF 0.2 ON SECONDARY-III SHOULD BE MAINTAINED THROUGHOUT THE ENTIRE BURDEN RANGE UPTO 100VA ON ALL THE WINDINGS.

APPROVED &
COMMUNICATION VIDE Lt. No:

R.V. svadka 18/11/23

CHIEF ENGINEER

TRANSMISSION / TANTRANSCO
6th Floor, N.P.K.R.R. Marigai,
144, Anna Salai, Chennai-600 002.

NAME OF CUSTOMER/PROJECT: TAMAILNADU TRANSMISSION CORP. LTD
400/110KV SUBSTATION AT THAPPAGUNDU

NAME OF CONSULTANT: BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION PROJECTS DIVISION

DATE: 18/11/23

REVISIONS: 01

PROJECT NO: TB-2-363-510-001

SHEET NO: 02

TOTAL SHEETS: 08