



BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS ENGINEERING MANAGEMENT

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TYPE OF DOC.	TECHNICAL SPECIFICATION	NAME	RD	VK	VK
TITLE SUB-STATION AUTOMATION SYSTEM		SIGN	<i>[Signature]</i>	<i>[Signature]</i>	<i>[Signature]</i>
		DATE	20/09/13	22/9/13	
		GROUP	TBEM	W.O. No	86009
CUSTOMER/ CONSULTANT	Tamilnadu Transmission Corporation Limited (TANTRANSCO)				
PROJECT	765/400kV AIS S/S Ariyalur				

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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 765 & 400kV Substation automation System along with Control & Protection Panels at 765/400kV TANTRANSCO Ariyalur Substation complete with accessories as listed in this specification. Testing and Commissioning of all SAS equipments including Protective relays shall be done by the OEM Engineer.

The fitments 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 comprises of following sections:

- Section-1: Scope, Specific Technical Requirements and Quantities
- Section-2: Equipment Specification
- Section-3: Project Details & General Technical Requirements
- Section-4: Enclosures to Technical Specification

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

Note: The terms used in this specification namely, "Employer/Purchaser" refers to TANTRANSCO & "Contractor/Sub-contractor/manufacturer" refers to successful bidder.

2.0 THE EQUIPMENT IS REQUIRED FOR THE FOLLOWING PROJECT

Name of Customer: Tamilnadu Transmission Corporation Limited (TANTRANSCO)

Name of the Project: 765/400kV AIS S/S at Ariyalur

Refer Section - 3 for Project Details and General Specifications.

3.0 SPECIFIC TECHNICAL REQUIREMENTS

- 3.1 Refer Section-2 and Single Line Diagrams & Key Protection and Metering Single Line Diagram Enclosed with Section-4.

{ The Key Protection and Metering Single Line Diagram is for tender purpose only }

3.2 a) Complete Substation automation system based on IEC 61850 communication protocol including hardware and software along with associated equipments for the 765 and 400kV bays as shown in the SLD plus 3 Nos. spare feeders for each of the 765 and 400kV system.

b) For the 765 and 400kV Circuit Breakers with Controlled Switching Device (Please refer project SLD attached along with Technical Specification for clarity), the CSD controller (being supplied under a separate contract) shall be mounted on the respective relay panels in Switchyard Panel Room/Kiosk. Necessary space shall be considered in the panel. The actual dimension of the CSD controller & required logic to be incorporated in panel schematic for interfacing the CSD with panel shall be furnished to successful bidder during detailed engineering. The contact multipliers, selector switch & contactors if required for implementation of the CSD logic shall be in bidder's scope of supply under this tender.

c) Further, the integration of IEC 61850 communication protocol-based monitoring equipments like ~~Online dissolved Gas analyzer, Insulating Oil drying system~~, Online Bushing Monitoring System, Digital RTCC, Optical temperature sensors provided on each of the 1-ph 765/400/33 kV ICT/ 765kV Reactor (Line/Bus) Units (being supplied under a separate contract) with the offered SAS is also included in the present scope of the bidder.

For the purpose of interfacing of offered SAS with ICT/Reactor, any necessary co-ordination with the respective equipment suppliers for completion of the SAS shall be in bidder's scope.

d) 1-ph 765/400/33 kV ICT/ 765kV Reactor (Line/Bus) Units are being provided with ~~Online dissolved Gas analyzer, Insulating Oil drying system~~, Online Bushing Monitoring System, Digital RTCC, Optical temperature sensors. These equipments shall be IEC 61850-compliant & required to be integrated with the offered Substation Automation System (SAS). Above equipment, being supplied in separate packages, shall be connected to Managed Ethernet Switches compliant to IEC 61850 communication protocol through fiber optic cable. This Ethernet switches shall be mounted in Common Marshalling Box (CMB) of the Transformer/Reactor. However, to connect this Ethernet switch to Bay Ethernet switch (mounted in relay panel in SPR/Kiosk), all accessories and Optical fiber cable from CMB to relay room shall be in the scope of Bidder under this tender. The tentative signals from Optical sensors measuring unit ~~and online DGA~~ for each single phase transformer/reactor are as follows:

- i) Temperature measured by optical sensors (8 probes for each reactor & 16 probes for each transformer)
- ii) ~~H₂, CH₄, C₂H₆, C₂H₄, C₂H₂, CO, CO₂, O₂, and H₂O gas content~~
- iii) Alarm, watchdog from the monitoring equipments

Approx. distance between CMB and Switchyard Panel Room shall be 650m.

The Actual requirement of FO/Twisted cable for integration of ~~Online dissolved Gas analyzer, Insulating Oil drying system~~, Online Bushing Monitoring System, Digital RTCC, Optical temperature sensors etc shall be finalised during detailed engineering.

e) The FO cable requirement mentioned in BOQ is tentative. The FO cable supply is in scope of bidder as per actual requirement.

f) The bidder's scope shall include all primary equipment interface with control & relay Panel /SAS in the respective panel schematics during drawing submission at contract stage.

g) Wherever bidder offers any spare 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.

4.0 TECHNICAL REQUIREMENTS:

The manufacturer whose Control, Relay & Protection System (Control & Protection Intelligent Electronic Devices IEDs) and Sub-station Automation System are offered should have designed, manufactured, tested, installed and commissioned Control, Relay & Protection system along with Sub-station Automation System which must be in satisfactory operation on 400 kV or above system for at least 2 (two) years as on 31.03.2017.

AND

The Manufacturer or their joint venture or subsidiary company must have established repair, testing and integration facilities for Control, Relay & Protection System and Sub-station Automation System in India.

5.0 TRAINING :

The bidder shall impart training to Employer's Personnel as mentioned in section-2.

The charges for tutorials & other training materials for the trainees shall be included in the prices quoted by bidder. No price implication shall be entertained at a later stage.

However, the travel lodging, & boarding expenses of employers personnel, if any shall be done by Employer.

6.0 PRECOMMISSIONING & COMMISSIONING

PRE-COMMISSIONING: As per requirements specified in Section-2.

COMMISSIONING :

Charging of the facilities at rated voltage. Further, wherever appearing in this specification, the words - 'commissioning checks', 'installation checks', 'site tests', 'Performance guarantee tests', are to be considered as 'pre commissioning checks'.

7.0 BILL OF QUANTITIES

7.1 As per annexure-A, Section-1.

7.2 UNIT PRICE OF ALL THE CONTROL, PROTECTION, SAS, DFR, PMU, TWFL AND METERING FITMENTS

The addition/ deletion to the scope shall be as per the break-up unit rates for all the control, protection, SAS, DFR, PMU, TWFL and metering fitments furnished with the offer.

8.0 TYPE TEST

All equipment being supplied shall conform to type tests including additional type tests as per technical specification and shall be subject to routine tests in accordance with requirements stipulated under respective sections. The reports for all type tests and additional type tests as per technical specification shall be furnished by the bidder alongwith equipment / material drawings. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited base on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by the representatives(s) of TANTRANSCO. The test reports submitted shall be of the tests conducted within last **10 (ten) years prior to the date of originally scheduled bid opening (i.e 30.09.2016)**. In case the test reports are of the test conducted earlier than 10 (ten) years prior to **30.09.2016**, the bidder shall repeat these test(s) at no extra cost to the purchaser.

In the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design / manufacturing changes (including substitution of components) or due to non-compliance with the requirement stipulated in the Technical Specification or any/all additional type tests not carried out, same shall be carried out without any additional cost implication to the Purchaser.

9.0 DEVIATIONS :

The bidder shall list all the deviation from the specification separately. Offers without specific deviation will be deemed to be totally in compliance with the specification and NO DEVIATION on any account will be entertained at a later date.

10.0 MANUFACTURING QUALITY PLAN:

Bidder has to follow TANTRANSCO approved Manufacturing Quality Plan, SAT /FAT procedure at contract stage.

11.0 DRAWINGS and SCHEME

The documentation requirements detailed under Section-2 and 3 shall be submitted to BHEL at various stages of contract. Softcopy of the drawings and schemes are to be submitted at contract stage. Preparation of AS- BUILT drawings is also in the scope of the bidder.

12.0 DOCUMENTS REQUIRED WITH OFFER

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

BILL OF QUANTITIES			
Sl.No.	Description	Unit	Qty.
A)	Main Items:		
1	Relay Panel for 765 kV Line Feeder	Set	4
2	Relay Panel for 765 kV Line Reactor	Set	4
3	Relay Panel for 765/400/33 kV ICT (Both HV & IV side)	Set	2
4	Relay Panel for 765 kV Bus Reactor	Set	2
5	Relay Panel for 765 kV Tie Bay (for full diameter)	Set	3
6	Relay Panel for 765 kV Tie Bay (for half diameter)	Set	2
7	765 kV De-centralised Numerical Busbar Protection Panel (Single Busbar Protection)	Set	2
8	Islanding Relay Panel for 765 kV System	Set	1
9	Relay Panel for 400 kV Line Feeder	Set	6
10	Relay Panel for 400 kV Tie Bay (for full diameter)	Set	3
11	Relay Panel for 400 kV Tie Bay (for half diameter)	Set	2
12	400 kV De-centralised Numerical Busbar Protection Panel (Single Busbar Protection)	Set	2
13	Islanding Relay Panel for 400 kV System	Set	1
14	Sub-station Automation System (SAS) for 36 Bays	Lot	1
15	DFR (Disturbance & Fault Recorder) system with PMU and Travelling-Wave-Fault-Locator (TWFL) complete with all devices and separate workstation for all the 765 and 400kV feeders (to be compatible and communicable with other end DFR system)	Lot	1
16	ADSS cable (24 fibre) with HDPE pipe	kM	10
B)	Testing Instruments:		
1	Computerised Relay Test Kit	Set	1

Sl.No.	Description	Unit	Qty.
C)	Mandatory Spares:		
1	Bay Control Unit for 765kV (with Maximum Configuration used in 765kV Bays of the offered system)	No.	1
2	Bay Control Unit for 400kV (with Maximum Configuration used in 400kV Bays of the offered system)	No.	1
3	Numerical Main-1 Distance Protection Relay for 765kV Line Feeder	No.	1
4	Numerical Main-2 Distance Protection Relay for 765kV Line Feeder	No.	1
5	Numerical Main-1 Distance Protection Relay for 400kV Line Feeder	No.	1
6	Numerical Main-2 Distance Protection Relay for 400kV Line Feeder	No.	1
7	Numerical Main-1 Protection Relay for 765/400kV ICT	No.	1
8	Numerical Main-2 Protection Relay for 765/400kV ICT	No.	1
9	Numerical Relay for Busbar Protection - Central Unit	Set	2
10	Numerical Relay for Busbar Protection - Peripheral Unit	Set	2
11	Ethernet Switch for One Diameter plus 50% spare ports (with Maximum Configuration used in one diameter of the offered system)	No.	4
12	Ethernet Switch for Main Control Room plus 50% spare ports (with Maximum Configuration used in main control room of the offered system)	No.	1
13	Electronic Tri-Vector Meter (ABT)	No.	1
14	Automatic DC Selection Relay	No.	4
15	Master Trip Relay (86)	No.	4
16	Master Trip Relay (96) for Busbar Protection	No.	4
17	T-N-C Switch	No.	2
18	PT Selection Relay/ Switch	No.	2

Sl.No.	Description	Unit	Qty.
19	DC Supply Supervision Relay	No.	2
20	Trip Circuit Supervision Relay	No.	4
21	Single-Phase Trip Relay (With Self-Reset Contacts)	No.	2
22	Selector Switch for L/R Selection	No.	2
23	Selector Switch for A/R IN/OUT Selection	No.	2
24	Selector Switch for Carrier IN/OUT Selection	No.	2
25	Hard Disk for HMI Server	No.	1
26	Each Type of Hardware Modules for GPS Equipments	Set	1
27	Spares for Inverter of SAS	Set	1
28	Line Interface Unit for SAS FO LAN for One Diameter (with Maximum Configuration used in the offered system)	Set	1

Sl.No.	Description	Unit	Qty.
D)	Services:		
1	Supervision (Bay-Wise) of Site Testing and Commissioning of the Complete Control & Protection System and SAS/DFR/PMU/TWFL/Metering System offered, including the following: a) Testing & Commissioning of Numerical Protection Relays including Relay Parameterisation, Setting and Configuration. b) Testing & Commissioning of Busbar Protection, Metering System & SAS including termination of Network/ Optical Cables (Complete with supply of all end connectors, tees etc. as required). c) For Network/ Optical Cables which are in the bidder's scope, laying of cables shall be in BHEL's scope; However, supervision of Optical Cable laying is included in bidder's scope. d) Splicing & termination of FO cables (armoured & patch-cord). e) Arranging all necessary tools & tackles and equipment including Automatic Relay Test Kit for testing of the complete offered system (Control & Protection System/ SAS/ Metering System/ Communication System etc.) shall be bidder's responsibility. f) Site Acceptance Tests (SAT), Availability Tests. g) Integration of IEC 61850-based monitoring equipments (mounted on 765/400kV ICT, 765kV Bus/Line Reactor Units) with the offered SAS as per section-1.	Lot	30
2	Training Charges at Manufacturer's Works as per Section-2.	Lot	1
3	Training Charges at Site as per Section-2.	Lot	1
4	Complete Engineering of the offered System including the following: a) Diagram showing routing of ADSS FO Cables alongwith HDPE pipes/ patch cords/ LAN Cables and preparation of FO Cable/HDPE pipe/patch cord/LAN Cable BOQ. b) Relay setting Calculation and application Checks. c) Incorporation of complete primary equipment interfaces in the CRP schemes prepared by the bidder.	Lot	1

Sl.No.	Description	Unit	Qty.
Note:			
1. If any additional item as per the specification 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. BCUs and tri-vector meters shall be part of the respective relay panels.			
3. Proper sizing of inverter to be done by bidder, which shall be approved by TANTRANSCO/ BHEL.			
4. The busbar protection system (both Central Units and peripheral Units) of each of the 765 kV & 400 kV Numerical Busbar Protection Schemes shall be equipped completely for all the bays including the future bays indicated in the SLD plus 6 spare circuits.			
5. Complete Sub-station Automation System (SAS) for 36 Bays (Tentative list of supplies as per Annexure-B, Section-1) is included in bidder's scope under this tender. If any additional item as per the specification is required to be supplied for completion of the system over and above the items indicated above and Annexure-B, the same shall be indicated clearly in the offer. Otherwise, the same shall be deemed to be included in the offer.			
6. Tentative Line Lengths for different outgoing lines at 765/400 kV Ariyalur S/S are as follows: i) 765kV Ariyalur-to-Thiruvallam Line - 200km ii) 765kV Ariyalur-to-NCPS Line - 250km iii) 400kV Ariyalur-to-Pugalur Line - 250km iv) 400kV Ariyalur-to-Kalivanthapattu Line - 150km v) 400kV Ariyalur-to-New Neyvelli Line - 60km			
7. The above quantities are subject to change by $\pm 50\%$ at contract stage.			

Break-Up of Sub-station Automation System (Sl. No. A 14 of Bill of Quantity)			
Sl.No.	Description	Unit	Qty.
1	Bay Control Unit (BCU) for 765kV and 400kV Bays	Set	36
2	Bay Control Unit (BCU) for Sub-Station Auxiliary System	Set	1
3	Ethernet Switches (with 50% spare ports in each switch) as required for implementing redundant LANs at Station Level and Inter-Bay Level	Lot	1
4	Redundant Station HMI in hot stand-by mode	No.	2
5	Operator Work Station	No.	2
6	Engineering Work Station	No.	1
7	Metering PC	No.	1
8	Gateway Panel (Complete with panel, Gateway devices-2 Nos in redundant configuration, Hooter - 2 Nos for sub-station urgent and non-urgent alarms)	Set	1
9	Communication Equipment (Complete with MODEMs, Lightning Arrestors for MODEM, Communication Ports and Media Interface Device and all Accessories for redundant gateway interface for LDC) at Ariyalur S/S	Set	1
10	Communication Equipment (Complete with MODEMs, Lightning Arrestors for MODEM, Communication Ports and Media Interface Device and all Accessories for redundant gateway interface for LDC) at LDC End	Set	1
11	A3/A4 size Colour Laser Jet Printer	No.	1
12	A4 size Colour Laser Jet Printer	No.	1
13	All LAN Cables/ Communication Cables/ FO Patch Cords and Cable Connectors alongwith associated cable ducts and all accessories, FO patch panels (2 Sets), media converters, LIU etc. for completeness of the offered Control & Protection System/ SAS/ Metering System/ DFR System etc.	Lot	1
14	Time Synchronisation Equipments (GPS with all accessories, Antenna, Cables, Software, Lightning Arrestors for GPS, Separate time display unit display size of approx. 100 mm height. etc)	Set	1
15	Inverter	Set	2

16	Necessary elegant and ergonomic furniture required in Substation Central Control Room as per specification	Lot	1
17	Digital temperature sensor with backlit LCD display, transducer for SAS interface and all necessary connecting cables/ accessories for room temperature measurement in each Kiosk and switchyard control room.	Lot	1
18	Configuration tools for SAS and Relay panels: i) SAS HMI software for Client access. ii) Laptop computer with all necessary software - 1 set. iii) CMRI Instrument (DLMS compatible for ABT meter) – 1 No. iv) Software for configuration of all devices in relay panels - 1 set v) Software for configuration of all SAS devices - 1 set. vi) Special Crimping tools – 1 set vii) Test plug – 3 Nos. viii) Fibre optic Splicing Kit - 1 Set ix) Any other necessary tools for offered SAS & relay panels.	Lot	1

Note:

1. Complete Sub-station Automation System (SAS) for 36 Bays is included in bidder's scope under this tender. If any additional item as per the specification 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. For each of 765kV and 400kV system, spare BCUs (panel-mounted) for One Diameter each (3 Nos. spare BCU for each of 765kV and 400kV system) to be supplied and included in the BOQ above.

SECTION - 2
EQUIPMENT SPECIFICATION
~~SECTION 22~~

TECHNICAL SPECIFICATION FOR RELAY PANELS WITH SAS

1. General

This specification requires the design, manufacture, FAT, supply inclusive of insurance, transport and delivery to site, testing and commissioning of SAS, Control & Relay panels for 765 kV and 400 kV and other associated equipments. The equipments shall be capable of working satisfactorily in the intended environmental conditions and suitable for satisfactory performance for the application.

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

All necessary material and works towards field interface of Control & Relay panels to the switchgears, CT's, PT's, power supply equipment, communication equipment, SAS (As applicable) etc. are in the scope of the bidder.

All the testing and commissioning of the Control & Relay panels and SAS Equipments shall be carried out by engineers authorized /certified by the original equipment manufacturer of SAS with the witness of the concerned TANTRANSCO P&C engineer and the completion of all the works should be to the satisfaction of TANTRANSCO.

All the relevant files such as ICD, SCD,SSD,CID etc shall be updated in the relevant devices and provided in soft copy in CD and in a Spare HDD (Spare HDD to be supplied in the spares for SAS) to the concerned Protection & Communication engineer of TANTRANSCO.

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 C&R 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-41 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 : Minimum 3mm for planes housing the devices and for bottom plates. Minimum 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.

In case ^{powder}~~power~~ coating painting is adopted then the minimum thickness of paint shall be 70 microns and subject to the approval of TANTRANSCO.

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 lamicaid.
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 C&R panel shall be provided with necessary arrangements for receiving, isolating and tripping on fault of AC and DC supplies for various control of signaling, lighting and space heaters.
- ii) Each of the distribution circuits and incomer circuits of the AC auxiliary supply and DC auxiliary supply shall be provide with MCBs such as to ensure selective clearance of sub circuit faults.
- iii) MCBs should be of suitable rating with auxiliary contact for trip indication which shall be wired to SAS for alarm alert.
- iv) Potential circuit for metering and relaying shall be protected by fuses.
- v) 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.
- vi) Fuse shall have operation indications for indicating blown fuse condition.
- vii) Fuse carrier shall have imprints of fuse rating and voltage.
- viii) 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 flame, vermin, and rodent proof. 1100V grade for CT,PT circuits. 600V/1100V Grade for other circuits.
- ii) Flexible wires shall be used for wiring of devices on moving parts such as swinging panels or panel door.
- iii) Wire size :

4 Sq.mm for Auxiliary AC supply circuits.

2.5 Sq.mm for CT circuits, Earthing circuits and DC Auxiliary supply wiring.

1.5 sq.mm for PT Circuits and all other circuits.

Higher size wires for all of the above mentioned circuits is applicable if required as per engineering requirement.

- iv) 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
- v) 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.
- vi) 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.
- vii) Engraved core identification plastic ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire.
- viii) The wire number shown on the wiring shall be in accordance with IS 5578.
- ix) All wires directly connected to trip circuit breaker or device shall be distinguished by addition of red colour unlettered ferrule.
- x) 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 adjacent panels at site and wires for this purpose shall be provided and bunched inside the panel.
- xi) Bus wires shall run at the top the panels. The terminal blocks for the wires shall be with isolating links.
- xii) 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.

- xiii) 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.
- xiv) 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.
- xv) There shall be minimum clearance of 250mm between the first row of terminal blocks and the associated cable and plate or panel side wall.
- xvi) 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.
- xvii) For CT termination, links terminal blocks to be used shall have links for disconnection and connect type with plugging in facility for testing purposes. For VT termination, links terminal blocks to be used shall have links for disconnection and plugging in facility for testing purposes.
- xviii) 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. TRIVECTOR METER:

The tri-vector meter shall be AC static micro-processor based **ABT type** tri-vector energy meters, DLMS (Category-B) compliant, suitable for availability based tariff application. The meter should be capable to record and display Active, Reactive and apparent energy and maximum demand for 3 phase 4 wire as well as 3 phase 3 wire AC balanced/ unbalanced loads without effecting the accuracy for a power factor range of zero (lagging), unity and zero (leading) for export and import as per the requirement given in this specification. The meter shall be capable to measure in all the four quadrants. The meter's measurement of metering values such as Voltage, current, frequency, energy etc shall be based on true rms measurements.

3.1 STANDARDS APPLICABLE

Sl.No.	Standard No.	Title
1	IS 14697 – 1999 With latest amendment	AC static transformer operated Watt-hour and VAR-hour meters for class 0.2s and 0.5s.
2	CBIP technical report no. 304 with latest amendment (only for Magnet compliance)	Specification for AC static electricity energy meters
3	IEC 62053-22 with latest amendment	AC static Watt-hour meters for active energy, class 0.2 s.
5	IS-9000 With latest amendment	Basic environmental testing procedures for electronic and electrical items.
6	IS 15959	DLMS Companion Standard (ICS)

Meters matching with requirements of other national or international standard which ensure equal or better performance than the standards mentioned above shall also be considered. When the equipment offered by the bidder conforms to standards other than those specified above, salient points of difference between standards adopted and the standards specified in this specification shall be clearly brought out in the relevant schedule and copy of such standards along with their English translation shall invariably be furnished along with the offer.

Further, CMRI (Common Meter Reading Instrument) shall conform to CBIP Technical report no.88 with latest amendments. SUPPLY OF CMRI INCLUDED IN THE SCOPE OF BIDDER.

3.2 TECHNICAL PARAMETERS

The energy meter shall be indoor type connected with the secondary side of outdoor current and voltage transformers.

Supply system:

Rated Voltage : 63.5 Phase to Neutral

110 V Phase to Phase

Rated current : 1 Amps / 5 Amps

System frequency : 50 Hz +/- 5%

Earthing system : Solidly grounded

Accuracy : Class 0.2S.

Actual primary values wherever applicable shall be programmable in the meter as per the CT and PT value of the installed CTs and PTs.

3.3 GENERAL TECHNICAL REQUIREMENTS

3.3.1 The meter should be micro processor based 3 phase 4 wire type suitable for connection to 3 phase 4 wire as well as 3 phase 3 wire system.

3.3.2 The meter shall compute the active energy and load import; active energy and load export from the substation bus bars during each successive 15 minute integration period block and store it in its non volatile memory.

3.3.3 The metering system shall normally operate with the power drawn through the PT secondary voltage.

3.3.4 The meter shall be capable of withstanding surges and voltage spikes as per IS that occur in the PT & CT circuits of EHV switch yards by providing necessary isolation and/or suppression system built in the meter.

3.3.4 The active energy measurement shall be carried out on 3 phase 4 wire principle with accuracy as per class 0.2S of IEC 62053-22. The meter shall compute the active energy import and export and average frequency during each successive 15 minute block and store in its memory along with its sign. It shall also display on demand the active import and active export during the previous 15 minutes block. The values may be displayed directly in secondary quantities.

3.3.5 Further the meter shall continuously integrate and display on demand the cumulative active energy import and export from the substation up to date and time of meter reading. The cumulative active energy import and export reading at each midnight shall be stored in the meter memory for last forty-five (45) days and shall be reported at Base Computer Software (BCS) end. Separate registers shall be maintained for active energy import and export.

3.3.6 The average frequency (Hz) of previous 15 minute block shall be displayed on demand in the metering system.

3.3.7 The meter shall continuously compute the average of the RMS values (fundamental only) of the 3 lines to neutral PT secondary voltage as the percentage of 63.51 V and then display the same on demand.

3.3.8 The meter shall compute the reactive power (VAR) on 3 phase 4 wire principle with accuracy as per IEC 60687-2000 and integrate the reactive energy algebraically in two separate registers, one for the period for which RMS voltage is higher than 103%(Reactive High), and the other for the period for which the RMS voltage is below 97%.(Reactive Low). When lagging reactive power is being sent out from the substation bus bars, reactive registers shall move forward. When reactive power flow is in the reverse direction, reactive registers shall move backwards. The Nett KVARH

for voltage high (103%) & Nett KVARH for low voltage (97%) both shall be displayed.

3.3.9 Further, the reactive energy shall also be available as four different energy registers for viewing at BCS and on meter display:

- a) Reactive energy lag while active energy import (Q1)
- b) Reactive energy lead while active energy import (Q2)
- c) Reactive energy lead while active energy export (Q3)
- d) Reactive energy lag while active energy export (Q4)

3.3.10 Each metering module shall have a built in calendar in clock, having an accuracy as per IS standard. The calendar and clock shall be correctly set at the manufacturer's works. Current date (day-month-year) and time (hour-minute-seconds) shall be displayed on the front display section on demand. Clock adjustment shall be possible at site using the common meter reading instrument (CMRI) with proper security it shall be possible to set the clock with BCS clock.

An automatic back up for continued operation of the offered meters clock and calendar shall be provided through a long life battery capable of supplying the required power for at least 2 years under meter un-powered conditions. The offered meters shall be supplied duly fitted with the battery that shall not be required to be changed for at least 10 years as long as total VT interruption does not exceed two years.

3.3.11 Each meter shall have a unique identification code (serial number), which shall be marked permanently on the front as well as in its memory.

3.3.12 Each meter shall have a non volatile memory in which the parameters as specified in this specification shall be stored. The non volatile memory shall retain the data for a period not less than 10 years under un-powered condition; battery backup memory shall not be treated as NVM.

3.3.13 All meters shall be totally identical in all respects except for their unique identification codes. They shall be totally sealed with no possibility of any adjustment at site except for clock correction.

3.3.14 The meters shall safely withstand the usual fluctuation arising during faults in particular, VT secondary voltage 115% of rated voltage applied continuously and 190% voltage of rated for 3 seconds and CT secondary current 120% of rated current applied continuously and 20 times of maximum current applied for 0.5 seconds, shall not cause any damage to or the mal-operation of the meters.

3.3.15 The meter should be user configurable for all the parameters at site using the tools provided for the meter.

3.3.16 Power factor Range:

The meter shall be suitable for full power factor range from zero (lagging) through unity to zero (leading). The meter shall work as an active energy import and export and reactive (lag and lead) energy meter. The energy measurement should be true four quadrant type.

3.3.17 Power Supply Variation:

The meter shall be suitable for working with following supply variation

Specified operating range	-	0.8 to 1.15 Vref.
Limit range of operation	-	0.7 to 1.2 Vref.
Frequency	-	50 Hz $\pm$ 5%.

3.3.18 Accuracy:

Class of accuracy of the meter shall confirm to 0.2S as per the relevant standard. The accuracy should not drift with time.

Each of the meter supplied should be tested and certified for accuracy from a NABL recognised laboratory in India.

3.3.19 Power Consumption:

i) Voltage circuit: The active and apparent power consumption in each voltage circuit including the power supply of meter at reference voltage, reference temperature and reference frequency shall not exceed 1.5 Watt per phase and 8 VA per phase respectively.

ii)Current Circuit: The apparent power taken by each current circuit at basic current, reference frequency and reference temperature shall not exceed 1 VA per phase.

3.3.20 Starting Current:

The meter should start registering the energy at 0.1% In at unity power factor.

Maximum Current:

The rated maximum current of meter shall be 120% of basic current (Ib).

3.4 **GENERAL AND CONSTRUCTIONAL REQUIREMENTS**

3.4.1 Meters shall be designed and constructed in such a way so as to avoid causing any danger during use and under normal conditions. However, the following shall be ensured:

- a) Personnel safety against electric shock
- b) Personnel safety against effects of excessive temperature
- c) Protection against heat & spread of fire
- d) Protection against penetration of solid objects, dust and water

3.4.2 All the material and electronic power components used in the manufacture of the meter shall be of highest quality and reputed make to ensure higher reliability, longer life and sustained accuracy.

3.4.3 The meter shall be designed with application specific integrated circuits. The electronic components shall be mounted on the printed circuit board using latest Surface Mount Technology (SMT).

3.4.4 All insulating materials used in the construction of metering module shall be non-hygroscopic, non-ageing and of tested quality. All parts that are likely to develop corrosion shall be effectively protected against corrosion by providing suitable protective coating.

3.4.5 The meter shall be suitable for being connected through test terminal blocks to the voltage transformer having a rated secondary line to neutral voltage of $110/\sqrt{3}$ V and to current transformers having a rated secondary current of 1A as

per requirement. Necessary isolation and suppression shall also be built-in, for protecting the meters from surges and voltage spikes that occur in the VT and CT circuits of extra high voltage switchyards.

3.4.6 Each meter shall have test output devices (visual) for checking the accuracy of active energy (Wh), reactive energy (VARh) or apparent energy (VAh) measurement using a suitable test equipment. This device shall be suitable for use with sensing probe used with test benches or reference standards. The test output device shall have constant pulse rate ie pulse/unit (KWh, KVARh) and its value (Meter constant) should be indelibly printed/ appropriately mentioned on the rating plate.

3.4.7 The metering system shall conform to the degree of protection IP 53 in the normal working condition of IS12063/IEC529 for protection against ingress of dust, moisture and vermin.

3.4.8 The meter base, meter cover, terminal block (as applicable) shall be made of unbreakable, high grade, fire resistant, non-inflammable and good quality suitable material to ensure safety. The manufacturer shall clearly indicate the material used.

3.4.9 The terminal block and the meter case shall be designed such that it ensures reasonable safety against the spread of fire and shall not be ignited by thermic overload of live parts in contact with them.

3.4.10 All terminals for CT and VT connections shall be arranged at the lower/back side of the meters. Terminal shall have a suitable construction with barriers and cover to provide a safe and secure connection of CT & VT wires.

3.4.11 The metering system shall be compact in design. Entire design and construction shall be capable of withstanding stresses likely to occur in actual service and rough handling during transportation. The meter shall be convenient to transport and immune to shock and vibrations during transportation and handling as per the relevant standard. Meter shall have the capability and facility to compensate for errors of external measurement transformers i.e. CT and VT

3.5 **SEALING OF THE METER:**

Reliable sealing arrangement shall be provided for meter to avoid fiddling by unauthorized persons.

1. The meter cover shall have at least 2 sealing sources sealing arrangement should be accessible from front only.
2. Separate sealing arrangements shall be provided for terminal cover.
3. Sealing arrangement should be suitable for application of poly carbonate seals.
4. The manufacturer will provide his own seals on each meter before dispatch.

3.6 **MARKING OF METER:**

The marking on every meter shall be in accordance with IS 14697-1999.

Every meter shall have name plate beneath the meter cover such that the name plate cannot be accessed without opening the meter cover and without breaking the seals of the meter cover and the name plate should be marked indelibly.

The basic markings on the meter name plate shall be as follows:

- i. Manufacturer's name and trade mark and place of manufacture.
- ii. Type designation
- iii. Number of phases and wires
- iv. Serial Number
- v. Month and year of manufacture
- vi. Reference voltage & Frequency
- vii. Rated secondary current (Basic current & Maximum current)
- viii. Principal unit(s) of measurement
- ix. Meter constant (Impulse/unit KWh/KVARh)
- x. Class index of meter

The marking shall be indelible, distinct & readable from outside the meter.

3.7 **Connection Diagram and Terminal Markings:**

The connection diagram of the meter shall be clearly shown for 3 phase 4 wire system as well as 3 phase 3 wire system, on inside portion of the terminal cover

and shall be of permanent nature or suitably pasted in meter. The meter terminals shall also be marked and this marking should appear in the above diagram. In case of any special precautions need to be taken at the time of testing the meter, the same may be indicated along with the circuit diagram.

3.8 SALIENT FEATURES:

The metering system shall have the following additional salient features:

3.8.1 It shall be possible to check the healthiness of phase voltages by displaying all the voltages on the display of the metering system.

3.8.2 The meter shall work accurately irrespective of phase sequence of the mains supply.

3.8.3 The meter should remain powered up and functional even when either of any two phases or any one phase along with neutral is available to the meter.

3.8.4 The meter shall continue to record accurately as per prevailing electrical conditions even if the neutral of potential supply gets disconnected.

3.8.5 The metering system shall be provided with adequate design to ensure compliance to CBIP Technical Report No.304 (with latest amendments) for external magnetic influence criteria (AC electro magnet or DC magnet).

3.8.6 It shall not be possible to change the basic meter software by any means in the field. Moreover critical events like time set, MD reset operation, and tariff change shall be logged by the meter. Such events shall be logged in roll over mode for up to twenty numbers.

3.9 Display of Measured Values:

3.9.1 The measured value(s) shall be displayed through Liquid Crystal Display (Alpha numeric LCD backlit) section of metering system.

3.9.2 It should be possible to easily identify the single or multiple displayed parameters through legends/ unit on the metering system display.

3.9.3 The register shall be able to record and display starting from zero, for a minimum of 1500 hours, the energy corresponding to rated maximum current at reference voltage and unity power factor. The register shall not roll over in between this duration.

3.9.4 Any interrogation/ read operation shall not delete or alter any stored meter data.

3.10 **Meter Serial Number:**

In addition to providing serial number of the meter on the name plate, the meter serial number shall also be programmed into meter memory for identification through CMRI meter reading print out. The meter serial number shall also be made available on the metering system display on selection of appropriate option.

3.11 **Display, Load survey capability and billing point requirements:**

The meter shall be capable of recording 15 minutes average of the following parameters for at least last 45 days and shall display the following parameters on suitable selection through push button:

1. Date & Time
2. Imp WH
3. Exp WH
4. Imp Varh lag Q1
5. Imp Varh Lead Q2
6. Exp Varh Lag Q3
7. Exp Varh Lead Q4
8. Voltage RN
9. Voltage BN
10. Voltage CN
11. AVG Frequency

The meter shall be capable of recording 15 minute average of the following parameter for last 45 days

1. Date & Time
2. Imp WH
3. Exp WH
4. Imp Varh lag Q1
5. Imp Varh Lead Q2
6. Exp Varh Lag Q3
7. Exp Varh Lead Q4
8. Imp MD KW

9. Exp MD KW
- 10.AVG Volt Ph A
- 11.AVG Volt Ph B
- 12.AVG Volt Ph C
- 13.AVG Current Ph A
- 14.AVG Current Ph B
- 15.AVG Current Ph C
- 16.AVG Frequency
- 17.Net VARh High
- 18.Net VARh Low

15-minute average of the above parameters shall be available for last forty five (45) days. It shall be possible to select either demand or energy view at the BCS end. The load survey data shall be made available in the form of bar charts as well as in spread sheets at the metering PC end. The Base computer software shall have the facility to give the complete load survey data both in numeric and graphic form. All the 96 blocks shall be recorded for data indication on block day and no supply period also shall be recorded .

3.12 **Billing Parameters:**

All billing parameters shall be transferred to billing registers; the parameter shall be

- Active energy import
- Active energy export
- Apparent energy while active import .
- Apparent energywhile active export.
- Cumulative Reactive energies for the voltage high condition.
- Cumulative Reactive energies for the voltage low condition.

3.13 **DAILY MIDNIGHT PARAMETERS:**

The meter shall store following end day parameters for last forty five (45) days at 00:00 hrs.

1. Mid night Cum Imp WH (T)
2. Mid night Cum Exp WH (T)
3. Mid night Cum Varh High (V>103%)

4. Mid night Cum Varh Low ($V < 97\%$)
5. Mid night Cum Imp VARh Lag Q1
6. Mid night Cum Imp VARh Lead Q2
7. Mid night Cum Exp VARh Lag Q3
8. Mid night Cum Exp VARh Lead Q4

Other requirement as per CEA regulation

Above billing data, load survey data, anomaly information and instantaneous parameters data shall be retrievable through the meter's communication port through a common meter reading instrument (CMRI) using DLMS protocol as well as transferred (down loaded) to a metering PC to get complete details for view and print. It should be possible to export the data so collected into (common data format). The supplier will provide necessary facilities for the same in the base computer resident software. The necessary base computer software (BCS) for this purpose shall be provided with complete details.

3.14 **TOD (Time of day registers):**

The meter shall have TOD registers for active energy import and export, apparent energy import and export and apparent MD import and export. Maximum eight time of day registers for each energy and MD can be defined. It shall be possible to program number of TOD registers and TOD timings through software/CMRI with multilevel password security system and authenticated transaction.

3.15 **Maximum Demand (MD) Registration:**

The meter shall continuously monitor and calculate the average demand (Active and Apparent) during the integration period set and the maximum, out of these shall be stored along with date and time when it occurred in the meter memory. The maximum demand shall be computed on fixed block principle. The maximum registered value shall also be made available in the meter reading. The integration period shall be set as 15 minutes it shall be capable to change to other integration period (30/60 minutes), if required, through suitable high level software /MRI as an authenticated transaction.

3.16 **Maximum Demand Reset:**

The meter should have any of the following MD resetting options:

- (i) Auto reset of MD at predefined date and time shall be provided.
- (ii) Resetting through meter reading Instrument or computer capable of communicating with the meter with explicit password protection. The manufacture shall provide a software module specifically for resetting MD through MRI/Computer.
- (iii) Manual via common MD reset button.

3.17 **Data communication capability:**

The metering system shall have multiple communication ports for local reading and remote communication facility.

3.17.1 The meter shall be provided with a galvanically isolated optical communication port. (Such as IEC, PACT, ANSI etc) with removable cover and with locking arrangement so that it can be easily connected to a MRI / laptop for data transfer.

3.17.2 The optical communication port shall, be compliant to DLMS protocol and, also have a sealing provision.

3.17.3 In addition to the optical port, the meter shall be provided with one communication port either of Ethernet port IEC61850 protocol or RS-485 port with open protocol (MODBUS) for integration with the sub-station automation system to facilitate real time data acquisition of metered values and access of stored metering records.

3.18 **Real time clock:**

3.18.1 The meter offered should have a real time clock and calendar based on a quartz crystal with a battery totally independent of power supply.

3.18.2 A lithium maintenance free battery of long life (minimum ten years) shall be provided for operation of time clock. It should be possible to select the various time zones for various seasons of the year through suitable software built into the electronic register.

3.18.2 The accuracy of the clock shall not be less than 5 minute in a year or better.

3.18.3 It should be possible to reset Real Time Clock of the meter through a manually triggered command from Base Computer Software.

3.18.4 The clock of the trivector meter should be synchronised with the GPS clock of the SAS.

3.19 **Self Diagnostic Feature:**

The meter shall be capable of performing complete self diagnostic check to monitor the circuits for any malfunctioning to ensure integrity of data in memory location all the time. The meter shall have indications/ display for unsatisfactory/nonfunctioning/malfunctioning of the following:

- a) Time and date and
- b) Non volatile memory failure indication
- c) Low Battery indication at BCS

Above indications should be made available at BCS end also.

While installing the meter, it should be possible to check the correctness of CT/VT connection to the meter and their polarity from the functioning of the meter for different voltage injections with the help of vector phasor diagrams. For this purpose suitable software for field diagnosis of meter connections with the help of MRI should be supplied.

The details of malfunctioning of time and date shall be recorded in the meter memory.

3.20 **Anomaly detection features:**

The meter shall have features to detect the occurrence and restoration of, at least, the following common ways of anomaly:

- a) Missing potential: The meter shall be capable of detecting and recording occurrences and restoration of missing potential (1 phase or 2 phases) which can happen due to intentional/ accidental disconnection of potential leads.
- b) CT polarity reversal: The meter shall be capable of detecting and recording occurrences and restoration of CT polarity reversal of one or more phases.
- c) Current and voltage unbalance: The meter shall be capable of detecting and recording occurrences and restoration of unbalance of current and voltage. Snap shots (numerical values) of phase wise voltages, phase wise active currents, phase wise power factors and energy (active energy) readings shall be provided with the above specified events.

- d) Last hundred (100) events (occurrence+restoration), in total, shall be stored in the meter memory on first in first out basis.
- e) There shall be four separate compartments for logging of different type of anomalies:

Compartment No.1	20 events of Missing Potential
Compartment No.2	20 events of CT Reversal
Compartment No.3	40 events for Voltage Unbalance, Current Unbalance
Compartment No.4	20 events of Feeder Fail and Power On/Off

Once one or more compartments have become full, the last anomaly event pertaining to the same compartment shall be entered and the earliest (First one) anomaly event should disappear. Thus, in this manner each succeeding anomaly event shall replace the earliest recorded event, compartment wise. Events of one compartment/category should overwrite the events of their own compartment/category only.

4. ANNUNCIATORS:

- i) The annunciator unit shall be microprocessor based and field configurable. An automatic self supervision system to monitor the functioning of the annunciation system shall be provided with a means to alert the operator.
- ii) 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) The display in the annunciator unit shall be High density LED type or cluster LED type.
- 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.

- iv) A test, accept and reset push button facilities shall be provided for testing the annunciation unit.
- v) The annunciator unit should conform to the applicable parts of the IEC 60255/ Equivalent for type tests and routine tests.
- vi) The annunciator unit shall be equipped with 230VAC/220VDC redundant power supply modules.

5. General requirements for Numerical protection relays

- i) Technology shall be based on numeric type.
- ii) Equipped with Event recorder. Events storage shall be sufficient for the application. minimum 200 events of storage is preferable and with a time stamp resolution of 1ms.
- iii) Equipped with fault recorder to record in digital oscillography of instantaneous values of all the relevant analog channels during faults and disturbances. Trigger criteria and record length (pre-trigger and post trigger record length) for the recorder should be user configurable. Storage capacity for Disturbance and fault record storage shall be sufficient for the application.

Trigger criteria shall be user configurable to be triggered by any of the hardwired inputs and outputs as well as virtual inputs and outputs , boolean logic, under/over threshold levels of relevant analog channels etc. The sampling rate of fault recording shall be preferably 24 samples/cycle or higher.

- iv) Relay casings shall have a degree of protection of IP 50 for relay enclosure, IP50 for relay facia as per IEC 60529 or equivalent.
- v) Time stamping of events shall be of resolution of 1ms.
- vi) Equipped with Two optical Ethernet ports at the rear of the numerical relay for parallel redundancy (in compliance to IEC-62439-3) in networking on IEC 61850 Protocol. The above referred 2nos Ethernet ports shall also be used for time synchronization using SNTP protocol with guaranteed resolution of 1ms.

IEC 61850 protocol with type test certification/report for compliance with relevant parts of IEC 61850. The compliance shall include :

- Model implementation conformance statement (MICS)
- Protocol implementation conformance statement (PICS)

vii) Equipped with communication port (USB or RS232 or 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.

viii) 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.

ix) 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.

x) 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.)

xi) Provision for display of alarms with LED/ LCD/Graphic display. The LEDs shall be user programmable to any of the hardwired inputs and outputs as well as virtual inputs and outputs.

xii) 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.

xiii) All configuration files, data and records of the protection relay shall be stored in a non- volatile memory and shall not be lost on absence of dc supply.

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

xv) The relay should be equipped with user configurable opto isolated Binary inputs and potential free binary outputs as required for the specific application. **Numeric relays with non-programmable binary Inputs, non-programmable binary outputs, non-programmable are not acceptable.**

xvi) Where ever the numerical relay is connected to the 3phase VTs, the relay

should be equipped to display the angle of vectors with respect to A phase voltage vector i.e V_a angle=0 deg (Voltage vector of phase B and C with respect to Phase A) similarly current vector angle of phase A,B and C with respect to voltage vector A for relay connected to 3 phase CTs.

xvii) All relays shall have screw type terminations for wiring terminations.

xviii) Thermal with stand capabilities:

3x In - Continuously

100x In - 1 Second

40x In for 3 second

xix) Equipped with Trip rated binary output contacts specifically for tripping with Minimum of 4nos for 3-phase breaker application and 6nos for 3x1-ph breaker applications. The rating of trip rated contacts shall be:

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.

xx) Standards for type tests and routine tests compliance.

a) The numerical relay shall conform to 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

b) In particular the following type tests should be complied.

a. Power Input:

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

b. Accuracy Tests:

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

c. Insulation Tests:

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

d. Influencing Quantities

- i. Limits of operation
- ii. Permissible ripples
- iii. Interruption of input voltage

e. Electromagnetic Compatibility Test:

- i. 1 MHZ. burst disturbance test
- ii. Electrostatic Discharge Test
- iii. Radiated Electromagnetic Field Disturbance Test
- iv. Electrical Fast transient Disturbance Test
- v. Conducted Disturbances Tests induced by Radio Frequency Field
- vi. Magnetic Field Test
- vii. Emission (Radio interference level) Test.
- viii. Conducted Interference Test

f. Function Tests:

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

g. Environmental tests:

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

vi. Bump

vii. Shock

- c) All acceptance and routine test as stipulated in the relevant standards should be carried out by the supplier in presence of TANTRANSCO's representative without any extra cost

6. Electro-mechanical Relays:

- i) All relays shall confirm to IS: 3231
- ii) Unless otherwise specified all auxiliary relays and timers shall be supplied in non-draw out 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 watthour 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 :

- Model implementation conformance statement (MICS)
- Protocol implementation conformance statement (PICS)

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

8. PROTECTION FOR 765 kV / 400 kV LINES/FEEDERS:

MAIN-I & MAIN –II DISTANCE PROTECTION:

The numeric distance protection relays shall 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 binary 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.

4. Main-1 and Main-2 distance protection relay should be of different manufacturer.

5. Equipped with the following built in protection functions:

√ 21 : Distance protection

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

For Source to Impedance ratio:	4	15
Relay setting (Ohms)	10	2
Fault Locations (as % of relay setting)	60	60
Fault resistance (Ohms)	0	0
Maximum operating time (Milliseconds)	40 for all faults	45 for 3 ph. Faults & 60 for all other faults

- 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 0.05 Ohm – 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 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. zero sequence voltage detection for VT fuse fail detection shall be used so that the relay does not maloperate on system ground faults

√ 50/27 : SOTF

√ 25 : synchro check function

√ 50BF : LBB Function

✓ 79: Built in auto reclose function with single shot, single phase (3phase for 110kV) 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. 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.

✓ Event recorder

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

✓ Stub protection.

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 in the event of actual 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; ~~Minimum 12 nos for 110KV~~) of programmable opto isolated Binary inputs and sufficient numbers (minimum is 20 nos, ~~Minimum 16 nos 110KV~~) of programmable potential free binary outputs with wetting voltage for digital inputs to be field programmable to 48V / 110V / 220V DC.
9. The minimum number of LEDs shall be 14 nos, In case Graphic display is provided then atleast 4 nos LEDs shall be provided for important alarms.
10. The relay should be equipped to display the angle of vectors with respect to A phase voltage vector i.e V_a angle = 0 deg (Voltage vector of phase B and C with respect to Phase A) similarly current vector angle of phase A, B and C with respect to voltage vector A.

9. 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.
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 : 10% 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 : + 90 deg to -90 deg

E/F fault : + 90 deg to -90 deg

Equipped with in built 50LBB function.

Zero sequence voltage shall be based on 3-phase voltages.

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 765 kV/ 400 kV :

Redundant (1+1) numerical Bus Bar protection scheme for each bus

system for 400kV as well as 765kV shall be provided. The scheme shall be engineered so as to ensure that operation of any one out of two schemes connected to main faulty bus shall result in tripping of the same. Each of the redundant numerical bus bar protection scheme shall comply to the following requirements.

1. The numerical bus bar 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 numerical low impedance type, **distributed architecture** and shall have operate and restraint characteristics. The distributed Numerical based bus bar protection scheme shall comprise a central unit and peripheral units all of which communicate in real time through a high speed fiber optic communication link.
3. Each Bus Bar protection scheme shall comply to the following requirements.
 - (a) have maximum operating time up to trip impulse to trip relay for all types of faults of 25 milli seconds at 5 times setting value.
 - (b) Operate selectively for each zone of bus bars for all types of faults i.e Phase to phase , Phase to ground faults including high resistive faults.
 - (c) Give hundred percent security up to 63 KA fault level for 400KV. be stable for through fault condition up to 50KA fault level.
 - (d) incorporate continuous supervision of CT secondary's 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.
 - (e) be phase segregated triple pole type 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.
 - (f) shall include one overall check zone protection in addition to single/multiple zones specified. 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.

- (i) include provision for protection IN/OUT for each zone and check zone.
 - (j) be transient free in operation.
 - (k) includes continuous DC supply supervision.
4. The numeric relay shall be suitable for operating with CT inputs of 1A (nominal). The secondary of the CT shall be directly connected to the Bus bar relay without the aid of external auxiliary CTs. Ratio correction shall be possible with through the relay configuration tools itself.
 5. the relay must have harmonic rejection and shall not operate on second and third harmonics. Second harmonic rejection ratio 2:1 minimum, third harmonic rejection ratio 40 :1 minimum.
 6. the high speed electrically reset high speed tripping relays (96) for tripping each bay breakers on actuation of bus bar protection shall be on respective bay protection relay panels and necessary provision for running the tripping bus wires to actuate these relays shall be made. However, in case of distributed Bus bar protection, individual trip relay shall not be required if bay unit is having trip duty contacts for breaker tripping. 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.
 7. The relay should be equipped completely for supporting six numbers spare circuits in addition to all the circuits for feeders/ bays depicted in the single line diagram for the sub-station. In case of distributed Bus bar Protection, the bay units for future bays may be installed in a separate panel and the same shall be located in switchyard panel room where bus bar protection panel shall be installed.
 8. 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.
 9. The relay shall incorporate dynamic bus replica and provide necessary end

zone fault protection depending on the bus bar protection CT's location.

The status of isolators shall be ascertained by hardwired **double** indication method i.e Both N/C and N/O contact to be used.

10. 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.
11. Facility to monitor the individual bay currents, bus differential currents and bus restraint current for each zones shall be supported in the relay display as well as through configuration tools.
12. 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.
13. The bus bar protection relay shall be provided with built in breaker fail (50BF) / LBB protection implemented in the respective Peripheral bay unit for all the connected circuits. For LBB protection
 - Operating time : 15 ms
 - Resetting time : 15 ms
 - LBB protection scheme shall be implemented to get individual initiation from the corresponding phase of main protections of line for each over current element. However common three phase initiation is acceptable for other protections and transformer/reactor equipment protections.
 - Have setting range of 20% to 80% of rated current.
 - Have timer with continuously adjustable setting range of 0.1 to 1 second.
14. The relay shall be equipped with VT modules to measure the bus voltages so that reference load flow can be taken from bus voltage as well as for providing secure operation in case of inadvertent shorting of CT.

Note: In case separate LBB relay is stipulated for EHT breakers, then LBB relay shall be provided accordingly even though Bus bar relay is equipped with built in LBB protection.

11. TRANSFORMER PROTECTION (APPLICABLE FOR 765 kV/ 400 kV ICT:

a) BIAS DIFFERENTIAL PROTECTION RELAY FOR THREE 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.
3. Differential protection features and characteristics:
 - i. Based on low impedance differential principle for protection of three winding transformer. Three phase with faulty phase identification.
 - ii. Shall have three instantaneous high set over current units with facility to adjust 5 to 20 times normal current.
 - iii. Shall have second and fifth 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.
- 4. Shall have inbuilt restricted earth fault protection and inbuilt over fluxing protection.
 - i) Over Fluxing Protection shall be provided for HV side and shall comply with the following requirements:
 - (a) operate on the principle of Voltage to frequency ratio and shall be phase to phase connected
 - (b) have inverse time characteristics, matching with transformer over fluxing withstand capability curve
 - (c) provide an independent 'alarm' with the time delay continuously adjustable between 0.1 to 6.0 seconds at values of ' v/f ' between 100% to 130% of rated values
 - (d) tripping time shall be governed by ' v/f ' Vs. time characteristics of the relay
 - (e) have a set of characteristics for Various time multiplier settings. The maximum operating time of the relay shall not exceed 3 seconds and 1.5 seconds at ' v/f ' values of 1.4 and 1.5 times, the rated values, respectively.
 - (f) have an accuracy of operating time, better than $\pm 10\%$
 - (g) have a resetting ratio of 95 % or better
 - (h) Over flux protection shall be provided in the HV
 - ii) Restricted Earth Fault Protection shall
 - (a) be single pole type
 - (b) be of current/voltage operated type
 - (c) have a current setting range of 10-40% of 1 Amp./ have a suitable voltage setting range
 - (d) be tuned to the system frequency.
- 5. The protection relay shall be equipped with built in thermal overload protection.
- 6. 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.
- 7. Equipped with sufficient numbers (minimum is 16 nos) of programmable of

opto isolated Binary inputs and sufficient numbers (minimum is 20 nos) of programmable potential free binary outputs with wetting voltage for digital inputs to be field programmable to 48V / 110V / 220V DC.

8. The minimum number of LEDs shall be 14 nos, In case Graphic display is provided then atleast 4 nos LEDs shall be provided for important alarms.

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 Over current 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. Under Frequency Relay :

- * Comply with the general requirements for numeric type relay furnished in this technical specification document.
- * The relay support programmable scheme logic. The PSL shall support Boolean logic and shall be possible to configure using preferably IEC 61131-3 standard compliant tools.
- * The relay shall be equipped with separate protection elements for 4 independent stages for under frequency protection, 3 independent stages for (81RF) Frequency supervised rate of change of frequency protection.
- * The relay shall have a discrete (digital) selection unit with built in timer and associated tripping relays to activate tripping.
- *UF Relay should have both phasor estimation & frequency averaging methods to correctly determine UF condition during voltage dip condition also.

Under frequency protection function (81U)		
1	No of Stages	4 independent Stages
2	Frequency range	45 Hertz to 55 Hertz
3	Frequency steps	In 0.01 HZ
4	Timers	One timer 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
7	No of phases	3

Frequency supervised df/dt protection (81RF)		
1	No of Stages	3 independent Stages
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
5	No of phases	3

* The relay shall be equipped with built in VT supervision function and 2 protection elements for under voltage blocking function selectable between IDMT/DT to block all the frequency based protection elements. The under voltage measurement shall be possible on phase to phase as well as phase to neutral basis.

* The relay shall have negative sequence overvoltage function. zero sequence voltage detection for VT fuse fail detection shall be used so that the relay does not maloperate on system ground faults

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

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

* The relay functionality shall include measurement of phase/ line voltages (True rms) , sequence voltages , system frequency and phase angles.

* Relay should have the capability to build the logic with which one should be able to adapt to the load shedding requirement of the substation.

*Blocking of each of the protection elements shall be possible with user interface through keypad/ buttons as well as through configuration port and Engineering work station.

* The relay shall be highly reliable and immune to transient and surges. In case of any component failure in the relay, the relay should not cause undesired trip.

Relay outputs:

* 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.

Indications

* The relay shall be equipped with indication lamps that is programmable to any of the protection elements, inputs, outputs and logic outputs.

*Programmable LED indications shall be provided in the relay for each stage of protection elements operated and for faulted phase indication.

Relay Inputs:

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

* 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.

13.0 MISCELLANEOUS PROTECTION

13.1 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.

13.2 Trip Circuit Supervision Relays.

The trip circuits shall be supervised by means of relays. The scheme shall continuously monitor the trip circuit before closing and after closing of the breaker. The schemes shall detect (I) failure of the trip supply (ii) open circuit of trip circuit wiring and (iii) failure of mechanism to complete operation. 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.

The relays shall have necessary contacts to be connected to protection scheme and annunciation to SAS.

13.3 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 auto reclose relay, LBB relay as well as to cater to associated equipments like SER, DR etc., to be provided with operation element/ coil.

13.5 Check Synchronizing relay:-

Synchro check function should be part of the main relay.

The synchronism and energizing check functions 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.

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

13.6 Relay for Automatic DC selection

Relay for automatic DC selection shall comply with the relevant parts of IEC 60255 / IS standards. The performance of the relay shall be satisfactory so as to facilitate minimum interruption of DC during DC change over and the DC interruption during change over shall not cause the numeric relays to reboot / switch off, also all the numeric relays shall be type tested for DC supply interruption and suitable to function without reboot/power off during the DC change over.

In case diode oring based DC selection scheme is proposed, then the scheme should ensure that any kind of component failure will not cause shorting of the input DC sources, the dielectric isolation between the two input DC sources should be sufficient for safe operation. Spare diodes 2sets should be provided for the substation.

14. Numerical relay for LBB protection

Comply with the general requirements for numeric type relay furnished in this technical specification document. Built in timer and necessary I/Os. Relay shall be of triple pole type and equipped with auto reclose protection with check Synchronising function. The operating time as well as a resetting time of the relay shall be preferably less than 15 ms.

15. Test terminal blocks

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

16. Guideline for Distribution of auxiliary power supply for Kiosk:

a. All ACDBs and DCDBs of suitable rating shall be provided with auxiliary contacts wired in

to terminal block for alarm indication of each MCB tripping.

b. For each Kiosk pertaining to one diameter of EHV the following shall be provided:

- i. DCDB of suitable rating for 220V DC Source -1 with feeder MCBs for DC supply to relay panels for one diameter of EHV. Typically 5 feeder MCBs dedicated to five relay panels in one diameter plus feeder MCBs for other panels and 3 spare MCBs.
- ii. DCDB of suitable rating for 220V DC Source -2: Similar to DCDB-1
- iii. ACDB of suitable rating for 230V AC Source with feeder MCBs for AC supply to relay panels for one diameter of EHV. Typically 5 feeder MCBs dedicated to five relay panels in one diameter plus feeder MCBs for other panels, utility and auxiliary items and 3 spare MCBs.

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 765 kV bays, 400 kV bays, ICTs, Reactors and associated equipments at the substation and all the station auxiliary equipments of the substation. The scope of SAS commissioning is inclusive of the system integration with the SAS of the following items: Control & Relay panels for EHT bays, Online diagnostic monitoring system for transformers, Online diagnostic monitoring system for transformers bushing in this context all necessary materials and works are included in the SAS scope of supply and commissioning. Communication interface between field device of online diagnostic monitoring system for transformers, bushings and the associated Work station should be using fibre optic cable only as this media is necessary to protect from Electro magnetic interference and the high voltage surges experience in the switch yard. The details of Electrical bays in the substation are given in the single line diagram of the substation.

The substation automation system (SAS) 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 designed such that it enables the user for control & monitoring of the substation at the HMI level (through Operator work stations), at the Bay level (through BCU) and at the switchgear level/Manually (facilitated by TNC switch, Energy meters etc).

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. The distributed architecture for the complete SAS is to be implemented with all the control and relay panels for one complete diagram to be

located in a kiosk located in the switch yard close to the corresponding diameter. The kiosk is of pucca building that ensures the room temperature even without the air conditioner is well within the operating temperature of all the Control & relay panels housed in the kiosk. All the communication link between the Control & relay panels in the kiosk and the Control room is by fiber optic cables only. All the communication link between the online diagnostic monitoring system for transformers and its bushings, reactors etc and the Control room is by fiber optic cables only.

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.

- All the numerical IEDs must be fully IEC 61850 compliant and must have the following features.
- Peer-to-peer communication using GOOSE messages (IEC 61850) for interlocking.
- Interoperability with third party IEC 61850 compliant devices
- Generate XML file for integration/engineering with vendor independent SCADA systems.
- 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 C&R 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-coordinated 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.

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
• Exchange of display (first reaction)	< 1 s
• Presentation of a binary change in the process display	< 0.5 s
• Presentation of an analogue change in the process display	< 1 s
• From order to process output	< 0.5 s
• 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 ~~230 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 complete DC system, input & output supply Voltages of chargers, load currents, Battery voltages etc.
- 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.
- m) Reset facility from HMI for reset of all numerical relays, master trip relays.
- n) Monitoring of control room temperature, kiosk room temperature etc.

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 over ride function should be accessed with higher level pass word security. All critical interlocks such as close operation of breakers and isolators etc shall be implemented in hardwired method also. In order to provide additional security for safe operation of the primary equipments, the hard wired interlock shall also be implemented preferably at the yard control cubicle.

6) SUPERVISORY FUNCTION: DATA 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 disturbance files from the IEDs with integrated disturbance recorder systems shall be automatically uploaded to a station HMI database. All the analog values shall in the disturbance records shall be displayed in primary values. 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 relevant EHV system (765 kV and 400 Kv) shall be measured and communicated on MODBUS / IEC 61850/ Standard Open 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 765kV Bays .

All relevant Status, alarms pertaining to ⁷⁶⁵~~400~~ KV Bays.

- b. 400KV Bays:

All relevant Status, alarms pertaining to 400 KV Bays.

- c. For each transformer 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
- Buchholz relay alarm
- Buchholz 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 various voltage level 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:

Switchgear status indication

Measurements (U, P, Q, F)

Event list

Alarm list

Status and display of DC system

Status of display of fire protection system

Acquisition of alarm and fault record from protection relays

Disturbance records

Trend curves

All necessary Indication, alarms, analog values etc apart from the above mentioned items for the complete substation shall be provided.

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,current 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 :

Equipped with Two optical Ethernet ports at the rear of BCU for parallel redundancy (in compliance to IEC-62439-3) in networking on IEC 61850 Protocol.

The

above referred 2nos Ethernet ports shall also be used for time synchronization using SNTP

protocol with guaranteed resolution of 1ms.

Binary Inputs : Sufficient for application plus spare opto-isolated inputs

(Spare binary inputs shall be minimum 4 nos or 20% of application quantity whichever is higher).

Binary Outputs : Sufficient for application plus spare potential free outputs

(Spare binary outputs shall be minimum 4 nos or 20% of application quantity whichever is higher).

For BCU used for common alarms for the substaion : The BCU shall be equipped with I/O modules sufficient for the application plus spare I/O points that are spare Binary input : 16 Nos, spare Binary Output : 8 Nos, Spare DC Analog input : 8 Nos. All necessary station alarms including but not limited to GIS alarms, Fire alarm system, Inverter, online diagnostic monitoring system for transformer, bushings etc shall be wired to SAS and made available in the SAS HMI.

All binary inputs, binary outputs and LEDs of BCU must be user programmable, 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 switchgears

(Breakers, isolators) shall be routed through suitable **interposing relays** with a scheme to automatically check the healthiness of these interposing relays. The Bay control IED should be provided with sufficient number of **programmable LED'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 implemented with redundant power supply modules in the BCU or with automatic DC source selection with a suitable auxiliary relay."

Functions for BCU:

- Control mode selection
- Select-before-execute principle
- Command supervision:
- Interlocking and blocking
- Double command
- Synchro check, voltage selection
- Run Time Command cancellation
- Operation counters for circuit breakers and pumps
- Hydraulic pump/ Air compressor runtime supervision
- Operating pressure supervision through digital contacts only
- Breaker position indication per phase
- Alarm annunciation
- Measurement and display of Vrms, Irms ,HZ ,W, Var for each phase and for 3phase
- Local HMI (local guided, emergency mode) with Graphic display for real time display of the bay status, measurands etc. The single line diagram in the display of the BCU shall be user configurable at site.
- Interface to the station HMI.
- Data storage for at least 200 events
- 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.

Wherever there is a redundant LAN architecture is specified for SAS, each BCU shall be preferably equipped with two separate Ethernet ports for connection to redundant LANs preferably with separate IP addresses.

Synchronism and energizing check

The synchronism and energizing check functions 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.

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

- i) 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 a substation. The system shall be able to track the satellites to ensure no interruption of synchronization signal.
- ii) Time synchronization equipment shall include antenna, all necessary accessories and all special cables and processing equipment etc.

iii) 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 TANTRANSCO

iv) 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.)

v) Equipment shall meet the requirement of IEC 60255 for storage and operation.

vi) 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.

vi) Equipment shall have real time digital display in hour, minute, second (24 hour mode)

vii) A separate time display unit (100 mm display high) at a suitable height in the control room should also be provided.

vi) It shall be compatible for synchronization of all the SAS equipments, all numerical devices and IEDs in the relay panels, Event Loggers, Disturbance recorders, PMUs and SCADA at a substation etc.

vii) The equipments should be equipped and ready to provide time synchronization signals with the following ports:

a) Ethernet ports -2nos for SNTP time signaling through the two separate Ethernet LANs.

b) PPS Fibre optic ports of sufficient numbers to time synchronise the devices requiring accurate time signals like Digital fault recorder, PMUs etc.

c) IRIG-B (Modulated) ports – BNC type and FO serial ports of sufficient numbers to signal the relevant devices for the new diameters of 765KV and 400KV level as well as for 3 spare diameters each for 765KV and for 400KV level.

d) Potential free contact (Minimum pulse duration of 50 milli Seconds.)

e) PTP port for time synchronization of necessary devices.

The time synchronization of all the relevant SAS equipments shall be realized using the SNTP protocol through the SAS LAN. A time accuracy of 1ms shall be achieved for all the devices within SAS.

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 values.
 - * 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.

All interlock status information for control circuits pertaining to the CB, Isolator, earth switch should be displayed in the SAS. Where ever interlock is not satisfied that should be highlighted in separate colour for operator alert.

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:

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.

- The alarm date and time.
- The name of device in alarming state.
- A descriptive text.
- 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.

The SAS servers and the Engineering workstations, gateway devices shall be equipped with all necessary hardware and original softwares to accommodate the future electrical bays without additional cost to TANTRANSCO and without the need for additional licenses from original equipment manufacturer.

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.

- a. Solidmechanical and electrical design
- b. Security against electrical interference (EMI).
- c. High quality components and TAN TRANSCOs.
- d. Modular, well-tested hardware.
- e. Thoroughly developed and tested modular software.
- f. Easy-to-understand programming language for application programming.

- g. Detailed graphical documentation and application software.
- h. Built-in supervision and diagnostic function.
- i. Panel design appropriate to the harsh electrical environment and ambient conditions.
- j. Panel grounding immune against transient ground potential rise.

The entire SAS shall be provided with comprehensive cyber security including intrusion protection and protection against virus attacks preferably integrated in the Ethernet switches, routers, IEDs etc. The cyber security shall provide protection against unauthorized access to the equipment and unauthorized transfer, modification or destruction of data whether deliberate or accidental. The SAS vendor shall propose how the SAS solution provides the cyber security. In this context all the necessary hardware and softwares is included in the scope of the SAS.

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:

- e. List of Drawings.
- f. Substation automation system architecture.
- g. Block Diagram.
- h. Guaranteed technical parameters,
- i. List of Signal-Analogue/Digital.
- j. Schematic diagrams.
- k. List of Apparatus.
- l. List of Labels.
- m. Logic Diagram.
- n. Test schedule and reports of FAT/SAT
- o. Product Manuals'
- p. Operator's Manual.
- m. Listing of software and loadable in CD ROM as well as in the

spare HDD.

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.

* 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.

Type	Industrial grade substation-hardened computer hardware equipment suitable to be rack mount in a IP 41 compliant cabinet housing 19" rack frames.
	Includes all necessary software and hardware for the application. KVM extender with Full size Keyboard with 10key numeric keypad, Mouse, Monitor. DVD +/- RW read write facility. Communication ports : 3XUSB, Dual 1000Mbps LAN ports, Plus ports for other user interface.
Cabinet for Server	IP41 compliant standalone cabinet with outer protective glass door. Equipped with all necessary accessories.

Processor	Latest generation intel processor ,3 GHz or Higher
Bus side speed	1000MHZ or higher
Softwares	Windows 8.1 professional or advanced version. 32 bit or higher. With antivirus software package. All necessary softwares for the application.
HDD	2 nos HDD 500 GB in redundant RAID-2 configuration (In case 500 GB is not sufficient for application including data then higher capacity shall be provided for each HDD. The HDDs should be configured such that mirror image of the data is available in the other HDD.
RAM	Expandable RAM equipped for 4GB or 200% application requirement whichever is higher.
DISPLAY MONITOR	29" LED monitor Flicker free, high resolution of reputed make. Flicker free (TUV Certified), Anti glare, IPS Panel, Full HD Resolution (1920x1080) with HDMI port and conventional port interface for computer interface. Min height : 15.5".

Note : The above configuration is minimum requirement, however a higher configuration is required for the application then the server shall be provided accordingly.

The redundant station HMI server shall operate in hot standby mode and vice versa in case of a switch over. The real time data base of the main and redundant HMI servers shall be synchronized at all times without loss of real time data in case of a switchover. Also one remote client facility for Station HMI access with relevant original licenses and software shall be provided.

Each of the server shall be equipped with two Ethernet ports for parallel redundancy (in compliance to IEC-62439-3) in networking on IEC 61850 Protocol. The above referred 2nos Ethernet ports shall also be used for time synchronization using SNTP protocol with guaranteed resolution of 1ms.

22) Engineering Work station

Type	Industrial grade substation-hardened computer hardware equipment.
	Includes all necessary software and hardware for the application. Full size Keyboard with 10key numeric keypad, Mouse , Monitor. DVD +/- RW read write facility.

	Communication ports : 3xUSB, Dual 1000Mbps LAN ports, Plus ports for other user interface.
Processor	Latest generation intel processor ,3 GHz or Higher
Bus side speed	1000MHZ or higher
Software	Windows 8.1 professional or advanced version. 32 bit or higher. With antivirus software package. All necessary softwares for the application. HMI Client access software. All softwares for configuration of numerical relays, IEDs,BCUs etc. DR Software for View and analysis of COMTRADE files.
HDD	2 nos HDD 500 GB in redundant RAID-2 configuration (In case 500 GB is not sufficient for application including data then higher capacity shall be provided for each HDD. The HDDs should be configured such that mirror image of the data is available in the other HDD.
RAM	Expandable RAM equipped for 4GB or 200% application requirement whichever is higher.
DISPLAY MONITOR	29" LED monitor Flicker free, high resolution of reputed make. Flicker free (TUV Certified), Anti glare, IPS Panel, Full HD Resolution (1920x1080) with HDMI port and conventional port interface for computer interface. Min height : 15.5".

Note : The above configuration is minimum requirement, however a higher configuration is required for the application then the server shall be provided accordingly.

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 workstation 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.

23) Metering PC

Type	Industrial grade substation-hardened computer hardware equipment
	Includes all necessary software and hardware for the application. Full size Keyboard with 10key numeric keypad, Mouse ,Monitor. DVD +/- RW read write facility. Communication ports : 3xUSB, Dual 1000Mbps LAN ports, Plus ports for other user interface.
Cabinet for Server	IP41 compliant standalone cabinet with outer protective glass door. Equipped with all necessary accessories.
Processor	Latest generation intel processor ,3 GHz or Higher
Bus side speed	1000MHZ or higher
Software	Windows 8.1 professional or advanced version. 32 bit or higher. With antivirus software package. Base communication software for ABT meter configuration and

	automated data retrieval from ABT meters using DLMS protocol.
HDD	2 nos HDD 500 GB SATA. (In case 500 GB is not sufficient for application including data then higher capacity shall be provided for each HDD.)
RAM	Expandable RAM equipped for 4GB or 200% application requirement whichever is higher.
DISPLAY MONITOR	27" LED monitor Flicker free, high resolution of reputed make. Flicker free (TUV Certified), Anti glare, IPS Panel, Full HD Resolution (1920x1080) with HDMI port and conventional port interface for computer interface. Min height : 15.5".

Note : The above configuration is minimum requirement, however a higher configuration is required for the application then the server shall be provided accordingly.

All relevant original software and tools for viewing in real time and generating reports relevant to metering data.

Metering reports should be customized as per TANTRANSCO's requirements.

The metering data from the meters shall also be integrated in to the station HMI servers in real time through the SAS LAN. The metering PC should 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.

Station LANs:

- Communication network at Station level (i.e at Level-2) : Dual LANs preferably Bus topologies.

ii. Redundancy boxes for interface of each of the computers without of PRP (PARALLEL REDUNDANCY PROTOCOL) support for compatibility with redundant communication architecture using to parallel redundancy protocol should be provided. However all numerical relays, BCUs and SAS servers, Gateway should be inherently equipped with two ports using PRP (PARALLEL REDUNDANCY PROTOCOL).

Inter-bay LANs:

- i. Communication network at inter-bay level (i.e at Level-1) : LAN implemented with double Redundant Rings. This implies that the Ethernet switches shall support double ring connectivity.
- ii. Self healing ring architecture shall be provided. The ring LAN architecture shall have the latest **IEEE** Standard version of RSTP with acceptable recovery time satisfactory for the application. Alternatively Redundant LANs based on PRP (parallel redundancy protocol) that facilitates vendor interoperable communications according to IEC 62439-3 is also acceptable.
- iii. Separate line interface unit for one full ~~40G~~ dia towards fiber optic cable interface for inter bay LANs shall be provided.

General:

The station LAN's shall be separate from the bay level LAN's.

All the LANs (Level-1, level-2 stipulated in IEC 61850 standard) for SAS shall support the following features:

- * The entire SAS shall be provided with comprehensive cyber security including intrusion protection and protection against virus attacks preferably integrated in the Ethernet switches, routers, IEDs etc. The cyber security shall provide protection against unauthorized access to the equipment and unauthorized transfer, modification or destruction of data whether deliberate or accidental. The SAS vendor shall propose how the SAS solution provides the cyber security.
- * IEEE 802.1Q VLAN facility.
- * Traffic segregation and prioritization control via IEEE 802.1p and IEEE 802.1Q

- * Support SNMP preferably the latest version to provide secure and full network management. Port Security through disabling of packets from unauthorized MAC addresses. RMON for monitoring of network status & statistics.
- * IGMP Snooping enabling reductions in multicast traffic
- * SNTP for synchronizing the internal clock of all the devices connected to the LAN.
 - * RSTP (IEEE 802.1w) industry standard method for providing recovery of redundant networks
 - * RMON for monitoring of network status & statistics
 - * Port Mirroring assisting network troubleshooting
 - * Event Logs creating a historical record of events occurring on the network
 - * Port Security through disabling of packets from unauthorized MAC addresses
 - * SSL Web encryption preventing eavesdropping, tampering or message forgery
- * The backbone link for each ring network

25) CAPACITY:

The system should be capable of handling up to 150 IEDs and 10,000 data points. In case the application considering with future bays necessitates to support higher number of devices and data points then the system shall be equipped accordingly.

26) SEQUENCE 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.

*** The Ethernet switches shall be equipped with 50% spare ports.**

* Dedicated Separate set of Ethernet switches shall be provided for each dia.

* Ethernet switches shall support the features stipulated under general specification for the LAN.

* Should be Compliant to parallel redundancy Protocol (PRP) in networking on IEC 61850.

* Digital Diagnostic Monitoring (DDM) for Fiber :

Ethernet switches shall be equipped with the functionality to monitor ST/SC (as well as SFP) connectors, and NMS via SNMP trap when abnormalities are detected, allowing

operators to initiate maintenance procedures, Further the complete LAN system shall allow system operators to monitor things like transmission and reception power, temperature, and voltage/current along optical fiber connections in real time.

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.**

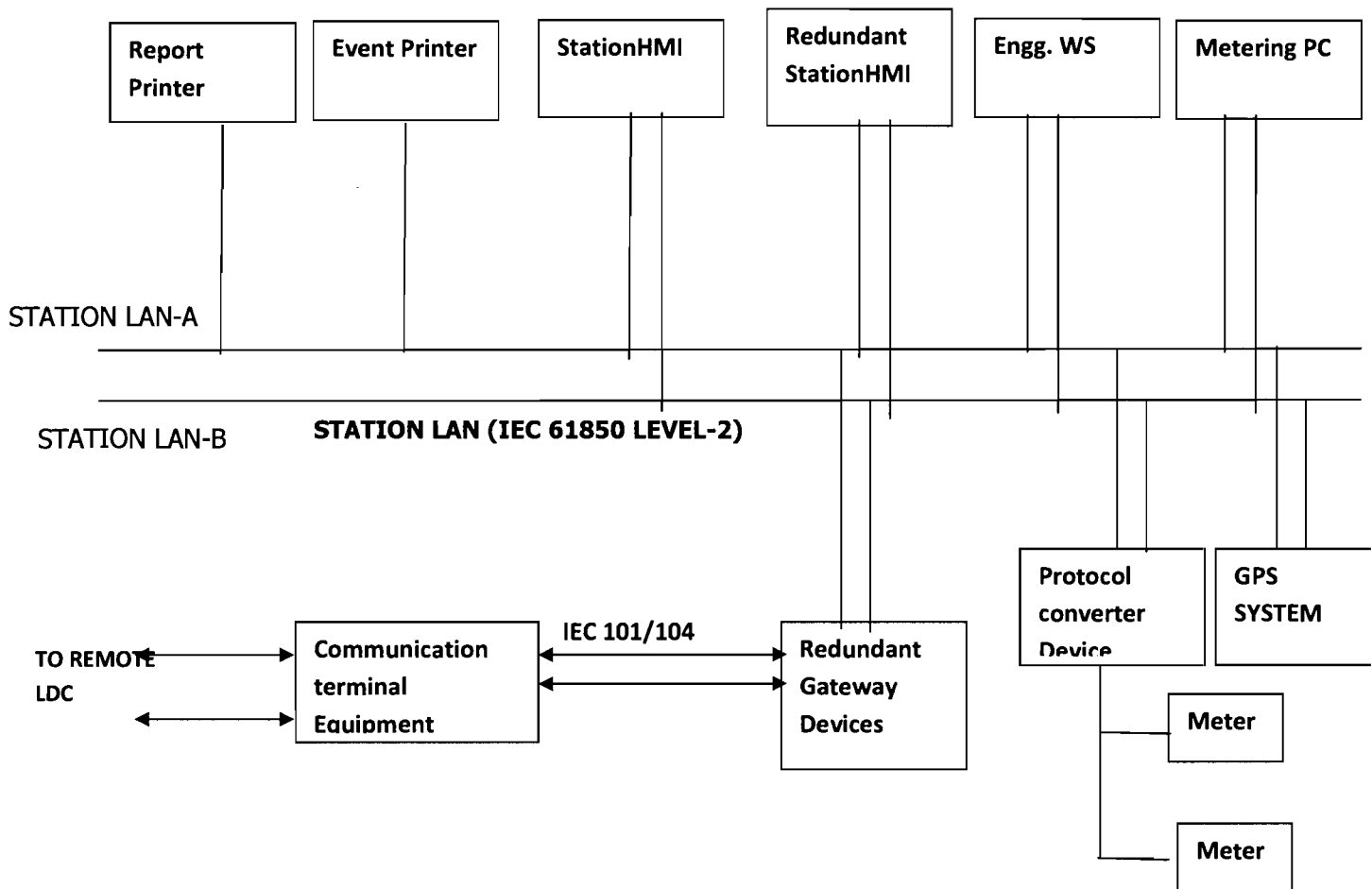
- Support IEC 61850 protocol, IEC 60870-5-101/104 protocol.

- **Perform the data concentration** by directly collecting data from the bay level devices and provide the same to the remote LDC/Master with out 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.
- 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 rack mount 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.
- Gateway shall be equipped with redundant power supply modules and communication modules.

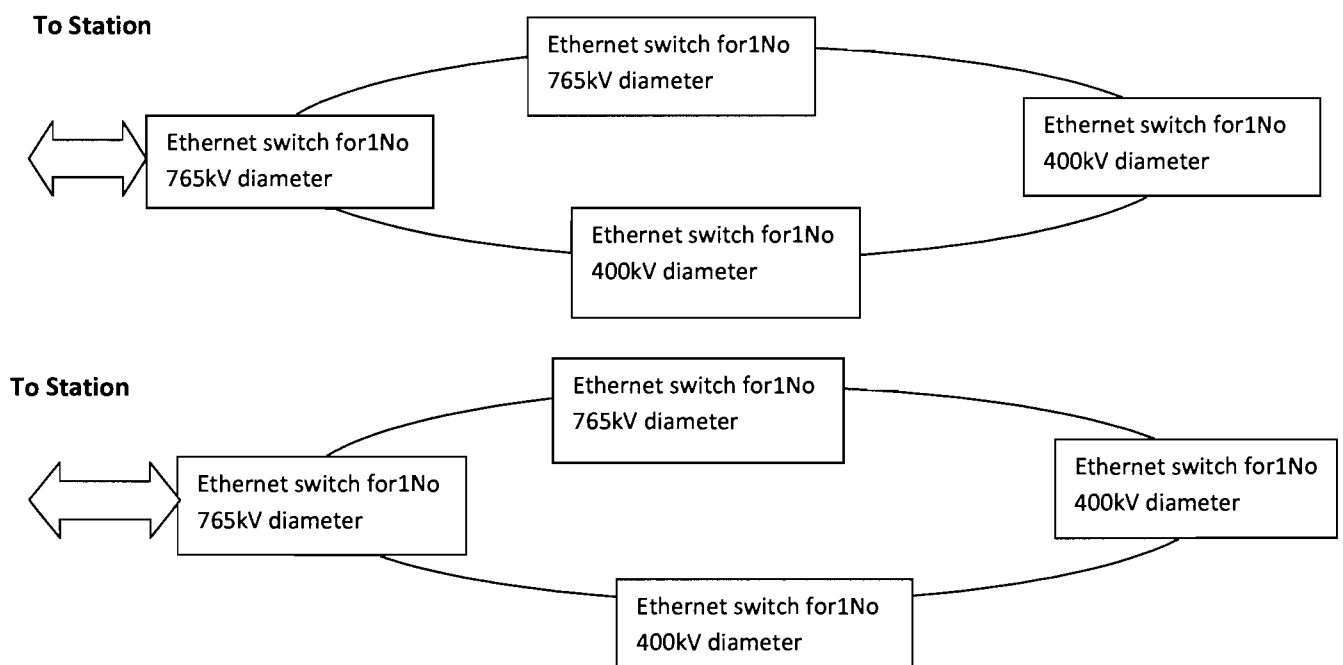
Redundant Gateways i.e 2 nos Gateways operating in redundant configuration shall be provided. One of which operating in online and the other operating in hot standby by shall be provided. The switchover between gateway devices shall be Automatic, quick enough for the application, bump less without loss of SAS data during switchover, the databases of the online and hot stand by shall be synchronized in real time. It shall be possible to operate with one gateway device in case of outage or failure of one gateway device.

Each of the gateway unit shall be equipped with two Ethernet ports for parallel redundancy (in compliance to IEC-62439-3) in networking on IEC 61850 Protocol. The above referred 2nos Ethernet ports shall also be used for time synchronization using SNTP protocol with guaranteed resolution of 1ms.

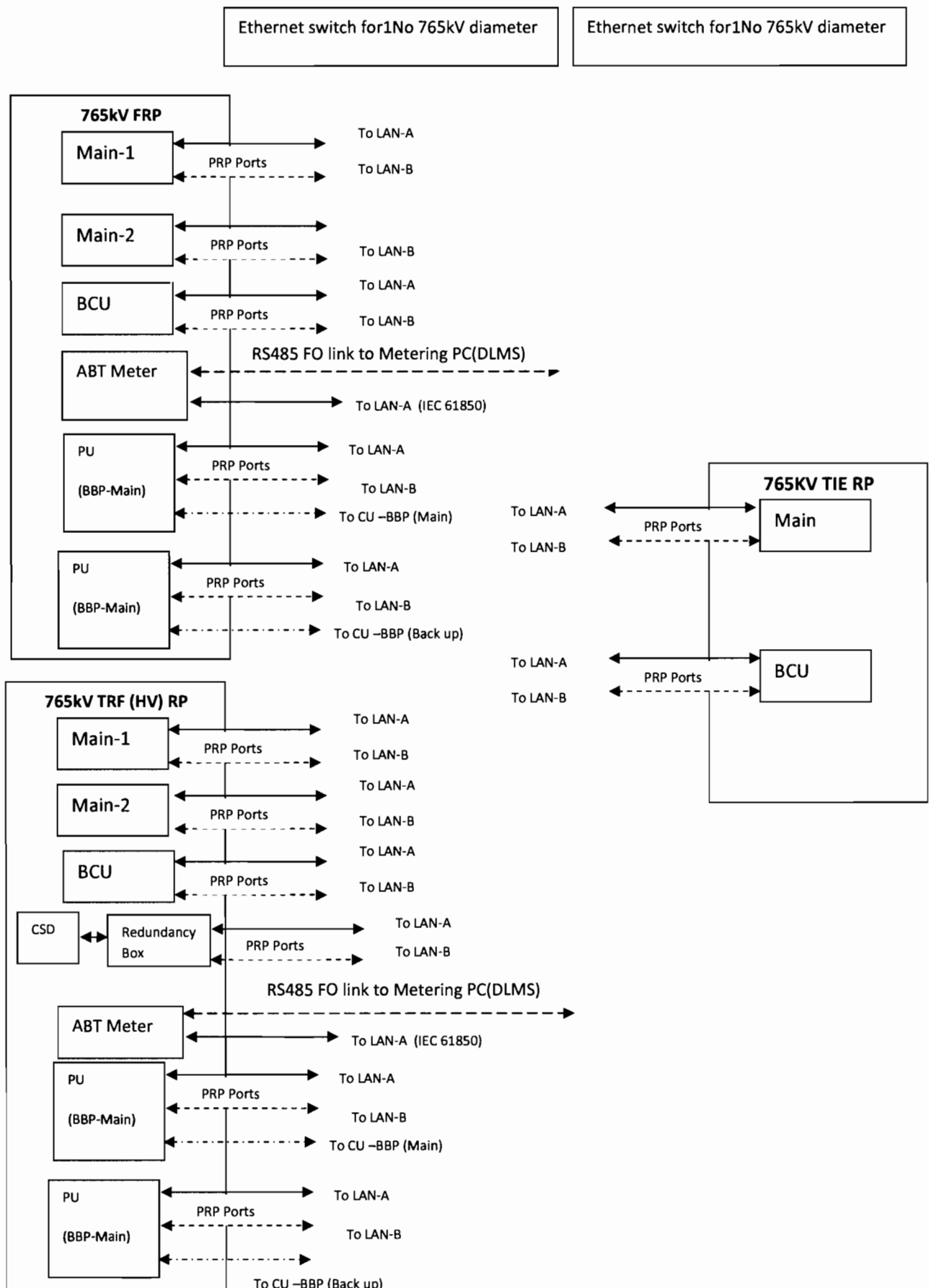
29) CONCEPTUAL SCHEME FOR SAS



INTERBAY LAN (IEC 61850 LEVEL-1)



SAS ARCHITECHTURE : INTERBAY LAN (IEC 61850 LEVEL-1)



Note :

1. Link between Ethernet switches in each diameter is of ring architecture with RSTP protocol the ring recovery time should be small enough to avoid disruption to sub-station automation system. This is applicable for LAN-A as well as LAN-B Ethernet switches. Ethernet switches should also be compliant to PRP.
2. All Devices connected to Both LAN-A and LAN-B should be compliant to parallel redundancy protocol.
3. Ethernet switch for one diameter should be equipped with tributary ports for connecting all devices in the relay panels for one EHV diameter plus 50% spare ports.
4. Devices shown in the drawings above is for conceptual information. Any other devices and relay panels in each diameter will be applicable as required.
5. Necessary technical support such as ensuring protocol interoperability towards the integration of SAS Data at Remote VDC end is included in the scope of this tender.

30. INVERTER :

1.The inverters shall comply with the following specification and characteristics:

TYPE	Type of inverter On Line μ P controlled IGBT based Static inverter
Rating @ 50 °c of each inverter	120% of assigned load or 3 KVA whichever is higher.
Type of power switching	Pulse width modulation
No. of inverters	2 nos to operate in redundant configuration with automatic switch over in case of failure of one unit.
Input Voltage	220V DC +/- 10% taken from station battery banks
Output voltage	Single phase 230V AC + /-1%
Nominal frequency	50 Hz
Frequency regulation i) Free running	0.01 HZ
Total harmonic distortion of output voltage	Less than 2.5% for linear load & Less than 5% for non-linear load
Single harmonic of output voltage	Less than 3%
Power factor range	Rated 0.8 (0.6 to Unity, within KVA & KW)
Method of cooling	Forced air cooling
Assigned Load	SAS Servers, Engineering Workstation, Metering PC, LAN Equipments pertaining to Level-2, Printers Etc.
Alarm	Dry contact for minor and major alarm

Note: A worksheet depicting the total calculation of the assigned load should be furnished in assessing the rating of the inverter.

2.The inverters shall comply with the following characteristics:

i) The inverters shall normally operate in synchronism with the mains AC power source. Upon loss of the mains AC power source or its frequency deviating beyond a preset range, the inverters shall revert to their own internal frequency standard. When the mains AC source returns to normal, the inverters shall return to synchronized operation with the mains AC source. Such reversal of operation of

inverters from synchronous to free running mode and vice-versa shall not introduce any distortion or interruption to the connected loads. A suitable dead band for frequency may be provided to avoid unnecessary frequent reversal of inverter operation between free running mode and synchronized mode under fluctuating frequency conditions.

ii). For safe operation in the event of Power failure or input source voltage dropping below preset value, necessary safeguard software shall be built in for proper shutdown and restart.

iii) The inverters shall be synchronized to the main AC source unless that source deviates from 50 Hz by more than 1% (adjustable to "1/2/3/4/5%).

iv). The inverters shall provide interrupter switch to isolate the unit from the load on failure of the unit. The interrupter switch shall be rated to carry full continuous load and to interrupt the inverter under full fault load.

v).The inverters shall be capable of supporting a start-up surge or overload of 150 % of rated output for up to 60 seconds.

vi).The transient voltage response shall not exceed "4% for the first half-cycle recovering to 1% within ten cycles for a 100 percent step load application or removal.

3. Control panel for auto/manual switch over of the redundant inverters shall be provided with the inverter.

4.The scope of supply, installation, testing and commissioning of inverter also includes All the necessary AC Distribution boards, DC Distribution boards, Control panel to facilitate manual change over, auto change over and bypass mode with meters for monitoring the voltages. Tender scope includes all the necessary power cables and control cables for this equipment.

5. Type tests for inverter:

The inverter shall comply to IS 13314 / Equivalent standards as applicable for the KVA required for the project

This includes the following tests.

1. Visual inspection test
2. High voltage test
3. Insulation resistance test
4. No-load test

5. Output test
6. Climatic tests
7. Harmonic contents test
8. Radio frequency interference test for conducted emission in the AC output circuit.

31. Laptop computer for SAS tool

Type	Reputed make laptop computer
Processor	Latest generation intel processor ,3 GHz or Higher
Software	1.Windows 8.1 professional or advanced version. 32 bit or higher. 2. Antivirus software package validity for entire project guarantee period. 3. HMI software for client access to SAS HMI. 4. MS office suite latest version. 5.All other necessary software for configuration of SAS devices, Relay panels devices.
HDD	2 nos HDD 500 GB (In case 500 GB is not sufficient for application including data then higher capacity shall be provided for each HDD.)
RAM	Expandable RAM equipped for 4GB or 200% application requirement whichever is higher.
DISPLAY	15" LED monitor HD resolution, Anti glare.
Optical drive	DVD +/-RW
Keyboard & MOUSE	Full size Spill resistant keyboard with 10key numeric keypad, Optical mouse.
Connectivity	Wifi, Bluetooth, USB port-3nos, RJ45 10/100Mbps Ethernet port.

BILL OF MATERIALS FOR CONTROL & PROTECTION RELAY PANELS

Note :

1. The bill of materials for relay panels in this section is for conceptual information, however any additional component and devices required in the relay panels to fulfill the protection, control and metering scheme shall be included without additional cost.

2. The Bus bar protection panel shall be equipped completely to accommodate all the Bays including future Bays depicted in the single line diagram of the substations plus 6 spare circuits.

3. The under frequency scheme for feeders shall be equipped completely to accommodate all the feeders including future feeders depicted in the single line diagram of the substations plus 3 spare feeders.

4. DC supervision relay should be provided for each of DC sources and at the DC output of the DC selection relay. The DC fail alarm should be made available to the SAS.

5. If Functions of supervision relays, trip relays, selector switches, auxiliary relays are incorporated in a multifunction IED then it is 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 failure of simultaneous failures of Main-I/Main and main-II/Backup protection scheme

6. VT selection for control & Relay panes:

VT selector switch for selection between Line VT/ Bus VT-1/ Bus VT2 shall be provided. However the scheme shall be provided with logic to ascertain the correct Bus VT. Separate core shall be wired for Main-1 protection, Main-2 protection and metering devices.

7. Redundancy boxes for interface of each of the IEDs with single Ethernet port for compatibility with redundant communication architecture using to parallel redundancy protocol should be provided. However all numerical relays, BCUs, Gateway and SAS servers should be inherently equipped with two ports using PRP (PARALLEL REDUNDANCY PROTOCOL).

I. BOM : Relay panel for 765 kV Feeder/Lines as well as for 400 kV Feeder/Lines

- | | | |
|-----|--|--------------|
| 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. Make should be different from Main-1. | 1 No |
| 3. | Bay control unit | 1 No |
| 4. | Auxiliary relay for Automatic DC source selection | As required. |
| 5. | Electronic ABT Trivector meter(As per specification) | 1No. |
| 6. | Single phase trip relay (with self-reset contacts) | 6 Nos. |
| 7. | Trip circuit supervision relay | 6 Nos. |
| 8. | DC supply supervision relay | As required. |
| 9. | Control switch (TNC) spring return type with pistol grip handle for Breaker | 1 No. |
| 10. | P.T. selection scheme with bistable relays | 1 Set |
| 11. | Bus bar Tripping relay (96) | 1 No |
| 12. | Three phase Master Trip relay (H&ER reset contacts, Hand reset flags) | 2 Nos. |
| 13. | Three phase master Trip relay for UF (81U,81R) scheme
(Self reset contacts, HR flags) | 1 No. |
| 14. | Supervision relays for all the master tripping and lockout relays | As required |
| 15. | Selector switch (A/R IN/OUT; 2Position stayput) | 2 Nos. |
| 16. | Selector switch (Carrier IN/OUT, 2Position, 4 Ways,Stay put) | 2 Nos. |
| 17. | Auxiliary relay for Automatic DC source selection | 1 Set |
| 18. | Auxiliary relay for circuit breaker alarms/trip
(Typically :Loss of SF6, PD Trip, General Lockout, SF6 Lockout, 81X) | As required |
| 19. | Synchronising socket 12 Pin / Bus wiring | As required |
| 20. | Auxiliary relays and timers to fullfill protection scheme | As required |
| 21. | Standard relay panel accessories as stipulated in this specification | -As required |

II. BOM: ISLANDING PANEL for 765 kV Feeders as well as for 400 kV Feeders

1. a) Numerical under frequency relay 1 Set
(As per specification includes 81U,81RF,27,59 etc)
- * b) SEPARATE RELAY FOR 27/59 FUNCTION SHALL BE SUPPLIED .
2. DC supply supervision relay As required.
3. P.T. selection scheme with bistable relays 1 Set
4. Supervision relays for all the tripping and lockout relays As required
5. Selector switch for IN/OUT selection of UV,UF,f+df/dt, As required
6. Auxiliary relays and timers to full fill protection scheme As required
7. Auxiliary relay for Automatic DC source selection As required.
8. 3-phase Master Trip relay for UF (for 81U,81RF) scheme for future feeders: 6 nos
9. Supervision relays for all the 86UF relays 6 nos
10. Standard relay panel accessories as stipulated in this specification As required

Note :

1. Master Trip relay for UF (81U,81RF) scheme is to be provided in the respective feeder relay panels.
2. As the SAS is in distributed architecture and in order to reduce the cabling, the stage wise trip output commands for respective feeders shall be communicated through GOOSE messaging to the numerical main-1 and main-2 protection relays of respective feeder bays.

III. BOM: Relay panel for 765 kV Tie breaker as well as for 400 kV Tie breaker :

1. Bay Control unit 1 No
2. Numerical relay for LBB and O/C,E/F protection 1 No
3. Three phase Master Trip relay (H&ER reset contacts, Hand reset flags) 2 Nos.
4. Three phase Trip relay for UF (81U,81R) scheme 1 No.
(Self reset contacts, HR flags)

- | | |
|--|--------------|
| 5. Single phase trip relay with self reset contact | 6 Nos |
| 6. Trip Circuit Supervision relay (Pre close and Post close) | 6 Nos |
| 7. DC supervision relay | As required. |
| 8. Ethernet switch as per specification | As required |

(Atleast 1 no for one full 400KV dia)

- | | |
|---|--------------|
| 9. TNC Control switch spring return type with pistol grip handle for Breaker 1 No 10. Relay for Automatic DC source selection | As required. |
|---|--------------|

- | | |
|--|--------------|
| 11. High speed trip relay (96) for busbar protection | As required. |
|--|--------------|

- | | |
|--|-------------|
| 12. Supervision relays for all the tripping and lockout relays | As required |
|--|-------------|

- | | |
|---------------------------------|-------------|
| 13. Auxiliary relays and timers | As required |
|---------------------------------|-------------|

- | | |
|---|-------------|
| 14. Auxiliary relay for circuit breaker alarms/trip | As required |
|---|-------------|

(Typically : Loss of SF6, PD Trip, General Lockout, SF6 Lockout, 81X)

- | | |
|---|--|
| 15. Standard relay panel accessories as described in this technical specification document. | |
|---|--|

IV. BILL OF MATERIALS FOR BUS BAR PROTECTION RELAY PANEL 765 KV as well as for 400 KV:

- | | |
|---|-------|
| 1) Set of low impedance bus bar protection scheme of Numerical type for single/double zone with check zone for bus. | 1 Set |
|---|-------|

i) Central unit -1 No.

ii) Peripheral units –As required for all Main breakers of each diameter plus six spare

peripheral units. + future Diameters shown in SLD ~~Diagram~~

- | | |
|--------------------------|--------------|
| 2) DC supervision relays | As required. |
|--------------------------|--------------|

- | | |
|--|-------------|
| 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) | As required |
|----------------------------|-------------|

(shall be be a part of relay panel of the respective panels)

- 7) Supervision relay for B/B protection As required

trip relays (shall be a part of relay panel of the respective panels)

- 8) Standard relay panel accessories as stipulated in this specification As required

Note :

- 1.The Bus bar protection is a redundant (1+1) scheme i.e The above BOM will be duplicated in second set of Bus bar protection panel. ~~One set of busbar protection should be of different make from the other set.~~
- 2.Spare Peripheral units shall be installed in a separate panel and the same shall be located in switchyard panel room where bus bar protection panel shall be installed.
3. Peripheral units with all necessary associated materials shall be installed in the respective bay protection relay panels.
4. For dedicated FO link for redundant Busbar protection scheme consider LIUs as required apart from the LIUs for the SAS LANs.

V.BOM : RELAY PANEL FOR 765 kV / 400 kV ICT (AUTO TRANSFORMER)

- | | |
|--|--------------|
| 3. Electronic Trivector meter | 2 Nos. |
| 4. Numerical relay for Main-1 protection
(As per specification for biased differential protection for three winding Transformer plus non-directional over current protection with LBB and high set for HV side) | 1 No. |
| 5. Numerical relay for Main-2 protection
(As per specification for biased differential protection for three winding Transformer plus non-directional over current protection with LBB and high set for HV side) | 1 No. |
| 6. Numerical non-direction over current protection relay with LBB and high set for LV side | 1 No. |
| 5. Relay for Automatic DC selection | As required. |
| 6. Bay control units for HV and LV | 2 Nos |
| 7. TNC Control switch spring return type with pistol grip handle for Breaker | 2 Nos |
| 8. Three phase Master Trip relay (H&ER reset contacts, Hand reset flags) | As required |
| 9. Trip transfer switch | 1 Set |

(3 Position (Normal-BCU Auto-Transfer selector switch), stay put, Lockable type with removable key, sufficient way)(This item applicable if transfer breaker is available)

10. Trip circuit supervision relay for HV and LV trip coils As required
(pre close and post close)
11. D.C. supply supervision relay As required.
12. Transducer for Tap position indication 1 no.
(30-250VDC auxiliary supply, IEC 60688 compliant, Output 4-20mA)
13. Supervision relays for all the tripping and lockout relays As required
14. Auxiliary relay for transformer alarms and trip As required

(Typically : Buchholz alarm-3 Element, Oil flow alarm-3, WTI-3 Element, OTI-3 Element, Oil level alarm-3 Element, PRV Trip-3 Element, Buchholz trip-3 Element, OLTC Low oil Level- 3Element)
15. Auxiliary relay for circuit breaker alarms/trip As required
(Typically :Loss of SF6, PD Trip, General Lockout, SF6 Lockout, 81X)
16. Auxiliary relays and timers to fulfill scheme As required
17. P.T. selection scheme with bistable relays (for HV and LV) 2 Sets.
18. High Speed tripping relay (96) for B/B protection 2 Nos
19. Standard relay panel accessories as stipulated in this specification As required
21. Selector switch for L/R selection 2 Nos

Note :

1.Main-1 and main-2 numerical relays should be of different make.

2. CSD in the scope of supply of breaker for each transformer shall be installed in the transformer relay and integrated with SAS.

VI.BILL OF MATERIALS FOR RELAY ^{Panel} FOR 765 KV LINE REACTOR AS WELL AS FOR 400 KV LINE REACTOR:

1. Numerical Reactor differential protection relay (87R) - 1 Each
2. Numerical Restricted earth fault protection relay (64R) -As required

(Low Z based For Neutral and neutral grounding reactor side as applicable)
3. Numerical Local breaker back up protection (LBB) (50Z) - 1 Each

- | | | |
|-----|---|----------------|
| 4. | Numerical under impedance protection relay (21R) | - 1 Each |
| 5. | Numerical protection relay for (50/51, 50N/51N,64R,50Z,59) | As required |
| 6. | Numerical neutral displacement protection relay | As required |
| 7. | Flag relays for thermal imaging, MOG,WTI,OTI,
Bucholz,PRV and status indication. | As required. |
| 8. | Bay control unit | 1 No |
| 9. | DC supervision relays | As required. |
| 10. | Auxiliary relays and timers,trip relays etc. to fulfill
protection & automation scheme. | - As required. |
| 11. | High speed trip relay (96) for busbar protection | 1 No |
| 12. | Three phase Master Trip relay (H&ER reset contacts, Hand reset flags) | 2 Nos. |
| 13. | Supervision relays for all the tripping and lockout relays | As required |
| 14. | TNC Control switch spring return type with pistol grip handle for Breaker | 1 No |
| 15. | Auxiliary relay for circuit breaker alarms/trip
(Typically :Loss of SF6, PD Trip, General Lockout, SF6 Lockout, 81X) | As required |
| 16. | LBB isolation link | 1 No. |
| 17. | Relay for Automatic DC source selection | 1 no. |
| 18. | Standard relay panel accessories as described in this technical specification document. | |

Note :

1.The protection scheme for Bus reactor may be grouped in to Grouped in to two numerical multifunction protection relays wherein the differential protection and backup impedance shall not be implemented in the same relay. In this context the protection scheme shall be such that all type of faults within the reactor shall be detected by both the group 1 & group2 relays. However separate numerical relay for LBB protection is applicable.

2. CT supervision, VT supervision shall be provided in the relays.

3. CSD in the scope of supply of breaker for reactor shall be installed in the reactor relay and integrated with SAS.

VI.BILL OF MATERIALS FOR RELAY PANEL FOR 765 KV BUS REACTOR AS WELL AS FOR 400 KV BUS REACTOR:

1. Numerical Reactor differential protection relay (87R) - 1 Each
2. Numerical Restricted earth fault protection relay (64R) -As required
(Low Z based For Neutral and neutral grounding reactor side as applicable)
3. Numerical Local breaker back up protection (LBB) (50Z) - As required
4. Numerical under impedance protection relay (21R) - 1 Each
5. Numerical protection relay for (50/51, 50N/51N,64R,50Z,) As required
6. Numerical neutral displacement protection relay As required
7. Flag relays for thermal imaging, MOG,WTI,OTI, As required.
Bucholz,PRV and status indication.
8. Bay control unit 1 No
9. DC supervision relays As required.
10. Auxiliary relays and timers,trip relays etc. to fulfill - As required.
protection & automation scheme.
11. High speed trip relay (96) for busbar protection 1 No
12. Three phase Master Trip relay (H&ER reset contacts, Hand reset flags) 2 Nos.
13. Supervision relays for all the tripping and lockout relays As required
14. TNC Control switch spring return type with pistol grip handle for Breaker 1 No
15. Auxiliary relay for circuit breaker alarms/trip As required
(Typically :Loss of SF6, PD Trip, General Lockout, SF6 Lockout, 81X)
16. LBB isolation link 1 No.

17. Relay for Automatic DC source selection

As required.

18. Standard relay panel accessories as described in this technical specification document.

Note :

1. The protection scheme for Bus reactor may be grouped in to Grouped in to two numerical multifunction protection relays wherein the differential protection and backup impedance shall not be implemented in the same relay. In this context the protection scheme shall be such that all type of faults within the reactor shall be detected by both the group 1 & group2 relays. However separate numerical relay for LBB protection is applicable in case the LBB for the breaker(s) are not covered in any other scheme.

2. CT supervision, VT supervision shall be provided in the relays.

3. CSD in the scope of supply of breaker for reactor shall be installed in the reactor relay and integrated with SAS.

VII. Standard relay panel accessories:

All the Control & Relay panels shall have the following

- | | | |
|--|---|------------------------|
| 1. Cubicle illumination Lamp (CFL/LED) 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 testing metering & protection devices | - | As required |
| 5. Test block | - | As required |
| 6. Cable glands | | As required |
| 7. Terminal blocks | | As required+20% Spares |
| 8. Wires for CT, Earthing | | As required |

(2.5 Sq.mm, Multi strand, 1100V Grade, PVC Insulated, FRLS)

- | | | |
|--|--|-------------|
| 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 | | 1 Each |
| (Free standing, self supported, with swing frame for devices and outer glass door.) | | |
| 12. Labels for devices | 2 Sets | |
| (Inside and outside the panel) | | |
| 13. Label for panel designation | - | 2 Nos |
| 14. MCBs (with auxiliary contact) for DC Supply and AC supply distribution | | As required |
| circuits | | |
| 15. DC fail test/accept button | - | 2 Each |
| 16. AC bell for DC fail alarm | - | 1 no |
| 17. Synchronising socket (12 Pin) | - | 1 No. |
| (Applicable for interface with synchronising trolley) | 1 No. | |
| 18. Push button for manual resetting of master trip relays (86,96) | | As required |
| 19. Fuses (VT circuits) and links | | As required |
| 20. Dedicated Line interface unit for interbay fiber optic LAN interface | | As required |
| (Typically 4 nos; i.e 2 Units for each LAN. For dedicated FO link for redundant Busbar protection scheme consider LIUs as required) | | |
| 21. Isolation links for isolation of LBB, trip outputs etc. | | As required |
| 22. Cable glands | | As required. |

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. |

VIII. BOM FOR SAS (Applicable for each SAS)

Sl. No	Description	Unit	Qty
1	Industrial grade computer for station HMI (As per technical specification)	Nos.	2
2	Engineering work station (As per technical specification)	No.	1
3	Metering PC (As per technical specification)	No.	1
4	Gateway Panel (Complete with panel, Gateway Devices- 2nos in redundant configuration, Hooter-2nos for substation urgent & non-urgent alarms)	No.	1
5	Communication equipment (Complete with MODEMs, Lightning arrestors for MODEM, Communication ports and Media interface device etc for gateway redundant interface to LDC)	sets	2 (i.e 1 set at SS and 1 set at Remote LDC)
6	Bay Control Unit	Nos.	As required. (Refer note below.)
7	Ethernet Switches (50 % spare ports in each switch) to implement Redundant LANs at Station level and inter bay level	Nos.	As required.
8	General printer (A3 Colour LASER Jet Printer)	No.	1
9	Report printer (A4 Colour LASER Jet Printer)	No.	1
10	All LAN cables with associated cable ducts and all accessories, media converters etc running within a KIOSK for each diameter as well as in control room building). All communication cables with associated cable ducts and all accessories, media converters etc for control, protection, metering scheme running within a KIOSK for each diameter as well as in control room building) Line interface units : As required. FO Patch panel – 2sets (in control room for termination and interface of FO cables from the switchyard)	Lot	1
11	Time synchronization system (GPS with all accessories, Antenna, cables, software, Lightning arrestors for GPS, Separate time display unit display size of approx. 100 mm height. etc)	Set	1

12	Configuration tools for SAS and Relay panels. 1.SAS HMI software for Client access. 2.Laptop computer with all necessary software-1 set. 3. CMRI Instrument (DLMS compatible for ABT meter)-1No. 4. Software for configuration of all devices in relay panels- 1 set 5. Software for configuration of all SAS devices-1 set. 6. Special Crimping tools – 1 set 7. Test plug – 3nos 8. Fibre optic Splicing kit-1 set. 9.Any other necessary tools for SAS & relay panels.	Set	1
13	Inverter (As per technical specification)	Sets	2
14	Relevant manuals as per SA specification.	Lot	1
15	Furniture : Chair (industrial grade revolving type with cushion, neck rest and adjustable height and wheels for mobility.)	Nos.	5
16	Furniture : Curved type Tables for SAS operator – 2Nos; Table for Engg WS & Metering PC : 2nos. Each table shall be provided with lockable drawers-2nos.	Lot	1
17	Furniture : Tables with drawers-4nos suitable for housing all the drawings & manuals of the SAS and protection system.	Lot	1
18	Digital temperature sensor with backlit LCD display and transducer for SAS interface for room temperature measurement in each Kiosk and switchyard Control Room	Sets	As required

Note:

1. The ~~price of the~~ relay panel shall be inclusive of the BCU mentioned in the BOM for the respective relay panel. The BCU/IED for common alarms shall be considered under supply of SAS.
2. IED(s)/ BCU(s) with graphic display of sufficient I/O capacity shall be offered for covering all the sub-station auxiliary items, RMU, Fire alarm system, complete Power supply (Charger, Battery and distribution system (DCDB, ACDB), 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.

4. Furniture shall be industrial grade, reputed brand with design life for 20 years.

5. Outdoor type ~~arranged~~ Fibre optic cables ^(Add) for the SAS LANs for linking the Relay panels in each diameter housed in each kiosk to the SAS LANs (at level-1,2) and for implementing communication link for any other control, protection and metering scheme should be provided in the SAS scope if a separate price item for these cables are not in the price schedule.

XV. Spares:

Sl.no	Description	Unit	Qty	Remark
1	Bay control Unit for 765 KV	No.	1	BCU shall be equipped with maximum configuration stipulated among 765 kV Bays application.
2	Bay control Unit for 400 KV	No.	1	BCU shall be equipped with maximum configuration stipulated among 400 kV Bays application.
2	Numerical Main-1 Distance protection relay suitable for 765 kV feeder	No.	1	Main-1 as stipulated for 765 kV relay panel.
3	Numerical Main-2 Distance protection relay suitable for 765 kV feeder	No.	1	Main-2 as stipulated for 765 KV relay panel.
2	Numerical Main-1 Distance protection relay suitable for 400 kV feeder	No.	1	Main-1 as stipulated for 400 kV relay panel.
3	Numerical Main-2 Distance protection relay suitable for 400KV feeder	No.	1	Main-2 as stipulated for 400KV relay panel.
4	Numerical Main-1 protection relay for 765 kV/400 kV ICT.	No.	1	Main-1 relay as stipulated for relay panel for ICTs.
5	Numerical Main-2 protection relay for 765 kV/400 kV ICT.	No.	1	Main-1 relay as stipulated for relay panel for ICTs.
7	Numeric relay for bus bar protection- Central Unit	Sets	2	Each set should be of different make corresponding to the bus bar relay panel.
8	Numeric relay for bus bar protection- Peripheral Unit	Sets	2	Each set should be of different make corresponding to the bus bar relay panel.
9	Ethernet switch for one diameter plus 50% spare ports	Nos.	4	
10	Ethernet switch for Control room plus 50% spare ports	No.	1	
11	Electronic Trivector meter (ABT)	No.	1	As stipulated for relay panel
12	Automatic DC selection relay	Nos.	4	As stipulated for relay panel.
13	Master tripping relay (86)	No.	4	As stipulated for relay panel.
14	Master tripping relay for bus bar application (96)	No.	4	As stipulated for relay panel.
15	TNC Switch	Nos.	2	As stipulated for relay panel
16	PT selection relay / Switch	No.	2	As stipulated for relay panel.

17	D.C. supply supervision relay	Nos.	2	As stipulated for relay panel
18	Trip circuit supervision relay	Nos.	4	As stipulated for relay panel
19	Single phase trip relay (with self-reset contacts)	Nos.	2	As stipulated for relay panel
20	Selector switch for L/R selection	Nos.	2	As stipulated for relay panel
21	Selector switch (A/R IN/OUT)	Nos.	2	As stipulated for relay panel
22	Selector switch (Carrier IN/OUT)	Nos.	2	As stipulated for relay panel
23	Hard disk for HMI server	No.	1	As stipulated for SAS
24	Each type of Hardware Modules for GPS equipment	Set	1	
25	Spares for Inverter for SAS	Set	1	Includes all necessary spares for maintenance of Inverter for 5 years. IGBT should also be included.
26	Line interface unit for SAS FO LAN for one diameter	Set	1	Complete with FO patch cable.

Spares for relay panels and SAS in the scope of supply shall be the same make,model/type as in the actual supply. The numerical relays,IEDs,BCUs under the spares shall be equipped for maximum I/O configuration.

XVI. TRAINING SCOPE:

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

a) Training at supplier's 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. Training shall be organized in batche(s) wherein each batch shall comprise at least 5 trainees. 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.

All expenses for trainees towards boarding, lodging, travel , travel insurance etc to attend the training program is in the bidder's scope. In this context charges of any kind shall not be levied to TANTRANSCO.

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

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

- i. For 1 batch of at least 5 engineers oriented for operations of SAS & protection system. This training shall be imparted after commissioning of SAS.
- ii. For 1 batch of at least 5 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 for rectification of faults and prepare the trainees to use all the configuration tools for all of the SAS devices. The training should enable the trainees to carry out the necessary modifications in SAS for bay extensions / deletion/modifications etc.

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

Delivery 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.

XVI. Fiber optic cables for complete SAS,Control,protection,metering, DFR System :

~~Specification to be provided later.~~ Refer Section - 26 (Sheet No. 721 to 733)

XVII. DIGITAL FAULT RECORDER CUM PMU CUM FL

Technical Specification for Comprehensive Digital fault Recorder (DFR) System

The DFR Recorder shall be multi-time frame recording system used to monitor electrical power systems. It shall record analogue channels and digital (status) channels and store as max recordings as possible. The recorder shall record data simultaneously in three time domains: highspeed fault recording with a minimum sampling rate of 256 samples per cycle (continuously or triggered), low speed dynamic swing (continuously or triggered) at a sample rate of one point per cycle, and per day steady state trend recording with settable time frame between 1 point per minute or 1 point per 10 minutes.

Recording shall initiate when a single or Boolean equation combination of thresholds is violated, by a cross trigger signal from another recorder or by a manual trigger using the web interface. The recording lengths should be user selectable up to 60 seconds for high speed recording, up to 20 minutes for dynamic swing recording. Each record shall contain data of all the connected bays.

If there is any need for additional items such as hardware and software which are not specifically mentioned in this specification, but is required for the complete recorder system design, the vendor shall supply all such items that meet all of the purchaser's functional requirements defined in this specification.

The recorder shall consist of individual acquisition units, one for each feeder and an Evaluation unit which is common for the entire Substation. Whenever, more than one acquisition units are connected to an Evaluation unit, necessary hardware and

software shall also be supplied for on line transfer of data from all acquisition units to Evaluation unit.

The acquisition unit shall have the following features:

1. The acquisition unit shall have a 16 bit analog to digital convertor with a minimum of 8 analog inputs, 32 digital inputs.
2. The resolution for digital inputs shall be better than 80 ns.
3. The frequency response shall be DC on lower side and 3.0kHz or better on upper side.
4. It shall also have indication for data transfer, normal operation and powered up stage and shall communicate with evaluation units on fiber optic communication.
5. The acquisition unit shall be capable of acquiring current or voltage or milli Amp.
6. It shall supervise healthiness of Acquisition units, failure of acquisition must be indicated in acquisition unit as well as central unit
7. It shall supervise communication path between acquisition and central unit
8. It must have provision for mounting acquisition units at each bay to reduce panel wiring
9. It should have sampling rate of up to 256 samples per cycle for each input (CT,VT, Transducer and Binary input)
10. It must support LAN based triggering of all recorder connected in network
11. The drift in internal clock must not be greater than 0.1 sec, if GPS signal is lost (Not available) for 24 hours.
12. Shall support a maximum distance of up to 2 km between acquisition unit and central unit, and it shall also support compensation for communication delay between acquisition and central unit
13. The CT and VT input shall be selectable at site, if required same input of acquisition unit need to be used for either CT or VT
14. The recorder system shall be capable to directly acquire IEC 61850-9-2 sampled values ; it shall also be possible to acquire inputs on IEC 61850-8-1.

The recorder shall be capable of recording in COMTRADE format.

The disturbance recorder shall have an optional feature of Phasor Measurement Unit and travelling wave fault location (TWFL).

The disturbance recorder system offered shall have following functionality:

1. Transient Recorder
2. Short Term Recorder
3. Long Term Recorder
4. Continuous Recorder
5. Sequence of Events Recorder

Transient Recorder:

These records shall be very short in duration and typically include faults that are cleared immediately by circuit breaker operation. These events shall be analyzed to determine correct protection operation, fault location, or verification of system model parameters.

Short Term Record:

These records shall include all other time-delayed fault clearing and reclosing events where the system operation (stability) is not affected. These events shall be analyzed to determine correct protection operation, fault location or verification of system model parameters.

These records shall be possible to create by following ways:

Continuously: measurements are continuously recorded. A new record shall be available each 10 minutes.

Triggered: The fault recorder is triggered when a single or Boolean equation combination of thresholds is violated, by a cross-trigger signal from another recorder or by a manual trigger using the Web Interface.

Sampling Rate:

The triggered recorder sampling rate be user-selectable among 256, 128, or 64 points-per-cycle of the nominal frequency of the input signal.

Long Term Record:

These records include those events that affect system stability such as power swings, frequency variations and abnormal voltage problems. These events are usually analyzed to determine causes of incorrect system operations.

Sampling Rate:

The trigger and continuous recorder sampling rate is 1 point-per-cycle of the nominal frequency of the input signal.

Steady State Record

There records are steady state disturbances where system operation is not threatened, but power quality is affected. This may include harmonics or sub-harmonics produced by the load and/or the interaction between power system's components. Steady-state records are created daily. Measurements are continuously recorded and averaged over 1 or 10 min (user selectable). A new record is created at the rollover of each day.

Sampling Rate:

The daily steady-state recorder sampling rate is 256 points-per-cycle, aggregated in 1 point-per-minute or 1 point-per-10-minutes as selected by the user.

Sequence-of-Events Recorder (SER)

Recorder shall gather and time tag operational data from substation equipment and control schemes as they react to a system event. This data allows the chain of events to be studied for the cause (or causes) of any maloperation and the linkages between individual actions and effects. SOE records are created daily recording on a tabular format all the changes in digital and GOOSE inputs are monitored.

Sampling Rate:

The SOE sampling rate is 256 points-per-cycle of the nominal frequency of the input signal. Therefore, the resolution of the signal is better than 80 μ s.

Phasor Measurement Unit:

The equipment must be able to construct accurate synchrophasor data based on the incoming measurements from the units. The solution must be scalable in terms the number of analogue channels and phasors available. The synchrophasor measurement must be carried out according to IEEE C37.118.1a-2014 phasor measurement unit with M Class compliance.

Travelling wave fault locators:

Travelling wave fault location is particularly efficient way to define fault in the transmission line with in vicinity of a particular tower. Such accuracy within few hundred of meter is not achievable through traditional impedance based fault location.

Distance to fault locator:

Be microprocessor online type

Be suitable for breaker operating time of minimum 2 cycle

Should provide fault location in directly in km without requiring any additional computations.

Have fault location accuracy of +/- 150 meter or better

The accuracy should not be affected by following parameters,

- Presence of remote end infeed
- Series compensation
- Non uniform line length
- Mutual coupling
- Transposition of line
- Fault resistance
- Severe CVT transient

The acquisition units shall be either standalone for each line or composite unit with the capability to cater to four lines emanating from the substations. In case more than one line is to be accommodated in one acquisition unit, then suitable coupler unit shall be provided in individual line bay C&R panels and only secondary wiring shall be brought to common acquisition unit. While offering this option, bidders are advised to take care of maximum distance between acquisition unit & line bays C&R panels, which shall be placed in different Kiosks.

SECTION 26 ADSS CABLE
GUARANTEED TECHNICAL PARTICULARS FOR

1.0 All Dielectric Self- Supporting (ADSS) Cable:

1.1 General:

The ADSS cable shall be of non-metallic UG type to be laid in HDPE pipe in the cable trench. The cable shall be designed to withstand all prevailing environmental conditions including the effects of high electric and magnetic fields.

The ADSS cable shall follow the recommendations of IEEE P 1222. The ADSS cable shall be based on the following characteristics:

The ADSS cable shall be of all dielectric construction and designed to withstand the electromagnetic fields in the high voltage towers. The bidder shall list the electrical parameters of the ADSS cable types which are proposed.

The mechanical structure of the ADSS cable shall be designed to withstand the pulling tension of the cable inside the HDPE pipe and other environmental conditions. The ADSS cable selected shall tolerate the normal installation procedures. The bidder shall list the mechanical parameters of the ADSS cable and describe the cable structure, including how the fibres are located inside.

The cable structure shall be such that the fibres are protected against water, hydrogen, ultraviolet radiation and other environmental hazards encountered in India.

1.2 Design:

The cable shall be constructed from materials which have been technically proven and able to withstand the electrical and environmental conditions specified as in the specification.

The cable shall be designed with sufficient tensile strength to maintain clearance considerations and protect the optical fibres from external stresses and strains throughout the service life of 25 years. Consideration must be given to long term fatigue and creep. The central strength member shall be decoupled from the jacket material.

The cable shall be of smooth and of circular cross-section to avoid aerodynamic instability and shall be of minimum diameter to reduce tower loadings to a minimum.

The cable shall be fully filled so as to prevent water condensation and electrical degradation within the sheath. At maximum working tension the fibre shall not be subjected to a longitudinal strain greater than specified by the manufacturer and there shall be no detectable increase in fibre attenuation.

The ADSS cable is to be installed between the final splice box, forming the termination of the fibre cable in the power line and the FODP installed in the control room within the terminal building and shall be suitable for installation within the cable ducts and on cable trays. The cable shall comprise a tensile strength member, fibre support/bedding structure, core wrap/bedding, armoring and overall impervious jacket. No intermediate splices shall be permitted between its two termination points.

Cable marks shall be provided and installed to mark the location and route of fibre cables.

The ADSS cables shall enter the building through cable ducts and within each building, the cables shall be run upon cable trays or racks. The Contractor may utilize existing ducts, trays, racks etc., where appropriate, but shall supply these where none presently exist. The cables shall be affixed to cable supports using approved ties, clips or cleats at regular intervals.

On short run of cable, for which cable supports are not required the Contractor shall fix the cable to the structure of the building using approved fixings and cable cleats.

The Contractor shall be responsible for forming holes through walls and floors for the installation of these cables. Caution shall be taken to ensure existing equipment is protected from hole-drilling dust. The holes shall be neatly drilled and neatly finished for protection from moisture, dust and vermin intrusion. Suitable rubber covers should be fixed in these holes for holding the cables properly.

The ADSS cables shall be provided with a minimum outer jacket thickness of 3mm and meeting the following requirements:

- (a) UV resistant
- (b) Anti-hygroscopic

- (c) Rodentproof
- (d) Fire retardant with any acid gas evolution

The ADSS cables shall be laid along with the HDPE pipe of 40 mm diameter and 4 mm thickness and shall inter connect the final outdoor splice box and the FODP installed in control room within the terminal building.

All required fittings, supports, accessories, fibre optic distribution panels, HDPE pipe, ducts, conduits and any other item not specifically mentioned herein, but required for laying and installation of ADSS cable, shall be supplied along with the ADSS cable.

1.3 Jacket Construction:

The jacket shall be black, smooth, concentric and shall be free from holes, splits, blisters and other surface flaws. The jacket shall be extruded directly over the stranded buffer tube core and shall also be non-hygroscopic. Track-resistant jacket shall be provided for all ADSS cables to be laid on all transmission lines.

1.4 Jacket Material:

The jacket material shall have an operating ambient temperature range of -40°C to $+80^{\circ}\text{C}$

2.0 Electrical and Mechanical Requirements :

Table 2.1 provides ADSS Electrical and Mechanical Requirements for the minimum performance characteristics.

Table 2.1 ADSS Electrical and Mechanical Requirements

i)	Overall Diameter	13.0 mm or Manufacturer standard
ii)	Minimum bend radius	≤ 285 mm during installation 200 mm installed

ii)	Minimum bend radius	≤ 285 mm during installation 200 mm installed
iii)	Weight	≤ 160 kg/km.
iv)	Tensile strength	≤ 16000 N during installation ≤ 12500 N long term (Installed)

3.0 Fibre Types

Dual-Window Single Mode (DWSM) optical fibres of 24 Nos. shall be provided in the cable. DWSM requirements are defined in Table – 3.1

Table – 3.1- DWSM Optical Fibre Characteristics

Fibre Description	Dual-Window Single Mode
Core Diameter	8.3 μm or as per mfr. Standard.
Mode Field Diameter	As per CCITT G.652 D
Cladding Design	Either matched or depressed
Clad Diameter	125.0 $\mu\text{m} \pm 15\mu\text{m}$ or as per mfr. Standard
Core-Clad Concentricity Error	< 1.0 μm
Coating Diameter	250 $\mu\text{m} \pm 15\mu\text{m}$ or as per mfr. Standard
Coating Concentricity	≥ 0.70
Attenuation Coefficient	@ 1310 nm ≤ 0.40 dB/km or better @ 1550 nm ≤ 0.25 dB/km or better
Bend Performance	@ 1310 nm (40mm) ≤ 0.05 dB (100 turns) @ 1550 nm (40mm) ≤ 0.05 dB (100 turns)
Temperature Dependence	≤ 0.05 dB (-60°C to +85°C)
Cutoff Wavelength	≤ 1260 nm
Chromatic Dispersion Maximum	≤ 20 ps/(nm x km) 1550nm ≤ 3.5 ps/(nm x km) 1285-1330nm 6.0ps/(nm x km) 1270-1340nm
Zero Dispersion Wavelength	1300 to 1324 nm
Zero Dispersion Slope	< 0.093 ps/(nm ² xkm) maximum
Proof Test Level	50 kpsi
Cladding Non-circularity	< 2%

The fibres shall be entirely suitable for splicing by means of normal fusion splicing techniques. The fibre shall be manufactured from high grade silica and doped as necessary to provide the required transmission performance.

The chemical composition of the fibres shall be specially designed to minimize the effect of hydrogen on the transmission properties.

The fibre cable life expectancy shall be at least 25 years.

3.2 Fibre Parameters :

3.2.1 Attenuation Variation :

The attenuation coefficient for wavelengths between 1525 nm and 1575 nm shall not exceed the attenuation coefficient at 1550 nm by more than 0.01 dB/km. The

attenuation coefficient between 1285 nm and 1330 nm shall not exceed the attenuation coefficient at 1310 nm by more than 0.01 dB/km. The attenuation of the fibre shall be distributed uniformly throughout its length such that there are no point discontinuities in excess of 0.05 dB.

3.2.2 Fibre Coloring :

Fibre coloring shall conform to EIA/TIA-598. The color coding shall be permanent thus withstanding normal handling; e.g., during termination, testing, or cable relocation.

Color shall be integrated into the fibre coating and shall be homogeneous. The colour shall not bleed from one fibre to another and shall not fade when wiping the fibre with acetone or alcohol and shall not fade during fibre preparation for termination or splicing.

Each cable shall have traceability of each fibre back to the original fibre manufacturer's fibre number and parameters of the fibre.

If more than the specified number of fibres are included in any cable, the spare fibres shall be tested by the cable manufacturer and any defective fibres shall be suitably bundled, tagged and identified at the factory by the vendor.

3.2.3 Fibre Buffering and Protection:

The primary coating shall consist of an inert material which can be readily removed for splicing purposes without damage to the fibre and without necessitating the use of hazardous chemicals.

A secondary coating may be applied directly over the primary coating (tight buffering), or alternatively, a loose jacket may be provided (loose buffering). Where a tight fitting secondary coating is provided, it shall consist of an inert material. Where a loose jacket is provided, a gel or hydroscopic substance shall be included in the cable structure to prevent moisture from being retained inside the loose jacket.

The fibre coating shall be translucent such that fibre splicing techniques using optical alignment of cores by means of injection and detection of light through the cladding shall be supported. In addition, the fibre coating shall be optically matched to the cladding to promote cladding mode stripping.

The composition of the cable shall be specifically designed to reduce the production of hydrogen gas and to prevent the migration of hydrogen into the fibre.

The Bidder shall describe specific measures to reduce the production of hydrogen gases and any installation constraints that should be observed.

3.2.4 Technical Characteristics :

The longitudinal strain specifications shall conform to IEEE Standard 1138-1994 for OPGW cable or the latest standard.

3.2.5 Fiber Strain :

The optical fiber cable must have a minimum strain margin of 0.5%. Increase in attenuation due to fiber strain should be less than 0.05% as measured in accordance with test requirements of IEC 794 – 1, three cycles applied. For tensile load of upto 90% of the UTS, the cable strain shall not exceed 0.5%.

4.0 Cable Materials :

The materials used for optical fibre cable construction, shall meet the following requirements.

4.1 Filling Materials :

The interstices of the fibre optic unit and cable shall be filled with a suitable compound to prohibit any moisture ingress or any water longitudinal migration within the fibre optic unit or along the fibre optic cable. The water tightness of the cable shall meet or exceed the test performance criteria as per IEC-794-1-F-S.

The filling compound used shall be a non-toxic homogenous water-proofing gel that is free of dirt and foreign matter, nonhygroscopic, electrically nonconductive, non-nutritive to fungus. The compound shall also be fully compatible with all cable components it may come in contact with and shall inhibit the generation of hydrogen within the cable.

The filling compound shall remain stable for ambient temperatures between -20°C and +80°C and shall not drip, flow or leak with age or at high temperatures.

The waterproofing filling materials shall not affect fibre coating, color coding, or encapsulants commonly used in splice enclosures, shall be dermatologically safe, non-staining and easily removable with a non-toxic cleaning solvent.

4.2 Outside Jacket Materials :

The outer cable jacket shall consist of carbon black polyethylene resin. The jacket shall conform to low density, medium density and high density polyethylene standards as defined in ASTM D1248.

4.3 Sheathing Removal :

The cable sheath design shall permit easy removal without damage to the optical fibres or fibre units. The design shall incorporate a continuous rip cord under the jacket of the entire length of the cable.

4.5 Marking, Packaging and Shipping:

This section describes the requirements for marking, packaging and forwarding the fibre optic cable.

(a) Cable Identification Markings :

Fibre optic cable shall be permanently marked in English at regular intervals, with the Manufacturer, a trade name or identifier that readily describes the cable as Fibre Optic and Identification markings shall repeat at intervals no greater than two meters.

(b) Cable Length Markings :

The cable jacket shall include environmental-resistant printing at intervals of two meters indicating the length of the cable in meters from the starting point, the number of fibres contained in the cable and the date of manufacture.

(c) Reel Markings :

Each side of every reel of cable shall be permanently marked in a minimum of 3 cm high white lettering with the Contractor's address, destination address, cable part number and specification as to the type of cable, length, number of fibres, cable segment number, inspection stamp and date.

(d) Cable Drums :

The cables shall be supplied in non-returnable strong wooden (or alternatively steel) drums provided with lagging of adequate strength, constructed to protect the cable against any damage and displacement during transit, storage and subsequent handling and stringing operations in the field. The Bidder shall list the information concerning the following: weight, dimensions, material and standards applied.

All wooden components shall be manufactured out of seasoned soft wood free from defects that may materially weaken the component parts of the drums. Preservative

treatment for anti-termite/anti-fungus shall be applied to the entire drum with preservatives of a quality which is not harmful to the cable.

Before reeling, cardboard or double corrugated or thick bituminised waterproof bamboo paper shall be secured to the drum barrel and inside of flanges of the dry drum by means of a suitable commercial adhesive material. The paper should be dried before use. After reeling the cable the exposed surface of the outer layer of the cable shall be wrapped with thin polythene sheet across the flanges to protect the cable from dirt, grit and damage during transportation and handling and also to prevent ingress of rain water during storage and transport.

A minimum space of 75 mm shall be provided between the inner surface of the external protective lagging. There shall be minimum of two binders consisting of iron/galvanized steel wire. Each protective lagging shall have two recesses to accommodate the binders.

The cable ends shall be properly sealed and secured with the use of U-nails or bolts on the side of one of the flanges to avoid loosening of the cable layers in transport and handling.

The method of lagging to be employed shall be clearly stated in the tender. Each drum shall be accompanied by the following information:

- a. Manufacturer's name and address
- b. Contract/Award letter number.
- c. Type of the cable.
- d. Gross weight of the cable and drum.
- e. Weight of empty drum with lagging.
- f. Net weight of the cable.
- g. Length of the cable.
- h. Drum and lot number.
- i. Name and address of the consignee.
- j. Month and year of manufacture

4.6 Environmental Requirements

- a. Outside temperature varies in the range of 0°C to 100°C.
- b. The average annual rainfall is 100-140 mm.
- c. The relative humidity varies between 10% and 100%.
- d. The number of thunderstorm days is 65/year.
- e. Moderately hot and humid tropical climate conducive to rust and fungus growth.

4.7 Jacket construction :

The jacket material shall be made of anon-PVC material that is fire retardant and suitable for inside plant cabling applications. The jacket shall be smooth and shall be free from holes, split, blisters and other surface flaws. The jacket shall be easily strippable.

**GUARANTEED TECHNICAL PARTICULARS for FIBRE OPTIC CABLE
ALL DIELECTRIC SELF-SUPPORTING (ADSS)**

CABLE CONSTRUCTION			
Seq.	Parameter:	Unit:	Particulars:
1.	No. of Fibres Dual Window Single-Mode:	Each	
2.	Buffer Type:		
3.	Buffer Tube Diameter:	Mm	
4.	Buffer Tube material		
5.	No. of Buffer Tubes:	Each	
6.	No. of Fibers per Tube:	Each	
7.	Identification/Numbering of Individual tubes:		
8.	No. of empty tubes(if anv):	Each	
9.	Filling material:		
10.	Filling material compliant with Technical specifications?	Yes/No	
11.	Strength member(s):		
12.	Binding yarn tape:		
13.	Describe Central Core Design:		
14.	Outside jacket coating (if any):		
15.	Jacket thickness:(nominal	Mm	

	±deviation):		
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CABLE CONSTRUCTION			
Seq.	Parameter:	Unit:	Particulars:
16.	Jacket non-circularity:	%	
17.	Cable Diameter:(nominal $\pm$ deviation)	Mm	
18.	Cable cross-section area:	mm ²	
19.	Rip-cord provided?	Yes/No	
20.	Fully Compliant with IEEE P1138:	Yes/No	

MECHANICAL PROPERTIES OF CABLE:

21.	Max. breaking load/ Ultimate Tensile Strength(UTS)		
22.	Fibre strain margin:		
23.	Weight:	Kg/km	
24.	Crush strength:	Kg/m ²	
25.	Modulus of elasticity:	KN/mm ²	
26.	Minimum Bending Radius: Short Term: Long Term (Continuous):	Mm	
27.	Tensile proof test (Screening) level:		
28.	Maximum permissible tensile stress:		
29.	Everyday tensile stress:		
30.	Torsion:	twist / m	

CABLE SPOOL and DRUM

Seq.	Parameter:	Unit:	Particulars:
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31.	Available length per spool Maximum: Nominal:	Mtrs	
32.	Size of drum:	Mtrs.	
33.	Weight of empty drum:	Kg	
34.	Weight of drum with cable: spooled	Kg	
35.	Describe Drum Materials		
36.	Describe Cable end capping and protection against abrasion etc.,		
37.	Operating Temperature Range:	⁰ C	
38.	Expected Cable Life:	Years	

Date:
Place:
Seal

Signature
Name
Designation

**GUARANTEED TECHNICAL PARTICULARS for OPTICAL FIBRE
DUAL-WINDOW SINGLE MODE (DW-SM)**

OPTICAL PARAMETERS			
Seq.	Parameter:	Unit:	Particulars:
1.	Attenuation Coefficient @ 1310 nm: @ 1550 nm:	dB/km dB/km	
2.	Attenuation Variation with Wavelength (± 25 nm): Temperature:	dB/km	
3.	Nominal Mode Field Diameter @1310 nm: @ 1550 nm:	Micro mtr.	
4.	Mode Field Diameter Deviation @ 1310 nm: @ 1550 nm:	Micro mtr.	
5.	Mode field non-circularity:	%	
6.	Chromatic Dispersion Coefficient @ 1310 (1285-1330) nm: @ 1310 (1270-1340)nm: @ 1550 (1525-1475) nm:	ps/nm.km	
7.	Zero dispersion wavelength:	Nm	
8.	Zero dispersion Slope:	ps/nm ² .km	
9.	Cutoff wavelength:	Nm	
10.	Refractive Index:		
11.	Refractive Index profile:		
12.	Clad Design:		
13.	Numerical aperture:		
14.	Bandwidth Distance Product:	MHz.km	
15.	Bend Performance: (37.5 mm radius, 100 turns)		

GUARANTEED TECHNICAL PARTICULARS for OPTICAL FIBRE (DW-SM)

PHYSICAL and MECHANICAL PROPERTIES			
Seq.	Parameter:	Unit:	Particulars:
16.	Fiber manufacturer(s):		
17.	Fiber production method:		
18.	Core Diameter(nominal $\pm$ deviation):	Micromtr	
19.	Core non-circularity:	%	
20.	Cladding Diameter(nominal $\pm$ deviation):	Micromtr	
21.	Core- Clad concentricity Error:	Micromtr	
22.	Cladding non-circularity:	%	
23.	Protective coating type & material Primary: Secondary:		
24.	Protective Coating Diameter(nominal $\pm$ deviation):		
25.	Protective Coating removal Method:		
26.	Coating Concentricity		
27.	Colour coding scheme compliant with EIA 395A/IEC 304?	Yes/No.	
28.	Colouring material compliant with Technical specn?	Yes/No	

Date:

Place:

Seal:

Signature:

Name:

Designation:

5.Computerised Relay Testing Kit

1.General for instruments and testing equipments:

1. Onsite Service support during project guarantee period should be guaranteed.
2. Inland service support by the manufacturer should be available in Tamilnadu for all the instruments and testing equipments.
3. Calibration certificate for all the instruments and testing equipments not older than 2months from the date of supply should be furnished traceable to from NABL / Internationally recognized laboratory.
4. All equipments should be type tested as per IS/ IEC/Equivalent standards from NABL /Internationally recognized laboratory that should include but not limited to the following:

i. EMC & EMI

ii. Safety

iii. Environmental : Operating & Storage temperature, Operating humidity, Vibration,Shock.

Operating Temperature for the application requires in the range of should be 0 to +50°C,Relative Humidity Max. 95% non-condensing

iv. Degree of protection as per IEC 60529 /IS /Equivalent standard with suitable IPcode.

v. Any other type tests required for the application.

5. Operation manual should be provided.

6. Onsite demonstration cum training on the testing equipments should be provided.

7. The complete equipment should be designed /Engineered by the original equipment manufacturer.

1.. Computerised relay testing kit :

1. The BOM of the relay test kit under scope of supply is furnished below:

i. Computerized numerical relay test kit portable type.

ii. All necessary accessories for test kit

iii. Dedicated Laptop computer for test kit (Reputed make of latest model; Minimum configuration: 15" TFT screen,4GB RAM, 320GB HDDor better, COMBO DVD Drive,

complete with required cables and connectors with preloaded operating MS Window 7 professional or latest version and all the necessary application software). If application requires better configuration then the better configuration is applicable. Irrespective of any built in computer facility in the kit, a separate laptop computer with all necessary software should be provided.

iv. All hardwares and softwares for test kit for supporting the following requirements:

- Digital Trivector meters
- Automated testing of numerical relays including all the relevant protection functions and Power swing simulation.
- Transducers
- GPS timing reference unit for end-end testing of line protection schemes
- IEC 61850 modules (GOOSE Configuration, interpretation, publishing, Edit state sequence for customized testing)
- Edit and accurate Playback of COMTRADE format file (4V,6I)
- Heavy burden relays

v. Relay test templates based on relay model of all the models of all the reputed numerical relay manufacturers.

vi. Rugged carry case.

* The test kit should be suitable for dynamic and transient testing, with facility of transient (IEEE standard COMTRADE format) record playback for both analog and digital channels. Simulate disturbance signal along with DC and high frequency components (with sampling rate of 3kHz or better) as well as Binary signals. The software should be capable of creating customized relay

characteristics as well as of importing relay characteristics from IED/Relay

vii. All manuals in soft copy and hard copy for the complete test kit.

* V/I Generators:

The total current/voltage output channels: 8 nos

All AC and DC analog channel Outputs should be user interface software controlled/configurable.

General Protection/ Control features: Against short circuit, over voltage, improper ground connection over load & transient surges, the kit should have alarm/cut-off features settings to protect the instrument. All outputs shall be have short circuit protection and over voltage protection. Specifically current outputs shall be protected against open circuits and prolonged thermal overloads, voltage outputs protected from short circuits.

The test kit should be operable with power supply of 230VAC +/-10%, 50HZ+/-5%

Current Outputs:

6 phase currents outputs : 0-30A rms with resolution 1mA or finer.

Output burden : Minimum 150VA per phase.

Protection : All current outputs shall be protected against open circuits and prolonged thermal overloads

Voltage Outputs:

Voltage output:0-300 Volts AC/DC (Ph-N), with resolution 10mV or finer.

AC output shall be 3-phase voltage output.

Output Burden: 50VA minimum per phase

Protection : All current outputs shall be protected against short circuits and prolonged thermal overloads.

Aux.DC Output:

DC Output :0-250 V with power rating 50W min. (continuous rating), with continuous / step-less control.

Protection : All current outputs shall be protected against short circuits and prolonged thermal overloads. Provided with galvanic isolation.

Accuracy shall be $\pm 0.2\%$ for voltage and current sources throughout the range. The total distortion shall also be less than 0.2%.

Measuring input:

1. Voltage range -10V to +10 V DC
2. Current range -20mA to +20 mA DC
3. Accuracy -0.02% or better

Test Frequency V/I Generator/Amplifier shall have controlled frequency range from 10Hz to 1 kHz for sine and DC to 3 kHz (minimum) for transients with resolution of 1 mHz or better and accuracy 0.01 % or better

Phase angles:

0 to 359.9° lag/lead with resolution of 0.1 degree or better, with accuracy of 0.5 deg. (min.)

Binary I/O configuration

Minimum four binary outputs and eight inputs with galvanic isolation.

Software controlled input should be capable of sensing potential free relay contacts (NO/NC) as well as potential of 0 to 250V AC/DC.

Associated timers should have time resolution of 100µS or better. The

software controlled outputs should have potential free contacts

(NO/NC) with breaking capacity of 8 Amp 250V AC/DC.

Timer:

The Timer will be used to measure high-speed operation of electro mechanical, solid-state and microprocessor-based protection relays. It should incorporate ten (10) sets of banana plug receptacles, which can be programmed to be; Start, Stop Gates and Monitor, or all Stop Gates, or all Contact Continuity Monitors.

Start/Stop Gate De-Bounce facility to eliminate false triggering and contact bounce errors should be featured in the test kit.

Display:

A anti glare, backlit digital display will be provided, which will show the measured output for each current channel, phase angle, frequency, and output status (on or off) for both manual operation and when under computer control.

Standards for compliance:

IEC /Equivalent standard for EMC (Emission)

IEC /Equivalent standard for EMC (Immunity)

IEC /Equivalent for Safety

IEC /Equivalent for Shock, vibration, transit drop

Operating temperature : 0°C to 50°C

Relative humidity: Max 90% Non-condensing

* Only test equipment of reputed make with established service support in India for prompt after sales services and guarantee support including calibration capabilities will be acceptable. Acceptable make, model are OMICRON CMC356 /MEGGAR SMRT36 with associated hardware and software to meet the specification for the test kit.

* The kit should be provided with calibration certificate for minimum of 1 year validity and calibrated not older than 2 months from actual date of supply. Calibration certificate shall be from a NABL recognized laboratory.

* All firmware and software upgrades relevant to the complete test kit should be provided and installed in the kit at site free of cost for the entire contract guarantee period.

Training:

A demonstration cum training to TANTRANSCO engineers on the complete test kit shall be provided that should enable to operate the test kit in all aspects for all the testing of the devices stipulated in this specification.

6.Optical power meter

TECHNICAL SPECIFICATIONS:

- 1.Calibrated wavelength(nm) : 850/1300/1310/1400/1550/1625
- 2.Detector Type : InGaAs
- 3.Accuracy : $\pm 5\% \pm 1\text{Nw}$
- 4.Resolution : 0.01dB@-60 to +10dBm 0.1dB@-70 to -60dBm
5. Linearity : $\pm 5\%$
6. Auto power off : yes
7. Backlight : yes
8. Reference value :yes
9. Measuring range(dBm) : -70 to +26
10. USB interface : yes

AMENDMENT BY TANTRANSCO

ANNEXURE-II

S No	Vol/Sec	Page No	Clause No	Description	Query	Reply
1	Part- II Technical Specification Section-I	657	3	Bill of Quantities (BOQ) is given in Appendix-III	Please provide Appendix - III for better understanding of site wise BOQ.	BILL OF QUANTITIES SDH eqpt. -6 Nos. Multiplexer -6 Nos., Digital Protection coupler-40 Nos. EPAX-48S/32T-1 No. 48V/1250AH Battery -2 Nos. 48V/250A Battery Charger - 3 Nos. FODP for 500 fibres -1 No. 48 Fibre ADSS cable with HDPE pipe- 9 Kms. (Including other end equipments. Please refer Annexure-IA)
2	Part- II Technical Specification Section-I	656	2	Provision of an efficient Element Management System licensed to accommodate atleast 200 Network Elements and capable to accommodate atleast 300 Network Elements.	EMS/NMS is not specified in BOQ/ Price Schedule. We understand that same is not envisaged in current scope of work. Please confirm our understanding. If NMS/EMS is required, Please amend the BOQ accordingly.	EMS/NMS is essentially required. Please refer Annexure I-A

S No	Vol/Sec	Page No	Clause No	Description	Query	Reply
3	Part- II Technical Specification Section-I	657	3	Bill of Quantities (BOQ) is given in Appendix-III	In Table-2 , Equipment type proposed column, Required interfaces are more than given in price schedule. We understand that all type of equipment proposed given in table are not in current scope of work. Please clarify the scope and amend the BOQ accordingly.	BILL OF QUANTITIES SDH eqpt. - 6 Nos. Multiplexer-6 Nos., Digital Protection coupler-40 Nos. EPAX 48S/32T-1 No. 48V/1250AH Battery -2 Nos. 48V/250A Battery Charger - 3 Nos. FODP for 500 fibres - 1 No. 48 Fibre ADSS cable with HDPE pipe- 9 Kms. (Including other end equipments. Please refer Annexure-IA)
4	Part-II, Section-II	665	-	Scope Table: Interface card for Distance Protection (4 command) for North Chennai Pooling station 765 kV	Quantity is blank. Please clarify the quantity.	4 Nos. has already been included in the BoQ
5	Part-II, Section-II	669	-	Ethernet module: 1. 2 Nos. 4 port , 10/100 Mb, Layer-2 type Ethernet interface (Electrical) shall be provided with all SDH equipments.	Can bidder provide 1 No. of card consists of 8 Port. Please confirm.	Irrespective of 4 port or 8 port the bidder shall supply 2 Nos. of Layer 2 type Ethernet Interface cards.

S No	Vol/Sec	Page No	Clause No	Description	Query	Reply
6	Part-II, Section-II	669	-	Interface with Protection relays: In all power utilities protection inter-trip facility is provided to transfer the trip command received in a protection relay (Differential Line Protection & Distance Protection relay) at one end of a 230 kV and above level transmission line to be transferred through communication media to the relay at the other end of the line to clear the faulty line at both ends.	We understand that bidder has to provide interface for distance protection only. Please provide the lines where differential protection interface boards are required? Please Clarify.	Differential protection interface board not required
7	Part-II, Section-II	670	-	The number of Protection interface cards required is furnished in the Schedule-A.	Please provide Schedule-A for Protection interface cards	Either 40 Nos. protection interface cards or 40 Nos. stand alone Digital Protection couplers have to be supplied
8	Part-II, Section-II	676	-	Configuration of PDH Multiplexer: Ethernet interface card 4 channels (Layer-1 type)- 1 no. or as per Mfr.standard.	We are providing Ethernet interface cards along with SDH unit as per standards. Please confirm the same.	Ethernet interface card 4 channels (Layer-1 type)- 1 no. shall be provided in the Multiplexer.
9	Part-II, Section-II	676	-	ELEMENT MANAGEMENT SYSTEM (EMS):	We understand that specification is generic and EMS is not envisaged in current scope of work. Please confirm our understanding.	EMS/NMS is essentially required. Please refer Annexure I-A

S No	Vol/Sec	Page No	Clause No	Description	Query	Reply
10	Part- II Technical Specification Section-I	619	-	Integration and Testing of SAS data at Remote LDC end	1. Kindly confirm the scope of "Integration and Testing of SAS data at Remote LDC end" is included 2. 2. If yes, Kindly confirm the OEM of Remote LDC	Integration works at Remote Load dispatch centre is not in this tender scope. However the necessary technical support such as ensuring protocol interoperability towards the remote LDC is inclusive of tender scope of SAS.
11	Technical Specification Section-06	384	6.0 B)	In the specification of 390kV LA, the pressure relief mentioned is 63kA rms. This pressure relief (i.e., 63kA rms) is related to polymer type LA. But in the specification the type of LA recommended is Porcelain type. For supply of 390kV Porcelain LA, the pressure relief is 50kA rms.	Kindly confirm whether the requirement is Porcelain or Polymer type LA.	As per specification
12	SECTION- 01 765 KV AUTO TRANSFORMER	183	17.4	DIGITAL REMOTE TAP-CHANGER CONTROL PANEL	The quantity requirement of digital RTCC Relays per transformer or 3-ph bank and also let us know if any spare relay is required, Please Confirm	1 set comprised 1no of each type of Numerical relay /IED/Controller for RTCC panel is required for Spare for RTCC panel.

765/400KV AIS SUB STATION WITH ASSOCIATED AUTO TRANSFORMERS, SWITCHGEARS, REACTORS, ACCESSORIES, CONTROL PANELS, SUBSTATION AUTOMATION SYSTEM, CONTROL ROOM AND CIVIL WORKS COMPLETE AT ARIYALUR IN VILLUPURAM DISTRICT.
VILLUPURAM REGION

Sr. No.	Volume / Section	Clause No.	Bidder's Query	Reply
11	Section-22, SAS, Control & Relay Panels	11) TIME SYNCHRONISATION	Request to confirm whether PTP port is mandatory. If yes, request to confirm the necessary devices.	GPS system is specified to provide also PTP signalling for time synchronisation of DFR equipment as well all other equipments, devices for which the accuracy of PTP is necessary for the application.
12	Section-22, SAS, Control & Relay Panels	24) COMMUNICATION NETWORK: Inter-bay LANs	Request to confirm whether RSTP or PRP is required as both solutions have cost implication. Also all the IEDs are specified on PRP. Please confirm whether cable between IED and switch shall be on FO or RJ45	All numerical relays, IEDs , BCUs etc should be provided with PRP ethernet ports. Cable between IED/Relay/BCU and switch in general shall be FO cable. Each of the redundant LAN for the SAS application should be implemented in separate ring with RSTP.
13	Section-22, SAS, Control & Relay Panels	29) CONCEPTUAL SCHEME FOR SAS ARCHITECTURE : INTERBAY LAN (IEC 61850 LEVEL-1)	Request to clarify as ABT meters are not available on IEC61850 and only RS485 port available. We recommend meter to be on separate LAN to metering PC	Serial ethernet converter / Terminal server shall be provided in the respective relay panels for integration of the ABT meter data to the SAS LAN and for metering PC interface. Refer corrigendum for details.

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AMENDMENT BY TANTRANS CO

ANNEXURE-IV-A

AMENDMENT TO TECHNICAL SPECIFICATION SECTION-VI (Scetion-22,SAS,Control and Relay Panels):

- ✓ 1. In respect of the incomplete 765KV diameters, the SAS monitoring and control of the isolators, earth switches of the 765KV bay without the main breaker shall be implemented in the tie breaker of the respective bay itself. Accordingly the necessary Tie breaker BCU and numerical relays of the Tie breaker relay panel shall be equipped to facilitate SAS monitoring and control of these primary objects.
- ✓ 2. In respect of the incomplete 400KV diameters, the SAS monitoring and control of the isolators, earth switches of the 400 KV bay without the main breaker shall be implemented in the tie breaker of the respective bay itself. Accordingly the necessary Tie breaker BCU and numerical relays of the Tie breaker relay panel shall be equipped to facilitate SAS monitoring and control of these primary objects.
- ✓ 3. BOM: ISLANDING PANEL for 765 kV Feeders as well as for 400 kV Feeders:
1no Numerical voltage protection relay with 2 stage under voltage protection and 2 stage over voltage protection functions is included in the BOM.
This relay must be separate from UF protection relay.
- ✓ 4. Main and duplicate 765KV/400KV Busbar protection panels for can be of same make.
- ✓ 5. SAS :
 - ✓ a. The fibre optic cable ~~given in schedule II, sl no 100~~ required for each of the redundant SAS LANs shall be of 24 fibre ADSS cable housed in dedicated HDPE pipe for environmental protection. The Specification ADSS cable is already furnished in this tender document , the cable shall be rodent proof type also. The Fibre optic cable may be Single mode or multi mode type however it shall be ensured that the FO cable is compatible for all the connected devices.
 - ✓ b. The SAS BOM includes the necessary terminal servers/ Serial to Ethernet converters to bring the ABT meter data to the Metering PC and SAS. In this context necessary protocol converter with data buffer for providing DLMS data communication between the ABT meters and Metering PC as well to provide DLMS data to SAS and to remote billing centre should be provided.
 - ✓ c. Ethernet switches for each of the redundant LANs for SAS application should be separate.

✓ 6. The protection scheme for the 765KV/400KV ICT shall be as given below.

✓ **TRANSFORMER PROTECTION (APPLICABLE FOR 765 kV/ 400 kV ICT :**

In Transformer Protection to be classified as Group A & Group B.

In Group A – Transformer Differential Protection

Overfluxing protection (HV)

Directional o/c & E/F Protection for HV (Dedicated numerical relay)

Thermal over load protection

Neutral or residual over current protection (Connected in transformer neutral)

Buchholz (main tank) protection

Pressure relief device protection

Oil temperature protection

Tertiary (delta) winding protection

Fire protection

In Group B – REF Protection (Low impedance)

Overfluxing protection (LV)

Three phase impedance protection

Directional o/c & E/F Protection for LV (Dedicated numerical relay)

Neutral current protection (Applicable for Single phase transformer bank)

Current overload protection

Buchholz (OLTC) protection

Winding temperature protection

Oil level/ High low protection /Monitor, Fire protection

Group A Relays to be connected in DC Source – 1

Group B Relays to be connected in DC Source – 2.

Multifunction numerical relay 2nos for the 765KV/400KV ICT protection should be provided. Wherein each of the numerical relays should be equipped simultaneously for all the Functions of Group-A protection and Group-B protection. During commissioning one of the Numerical relays shall be configured for Group-A protection and the other relay for Group-B protection.

A) General

- i) The numerical differential protection relays shall comply with the specification for general requirements for numerical protection relay as furnished in this document.
- ii) The numeric relay shall be suitable for operating with CT inputs of 1A.
- iii) Where ever CT and VT is wired to the numerical relays, the relay should be provided with built in supervision of CT and VT respectively. VT fuse fail block of voltage manipulated protection should be provided. The Main CT and Tie CT shall be wired to separate CT modules so as to arrive at the vector sum of these CTs internally in the respective numerical relays.
- iv) 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.
- v) Equipped with sufficient numbers (minimum is 16 nos) of programmable of opto isolated Binary inputs and sufficient numbers (minimum is 20 nos) of programmable potential free binary outputs with wetting voltage for digital inputs to be field programmable to 48V / 110V / 220V DC.
- vi) The minimum number of LEDs shall be 14 nos, In case Graphic display is provided then atleast 4 nos LEDs shall be provided for important alarms.

b) BIAS DIFFERENTIAL PROTECTION FOR THREE WINDING TRANSFORMER PROTECTION:

Differential protection features and characteristics:

- i. Based on low impedance differential principle for protection of three winding transformer. Three phase with faulty phase identification.
- ii. Shall have three instantaneous high set over current units with facility to adjust 5 to 20 times normal current.
- iii. Shall have second and fifth 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.

b) Over fluxing protection.

Over Fluxing Protection shall be provided shall comply with the following requirements:

- (i) operate on the principle of measurement of Voltage to frequency ratio and shall be phase to phase connected
- (ii) have inverse time characteristics compatible with transformer over fluxing withstand capability curve.
- (iii) provide an independent 'alarm' with the time delay continuously adjustable between 0.1 to 6.0 seconds at values of ' V/f ' between 100% to 130% of rated values.
- (iv) tripping time shall be governed by ' V/f ' Vs. time characteristics of the relay
- (v) have a set of characteristics for Various time multiplier settings. The maximum operating time of the relay shall not exceed 3 seconds and 1.5 seconds at ' V/f ' values of 1.4 and 1.5 times, the rated values, respectively.
- (vi) have an accuracy of operating time within the tolerance of +/-10%. have a HIGH resetting ratio of 98 % or better

c) Restricted Earth Fault Protection shall

- (i) be of low impedance type
- (ii) be of current/voltage operated type
- (iii) have an operating current sensitivity of atleast 10% of nominal current with current setting range of 10-40% of 1 Amp.
- (iv) be tuned to the system frequency
- (v) Have a slope characteristic to provide a stability during external fault
- (vi) Low impedance principle shall be complemented with directional or phase angle measurement to ensure stability during external fault with CT saturation.

d) Under impedance protection

- i) Triple pole type with faulty phase indication
- ii) Single step polarize "mho" or impedance distance relay suitable for measuring phase to ground and phase to phase faults.
- iii) Have an adjustable characteristic angle between 30-80 degrees.
- iv) Have a definite time delay with adjustable setting range of 0.2 to 2 sec.
- v) Have a suitable ohmic range for covering the transformer impedance and shall be continuously variable.
- vi) Include VT failure function to block during VT fuse failure condition.
- vii) Equipped with three zones of protection with two forward zones and one reverse zone.

d) Thermal overload function

- Shall be of three pole type
- Shall be based on the thermal characteristics of the transformer by setting the time constant of the transformer
- The trip level shall be settable from 110% to 150%
- An alarm shall be settable for thermal levels from 80% to 110%

e) BACKUP DIRECTIONAL OVER CURRENT PROTECTION WITH HIGH SET INSTANTANEOUS FOR HV as well as for LV:

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.
 - i) Equipped with three over current and one earth fault protection elements.
 - ii) Necessary VT fuse failure function for alarm.
 - iii) Over current relay shall
 - Have directional IDMT characteristic with a definite minimum time of 3 sec at 10 times setting and have a variable setting range of 50-200% of rated current.
 - Have low transient . over reach high set instantaneous unit of continuously variable setting range of 500-2000% of rated current.
 - Have an adjustable characteristic angle of 30 to 60 degree lead
 - Shall have high set unit having low transient overreach & variable setting typically 500-2000% of rated current.
 - Include hand rest flag LEDs.
 - iv) Earth fault protection
 - Have directional IDMT characteristic with a definite minimum time of 3 sec at 10 times setting and have a variable setting range of 10-80% of rated current.
 - Have low transient . over reach high set instantaneous unit of continuously variable setting range of 200-800% of rated current.
 - Have an adjustable characteristic angle of 30 to 60 degree lead
 - Shall have high set unit having low transient overreach & variable setting typically 100-800% of rated current.
 - Include hand rest flag LEDs.
 - V) Neutral current protection (For single phase transformer bank)
 - Have directional IDMT characteristic with a definite minimum time of 3 sec at 10 times setting and have a variable setting range of 20-80% of rated current.

7). 765 KV Line Reactor protection

The protection shall be grouped as below wherein all protection functions of particular group can be implemented in one numerical relay.

765 KV selected Bus PT supply to be given for Reactor differential Relay to enable the inter term fault Protection.

Reactor Protection to be classified as Group A & Group B. Group A Relays to be connected in DC Source –1, Group B Relays to be connected in DC Source -2.

In Group A – Differential Protection

- Backup impedance protection
- Oil temperature protection
- Pressure relief device protection
- Fire protection

In Group B – REF Protection (For reactor and NGR)

- Neutral Displacement Protection
- Directional o/c & E/F Protection
- Buchholz protection
- Winding temperature protection
- Oil level/ High low protection /Monitor
- Fire protection

Multifunction numerical relay shall be used for Group-A protection, Multifunction numerical relay shall be used for Group-B protection.

Where ever CT and VT is wired to the numerical relays, the relay should be provided with built in supervision of CT and VT respectively. VT fuse fail block of voltage manipulated protection should be provided. Reactor Bushing CTs to be used for differential and REF Protection. The Main CT and Tie CT shall be wired to separate CT modules so as to arrive at the vector sum of these CTs internally in the respective numerical relays.

8. Bus reactor Protection (Applicable for 765KV as well as for 400KV)

The protection shall be grouped as below wherein all protection functions of particular group can be implemented in one numerical relay.

Selected Bus PT supply to be given for Reactor differential Relay to enable the inter term fault Protection.

Reactor Protection to be classified as Group A & Group B. Group A Relays to be connected in DC Source –1, Group B Relays to be connected in DC Source -2.

In Group A – Differential Protection

- Backup impedance protection
- Oil temperature protection
- Pressure relief device protection
- Fire protection

In Group B – REF Protection (For Bus reactor and NGR)

- Neutral Displacement Protection
- Directional o/c & E/F Protection
- Buchholz protection
- Winding temperature protection
- Oil level/ High low protection /Monitor
- Fire protection

Multifunction numerical relay shall be used for Group-A protection, Multifunction numerical relay shall be used for Group-B protection, However dedicated numerical relays for each of the following protections shall be provided:

Where ever CT and VT is wired to the numerical relays, the relay should be provided with built in supervision of CT and VT respectively. VT fuse fail block of voltage manipulated protection should be provided. Reactor Bushing CTs to be used for differential and REF Protection. For Backup impedance protection use the CTs of the main breaker and tie breaker in order to provide protection for the tee section of this diameter also. The Main CT and Tie CT shall be wired to separate CT modules so as to arrive at the vector sum of these CTs internally in the respective numerical relays.

9. Detailed Technical Specs for Controlled Switching Device

The control switching device (CSD) is applicable for the optimization of switching behavior of circuit Breaker used for switching the HV side of the 765 kV / 400 kV ICT and of 765 kV Main circuit breaker for 765 kV Bus reactor, Dedicated 765 KV breaker for the Line reactor.

The controlling relay shall also record and monitor the switching operations and make adjustment to the switching instants to optimize the switching behavior as necessary.

It shall provide self diagnostic facilities, signaling of alarms and enable downloading of data captured from the switching events.

2. Technical Specification for controlled switching device:

a) The CSD shall meet the technical and type tests requirements stipulated under "General requirements for Numeric type protection relays".

b) In addition to the type tests stipulated for the numerical relay, the CSD shall conform to the type tests as per IEC-60255-4 Appendix 'E' class III regarding HF disturbance test, and fast transient test shall be as per IEC-61000-4 level III and insulation test as per 60255-5.

c) The CSD shall be designed to operate correctly and satisfactorily with the range of auxiliary A/C & DC supply voltages and frequency as specified.

d) The CSD shall have functions for switching ON & OFF the circuit breakers.

1) For transformers it will be used for switching ON the transformer for reduction of the inrush currents. The limiting of inrush currents shall be within satisfactory limits for the application.

The CSD shall be provided with all the strategies mentioned below for transformer switching application:

- i) Controlled closing so as to energise at instant at the peak voltage (zero flux).
- ii) Controlled opening prior to controlled closing that takes residual flux into account. Controlled opening ensures repeatable flux conditions (polarity, magnitude) and opening is timed at peak voltage for each phase. Making conditions are tuned to fit to the locked interrupting conditions.
- iii) Automatic targeting by residual flux measurement which involves to energize at instants when the prospective flux equals the residual flux. The residual flux may be determined by the integration of the load side voltages. This strategy shall be preferable for implementation.

2) For Bus / Line Reactors CSD shall be provided with the strategy for control de-energizing to ensure reignition-free behavior for which the circuit breaker of

respective phase shall be opened at zero crossing of the current for each phase. Also controlled closing strategy shall be effective for minimizing inrush currents within satisfactory limits for the application.

e) The CSD shall get command to operate the breakers manually or through SCADA system. The CSD shall be able to analyze the current and voltage waves available through the signals from secondaries of CTs & PTs/CVTs for the purpose of calculation of optimum moment of the switching the circuit breaker and issue command to circuit breaker to operate.

f) The CSD shall also have an adaptive control feature to consider the next operating time of the breaker in calculation of optimum time of issuing the switching command. In calculation of next operating time of the breaker the CSD must consider all factors that may affect the operating time of the breaker such as, but not limited to, ambient temperature, hydraulic / pneumatic pressure of the operating mechanism, control voltage variation, etc. Schematic drawing for this purpose shall be provided by the contractor. The accuracy of the operating time estimation by the CSD shall be better than +0.5 ms. All the necessary sensors, cables etc. is inclusive of project scope of supply, erection, testing and commissioning works. Spare contacts in the auxiliary contacts of the circuit breaker should be provided for this purpose.

g) The CSD should have display facility at the front for the settings and measured values. Display facility can be either built in or add-on.

h) The CSD should be PC compatible for the setting of various parameters and downloading of the settings and measured values date time of switching etc. Window based software for this purpose shall be supplied by the contractor and this software shall be installed in the laptop to be provided for the SAS configuration tools.

i) The CSD shall be suitable for current input of 1 amp from the secondary of the CTs and 110 V (Ph to Ph) from the CVTs. The CSD shall also take care of transient and dynamic state values of the current from the secondary of the CTs and CVTs.

j) The CSD shall have time setting resolution of 0.1 ms or better.

k) The CSD shall have sufficient number of potential free binary output contacts and opto isolated binary inputs for connecting the monitoring equipment and to the SAS for annunciation.

l) The provision of bypassing the Controlled Switching Device shall be provided both through the BCU as well as the SAS HMI. In case of any non-operation of CSD after receiving close/trip command after a pre-determined time delay, the controlled switching device should automatically be bypassed so as to ensure that the trip/close commands are extended to the trip/close coils. Feedback of the same needs to be provided for operator's information.

m) Supply of CSD with all its associated materials such as sensors, transducers etc. is included in the scope of the Relay panel for ICT as well as the Relay panel for the Line reactor. The CSD should be supplied with required Pressure Transducers for Pneumatic Type of mechanism of CB. The CSD should be supplied with Temperature Transducer for temperature compensation of operating timing with the variation of ambient temperature

CSD shall be suitable for 19" rack mount installation preferably installed in the respective relay panel in the control room building. Installation of CSD other than the relay panel say in the LCC is subject to acceptance of TANTRANSCO.

n) CSD should be provided with the facilities and features listed below :

1. Detection of excessive inrush current and restrike/re-ignition on Opening of circuit breaker.
2. Detection of erroneous circuit breaker opening/closing time
3. Detection of alarms on opened sensor loop
4. Under voltage protection of CB control voltage
5. Recording of protection trip waveforms
 - CB alarms monitoring (compressor failure, etc.)
 - CB sensor monitoring (SF6 pressure, etc.)
6. Monitoring of the 3 load current and 3 source voltage
7. CB coil current supervision: detection of short circuits between coils, short circuits to supply
8. CSD should have the built-in bypass facility to bypass the device when It required.

9. Recorded wave forms should be compatible with the COMTRADE file format
10. CSD should have the facility of time synchronization and compatible with IEC 61850 and GOOSE protocol.
- 11.CSD shall have storage facility to store at least 1000 events including waveforms
- 12.CSD shall have idle time compensation feature

Testing and commissioning of CSD

CSD Performance and validation tests, integration of CSD with SAS is inclusive of the testing and commissioning of the relevant relay panels and SAS.

Necessary simulation studies for finalizing the configuration parameters of the CSD is inclusive of the project scope.

GUARANTEED TECHNICAL PARTICULARS FOR CSD:

S.no	Description	Guaranteed Specification
1	Make & Model	
2	Auxiliary supply operating range	
3	Digital Input (Equipped)	
5	Digital output (Equipped)	
7	Rating of control output relays provided	
8	Control strategy for Transformer	
a	Controlled close strategies	
b	Controlled Open strategies	
c	Assured limiting of Inrush current (in Per unit times full load current)	
9	Control strategy for Reactor	
a	Controlled close strategies	
b	Controlled Open strategies	
c	Assured limiting of Inrush current (in Per unit times full load current)	
10	Functionalities supported:	
a)	SOE (Mention resolution, record length)	
b)	Disturbance recorder (Mention resolution, record length, Sampling rate)	
c)	Fault recorder (Resolution, storage capacity)	
d)	Self diagnostics (Equipped?)	
11	Operating system	

12	Data transmission speed supported	
13	Communication ports (Mention media, speed & protocol)	
14	Communication port for device configuration (Mention media)	
15	Time synchronisation interface equipped (Mention media, standard supported)	
16	Provision of sufficient protection in the CSD to protect from natural hazards viz lightning & thunder systems.	
17	Provision of Electrical isolation between all the functional Boards and field connections.	
18	Operating temperature range	
19	Relative humidity -Operating range	
20	List out the type test standards complied by the BCU	

10. Cabinets

The requisite quantity of cabinets necessary to accommodate and assemble the control & protection devices of the respective relay panels shall be inclusive of the scope of supply of respective relay panels. No additional cost will be applicable for the required number of cabinet in this regard.

SECTION – 3

GENERAL TECHNICAL REQUIREMENTS

3.0 FOREWORD

The provisions under this section are intended to supplement general requirements for the materials, equipment's 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 : 765/400KV AIS SUB STATION AT ARIYALUR
- c) Transport facilities : Road/Rail

Physical and other parameters:

3.1.1 Location of the substation

- 3.1.2 Nearest Railway station : Tindivanam
Railway : Southern Railway

3.1.3 Meteorological data

- (i) Atmosphere : Polluted
- (ii) Maximum ambient temperature : 50°C
- (iii) Minimum ambient temperature : 20°C
- (iv) Maximum daily average ambient air temperature : 45° C
- (v) Maximum yearly average ambient air temperature : 32° C
- (vi) Maximum Humidity (%) : 100%
- (vii) Average thunder storm days per annum : 50
- (viii) Average rainy days per annum : 65
- (ix) Average annual rainfall (mm) : 750 mm
- (x) No. of months during which tropical monsoon condition prevail : 3
- (xi) Maximum wind pressure : 150 Kgf/Sqmm
- (xii) Altitude above MSL : <1000M

(xiii) Basic Wind Speed

: 47 m/s (Zone -4)

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

3.1.4 System Parameter

SL No	Description of parameters	765kV System	400 kV System
1.	System operating Voltage	765kV	400kV
2.	Maximum operating voltage of the system(rms)	800kV	420kV
3.	Rated Frequency	50HZ	50H
4.	Number of Phases	3	3
5.	Rated Insulation Levels (i) Full wave impulse withstand voltage.(1.2 to 50 micro sec) (ii) Switching impulse withstand voltage(250/2500 micro sec) dry and wet. (iii) One minute power frequency dry withstand voltage (rms) frequency dry withstand voltage (rms)	2100kVp 1550kVp 830kV	1550kVp 1050kVp 630kV
6.	Corona extinction voltage	508kV	320kV
7.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz at 508 kV rms for 765kV, and 266kV rms for 400kV system	2500 microvolts	1000 microvolts
8.	Minimum creepage distance (25mm/kV)	20000 mm	10500 mm
9.	Rated short circuit current for 1 sec. Duration	50kA	63kA
10.	System neutral earthing	Effectively earthed	Effectively earthed
11.	Seismic acceleration	0.3g horizontal	0.3g horizontal
12.	Plinth level of switchyard	500mm above FGL	500mm above FGL

3.1.5 AUXILIARY POWER SUPPLY:

Auxiliary electrical equipment's maintenance equipment's etc., shall be suitable for operation on the following supply system.

3 phase AC Supply	415V, 3 phase 4 wire 50 Hz, neutral grounded AC supply -10% to +10%, frequency +/- 5%
1 phase AC supply	240V, single phase, 50 Hz neutral grounded AC supply
DC supply	220, 2 wire DC supply + 10% to -15%, Ungrounded 48V, 2 wire DC supply , Positively earthed

3.2 GENERAL REQUIREMENT

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

3.2.1 The bidder shall also furnish drawings for the following:

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

3.2.2 GENERAL:

The bidder 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.

Any other items not specifically mentioned in the specification but which are required for erection of materials/equipment under the scope of work, testing and commissioning are deemed to be included in the scope of the specification unless specifically excluded.

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/equipment is furnished. The Technical specification contained herein for the materials are for the guidance of the tenderer.

The bidders are requested to procure the equipment's/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

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

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

3.4 STANDARD:

The works covered by the specification shall be designed, engineered, manufactured, built, tested and commissioned in accordance with the Acts, Rules, Laws and Regulations of India.

The equipment to be furnished under this specification shall conform to latest issue with all amendments (as on the date of bid opening) of standards specified in each section.

The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to compliment each other.

The Bidder shall also note that list of standards presented in this specification is not complete. Whenever necessary the list of standards shall be considered in conjunction with specific IS/IEC. When the specific requirements stipulated in the specifications exceed or differ than those required by the applicable standards, the stipulation of the Specification shall take precedence.

3.5 TYPE TEST:

The Type Test for all the 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 Ten years, subject to no change in design as on the originally scheduled date of technical bid opening i.e. **30.09.2016**

In case the type tests were conducted earlier than 10 (ten) years prior to the originally scheduled date of bid opening, the contractor shall repeat these test (s) at no extra cost to the purchaser.

However, in case of instrument transformers, the following type tests should have been conducted within 5 (five) years prior to the originally scheduled date of bid opening.

- i) Lightning Impulse Test
- ii) Switching Impulse Test
- iii) Multiple Chopped Impulse Test (For CT)
- iv) Chopped Impulse Test (For CVT)

In case the test reports are of these tests (for instrument transformers) as mentioned above are conducted earlier than 5 (five) years prior to the originally scheduled date of bid opening, the contractor shall repeat these test(s) at no extra cost to the BHEL. The original type test certificates shall be furnished for verification on request.

TANTRANSCO/BHEL reserves the right to demand repetition of some or all the type tests in the presence of purchaser's representative at no extra cost.

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

3.6 MATERIALS AND WORKMANSHIP:

All the materials shall be of the best class and capable of satisfactory operation in the tropics with humid atmosphere conditions. Unless otherwise specified, they shall conform to the requirements of the appropriate ISS/IEC. The workmanship shall be of the best grade and the entire construction in accordance with the best modern practice.

The equipment shall be designed to facilitate inspection and repairs and to ensure satisfactory operation under atmosphere condition prevailing at site and under such sudden variation of load and voltage as may be met with under working conditions in the system including those due to faulty synchronizing and short circuit within the rating of the apparatus.

The design shall incorporate every reasonable precaution and provision for the safety of all those concerned in the operation and maintenance of the equipment.

All the equipment's should operate without undue vibration and with the least practicable amount of noise.

3.7 INSPECTION:

The inspection may be carried out by the TANTRANSCO/BHEL at any stage of manufacture. The supplier shall grant free access to TANTRANSCO's/BHEL representative at a reasonable time when the work is in progress. The TANTRANSCO/BHEL shall have access at all times to the works and all other places of manufacture/fabrication, where the equipments are being manufactured/fabricated and the bidder shall provide TANTRANSCO's/BHEL representative all facilities for unrestricted inspection of the works, raw materials, manufacture of all the accessories and for conducting necessary tests.

Inspection and acceptance of any equipment under this specification by the TANTRANSCO/BHEL shall not relieve the supplier of his obligation of furnishing equipment in accordance with the specification and shall not prevent subsequent rejection if the equipment is found to be defective. The supplier shall keep the TANTRANSCO/BHEL informed in advance, about the manufacturing programme so that arrangement can be made for inspection.

The TANTRANSCO/BHEL, reserves the right to insist for witnessing the acceptance/routine testing of the bought out items. No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested.

The correct grade and quality of steel shall be used by the supplier. To ascertain quality of steel, the TANTRANSCO/BHEL may at his discretion get the material tested at an approved laboratory.

The bidder shall take an account the fabrication wastage while quoting the rates. The Employer will not accept any liability in connection with the wastage of steel during fabrication or otherwise. Steel shall be procured exclusively from the main producers. However, sections not rolled by main produces can be procured from reroller, provided rerolling of structural steel section is done from billets/ingots of tested quality. Rerolled sections are duly tested as per relevant standards. Supplier should obtain approval of list of primary producers of Steel and Zinc before Proto assembly.

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.

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:

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.

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.

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 equipment's and before charging each item of equipment's 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 equipment's in the presence of BHEL/ TANTRANSCO. Necessary tools, testing kits to be arranged by the Supplier.

3.10 DOCUMENTATION : All drawings shall conform to relevant international standards Organization (ISO) specification. All drawings shall be in ink and suitable for micro filming. All dimensions and data shall be in S.I. units.

3.11 PAINTING, GALVANISING:

All interiors and exteriors of all metal parts shall be thoroughly cleaned to remove all rust, scales, corrosion, greases or other adhering foreign matter and the surfaces treated by phosphating (e.g. seven tank phosphating sequences).

All metal surfaces exposed to atmosphere shall be given, in addition to the treatment, 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 limits specified. The paint shall not scale off or wrinkle or be removed by abrasion due to normal handling. All external paintings shall be as per shade **No.697/631 of IS-5**.

Paint inside the metallic housing shall be of anti condensation type and the paint on outside surfaces shall be suitable for outdoor installation.

All components shall be given adequate treatment of climate proofing as per **IS: 3202** so as to withstand corrosive and several service conditions.

All ferrous parts including all sizes of nuts, bolts, support channel structures, etc. as also the mechanism housing shall be hot dip galvanized conforming to latest version of IS : 2629 or epoxy painted. Spring washers shall be electro-galvanised.

All members of the structure members shall be hot dipped galvanised with a zinc coating of **610 gms. per square metre** . Galvanising shall be done after a work is completed, except that the nuts may be tapped or rerun after galvanization. The zinc coating shall be smooth, clean, of uniform thickness and free from defects. The preparation for galvanising itself shall not adversely affect the mechanical properties of the coated materials. The employer shall be at liberty to have the samples of zinc used, test checked in any laboratory at his own cost and reject the particular supply if it is below standard.

All galvanised material shall withstand test as per IS 2633-1972 or any other equivalent standard. The zinc used for galvanising fabricated material shall be of high grade Electrolytic zinc of 99.99% purity.

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 610gm of zinc per square meter of surface. The zinc coating shall be smooth, of uniform thickness and free from defects.

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 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.

3.16 RATING PLATES, NAME PLATES AND LABELS:-

The equipment's shall be provided with a rating plate or plates marked with but not limited to following data whatever needs to that particular equipment's.

- (a) Manufacturer's name or trade mark.
- (b) Serial number and type design making it possible to get all relevant information from the manufacturer.
- (c) Year of manufacture.
- (d) Rated voltage
- (e) Rated insulation level.
- (f) Rated frequency
- (g) Rated Normal current.
- (h) Rated short circuit breaking current
- (i) First pole to clear factor
- (j) Rated duration of short circuit
- (k) Rated auxiliary D.C. supply voltage of closing and opening devices.
- (l) Rated pressure of SF6 gas for operation and interruption.
- (m) Rated out of phase breaking current.
- (n) Rated supply voltage of auxiliary circuit.
- (o) Rated supply frequency of auxiliary circuits.
- (p) Purchase Order Number and Date.

The rating plate shall be visible in position of normal service and installation.

The rating plate shall be weather proof and corrosion proof.

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/labels shall also be submitted.

3.17 EARTHING:

The operating mechanism housing, control cabinets, support structure etc. shall be provided with two separate earthing terminals suitable for bolted connection to 50x8mm mild steel flat to be provided for connection to station earth mat.

Circuit breakers, LA, Isolator, CVT, CT, BPI shall be provided with two grounding pads suitable for connection to galvanized steel flat of Size 75X12 mm. 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.

3.18 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

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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.

3.19 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 2.0 mm thick cold rolled or 2.5 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 /EPDM 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 at least 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 at least 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.

3.20 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.

3.21 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.

3.22 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.

3.23 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.

3.24 LIST OF DRAWINGS AND DOCUMENTS :

The drawings for the equipments provided by the TANTRANSCO shall be followed strictly by the bidder while designing. For the rest of the equipments, the design is in the scope of the bidder and the same got approved by the TANTRANSCO.

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765/400KV AIS SUB STATION ARIYALUR

The bidder shall furnish One sets of relevant descriptive and illustrative published literature pamphlets and the following drawings/documents for preliminary study along with the offer.

- (i) General outline drawings showing dimensions and shipping weights, quantity of insulating media, etc.
- (ii) Sectional views showing the general constructional features of the circuit breaker including operating mechanism, arcing chambers, contacts with lifting dimensions for maintenance.
- (iii) Schematic diagrams of breaker offered for control supervision and re-closing.
- (iv) Structural drawing, design calculations and loading data for support structures.
- (v) Foundation drilling plan and loading data for foundation design.
- (vi) The Type Test Reports
- (vii) Bill of materials shall be furnished along with drawings.

The supplier shall, within 1 weeks of placement of order submit six sets of final version of all the above drawings for BHEL/TANTRANSCO's approval. The TANTRANSCO shall communicate its comments/approval on the drawings to the supplier within reasonable period. The Supplier shall, if necessary, modify the drawings and resubmit four copies of the modified drawings for TANTRANSCO's approval within two weeks from the date of comments.. However the drawing approval does not absolve the supplier from complying with the terms of the specification.

The following should be supplied to each consignee circle along with the initial supply of equipment's ordered.

- 1) Five copies of printed and bound volumes of operation, maintenance and erection manual in English along with the copies of approved drawings and type test reports etc.
- 2) Three sets of manuals detailed in item (1) shall be supplied to the TANTRANSCO/BHEL within one week from the date of approval of drawings.
- 3) The spares for the Equipment's ordered under the scope of the Contract should also be supplied to the consignee circle along with initial supply of the breakers.
- 4) It should be noted that if the above conditions are not fulfilled the initial payment will not be released.

3.25 QUALITY ASSURANCE PLAN:

The bidder shall invariably furnish following information along with his offer. (i) Statement giving list of important raw materials including but not limited to:

- (a) Contact material
- (b) Insulation
- (c) Porcelain
- (d) Sealing material
- (e) Contactor, limit switches, etc. in control cabinet.

Name of sub-supplier for the raw materials, list of standards according to which the raw materials are tested, list of test normally carried out on raw materials in presence of bidder's representative, copies of test certificates.

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- (ii) Information and copies of test certificates as in
- (i) above in respect of bought out accessories.
- (iii) List of areas in manufacturing process, where such inspections are normally carried out for quality control and details of such tests and inspections.
- (iv) Special features provided in the equipment to make it maintenance free.
- (v) List of testing equipment available with the Bidder for final testing of breakers vis-à-vis, the type, special, acceptance and routine tests specified in the relevant standards. These limitations shall be very clearly brought out in the relevant schedule i.e. schedule of deviations from specified test requirements.

The supplier shall submit following information to the TANTRANSCO.

- 1) List of raw materials as well bought out accessories and the names of sub-suppliers selected from those furnished along with offer.
- 2) Type test certificates of the raw material and bought out accessories.
- 3) Quality assurance plan (QAP) withhold points for TANTRANSCO inspection. The quality assurance plan and hold point shall be discussed between the employer and supplier before the QAP is finalized.

The supplier shall submit the routine test certificates of bought out items and raw material, at the time of routine testing of the fully assembled breaker.

3.26 **TEMPERATURE RISE :**

The maximum temperature attained by any part of the equipment when in service at site under continuous full load conditions and exposed to the direct rays of the sun shall not exceed 30 deg. Cover an ambient of 50 deg. C limits specified in relevant IEC. When the standard specify the limit of temperature rise these shall be exceeded when corrected for the difference between ambient temperature at site and that specified in the approved specifications. No material shall be dispatched from its point of manufacture unless the material has been satisfactorily inspected and tested.

3.27 **FITTINGS AND ACCESSORIES :**

Following is a partial list of some of the major fittings and accessories to be furnished by contractor as an integral part of the equipment.

Operation mechanism housing complete with:

- (a) Locking arrangement.
- (b) Heaters equipped with automatic thermostatic control and control switch.
- (c) Cable glands.
- (d) Local/Remote change over switch.
- (e) Operation Counter.
- (f) Terminal Blocks.
- (g) Control switches to cut off control power supply.
- (h) MCCBs/MCBs are required with permanent identification marks for protection of D.C. circuits and A.C. circuits.
- (i) Two earthing terminals.

3.28 PACKING AND FORWARDING:

The equipment shall be packed in crates suitable for vertical/horizontal Transport, as the case may be and suitable to withstand handling transport and outdoor storage during transit. The supplier shall be responsible for any damage to the equipment during transit due to improper and inadequate packing and handling. The easily damageable material shall be carefully packed and marked with the appropriate caution symbols. Wherever necessary, proper arrangement for lifting, such as lifting hooks etc., shall be provided. Any material found short inside the packing cases shall be supplied by supplier without any extra cost.

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.

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.

3.29 SPECIFICATION FOR NITRYL BUTYL RUBBER

The gaskets are to be used in tanks exposed to Transformer mineral oil/SF6 at about 110° C.

1. Hardness should be Shore A 70 ± 5.
2. Tensile Strength should be min. 10.8N/sq.mm (Minimum)
3. Elongation strength should be 270% (Minimum)

3.30 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 BHEL/TANTRANSCO. 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.

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Note: The supplier may please note that all resubmissions must incorporate, all comments given in the submission by the BHEL/TANTRANSCO 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 below mention Title block for Submission of Documents.

Title Block

Customer	M/s Tamil Nadu Transmission Corporation Limited
Project:	765/400KV Air Insulated substation Ariyalur
Contractor	BHEL

3.31 DOCUMENTS TO BE SUBMITTED ALONGWITH OFFER

Drawings, GTP, Type Test Reports and List of Past Supplies. Drawings & Documents

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

3.31 DOCUMENTATION SCHEDULE

Following Documentation schedule to be followed per project.

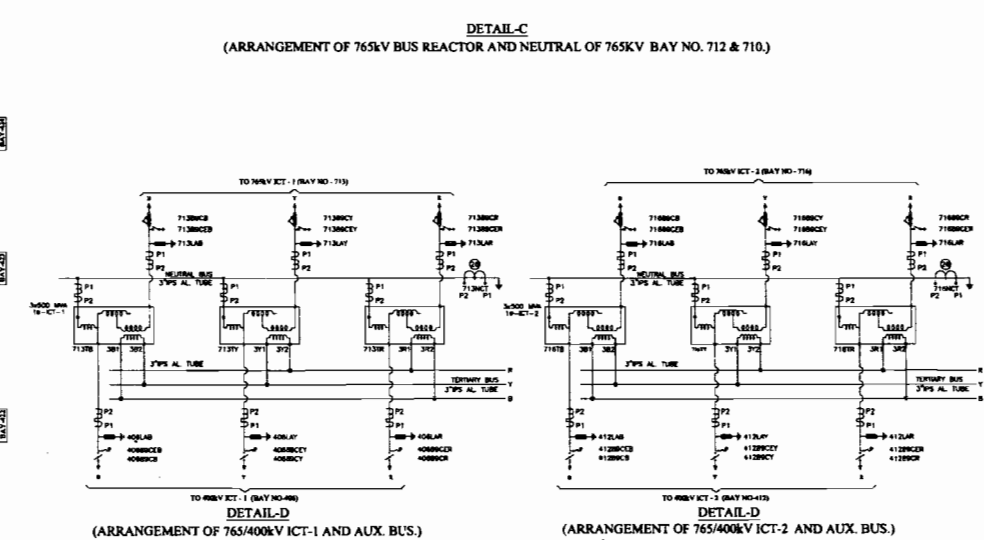
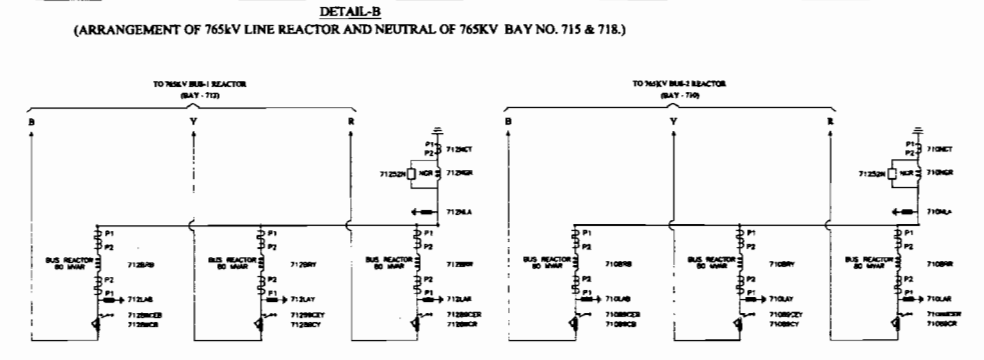
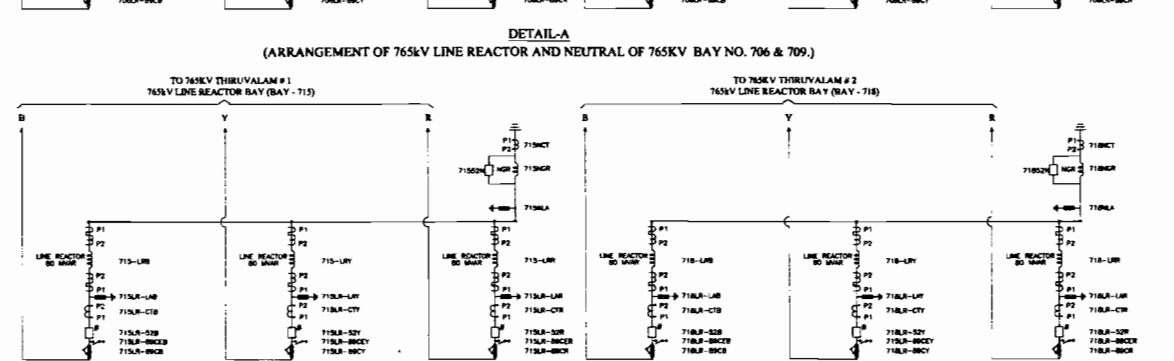
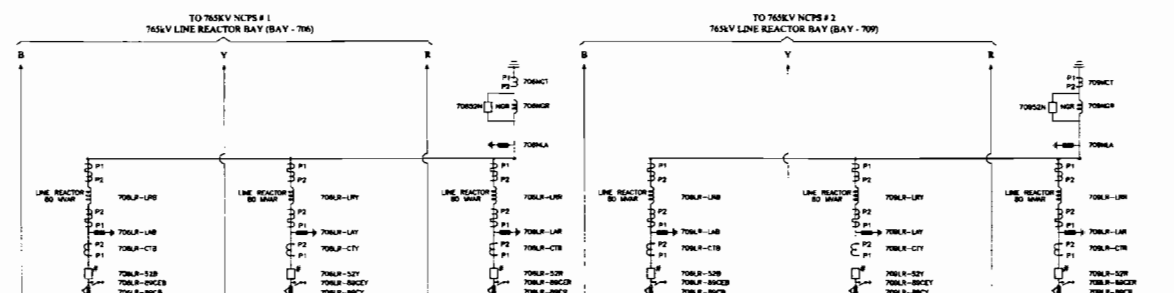
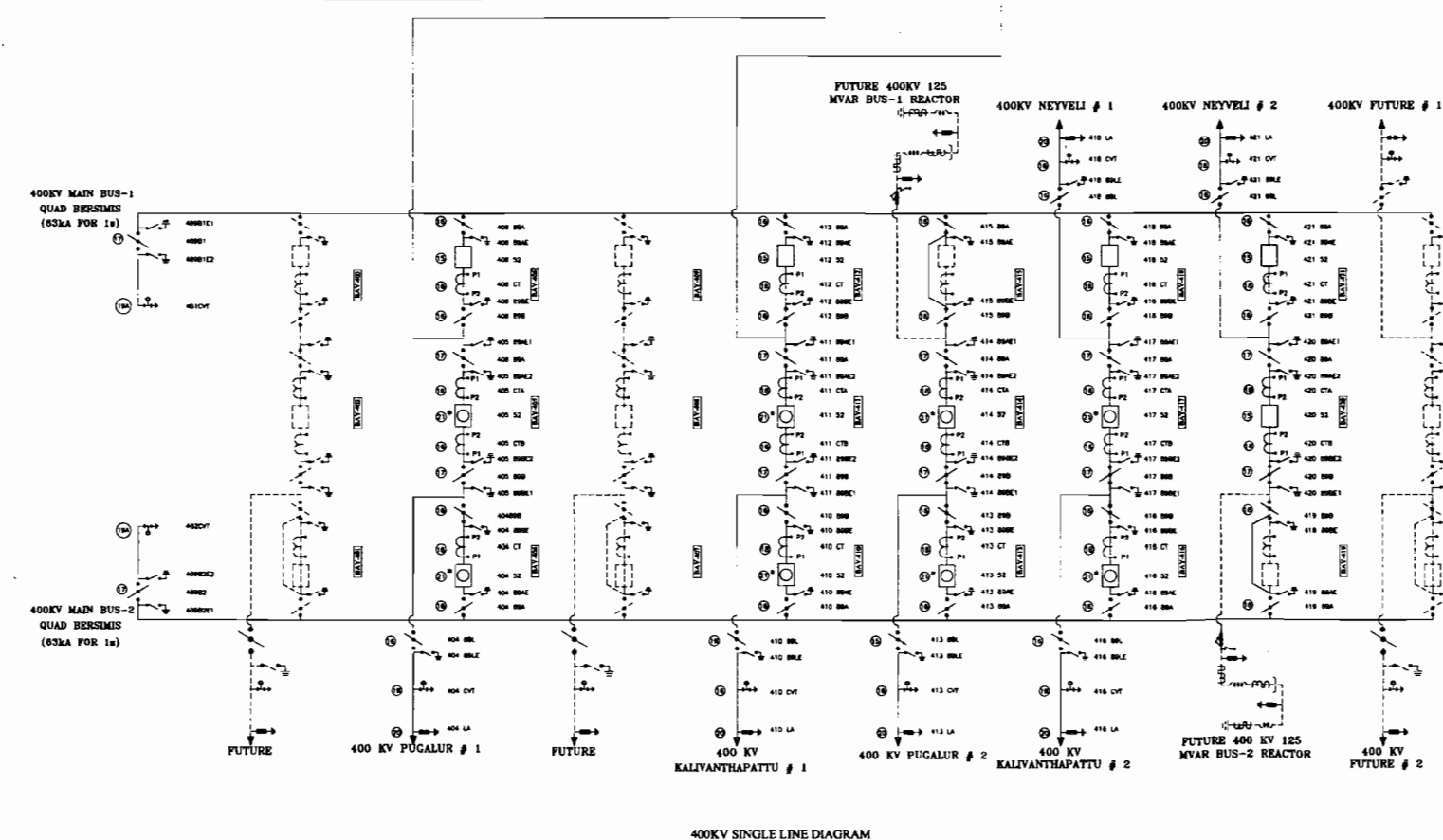
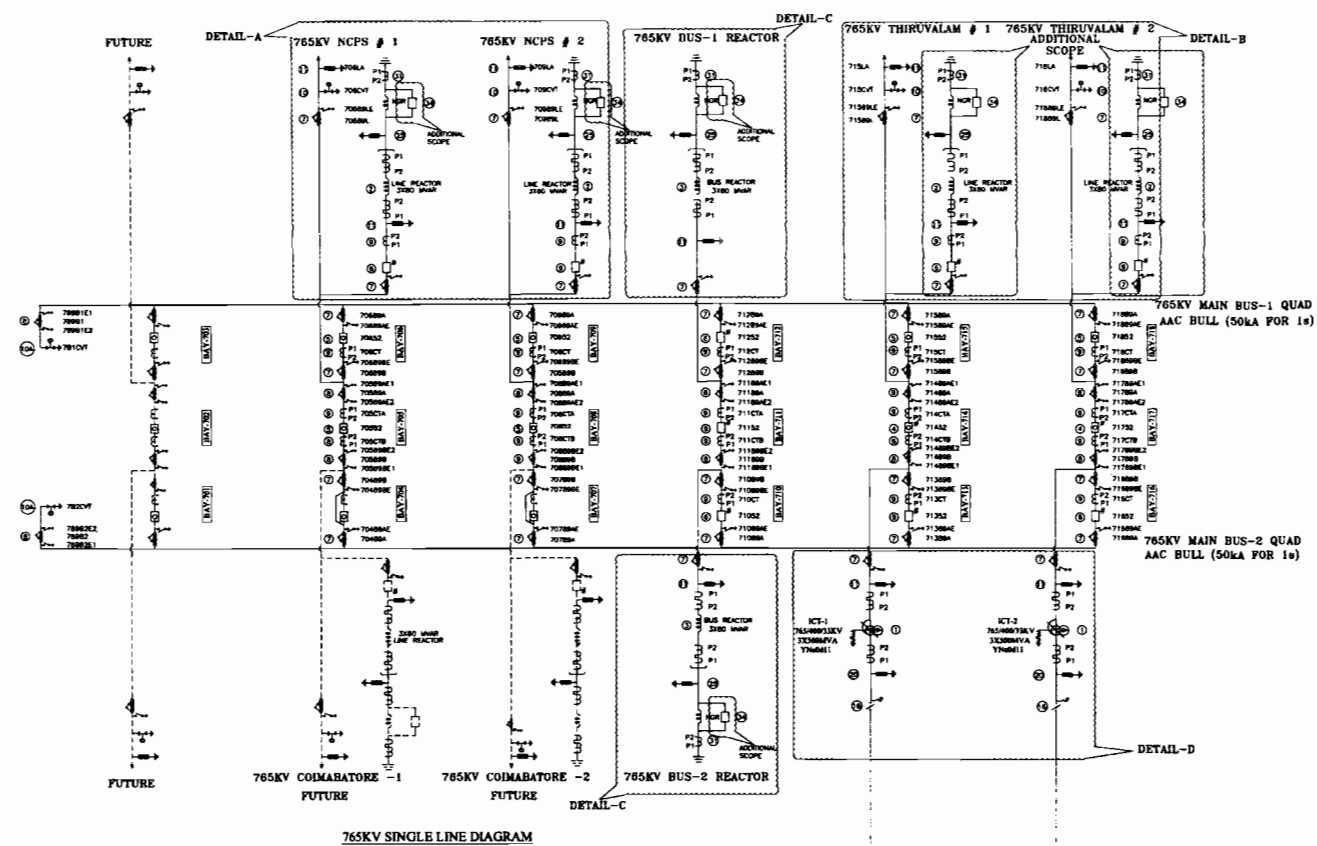
S. No.	DESCRIPTION	TENDER STAGE	CONTRACT STAGE FOR APPROVAL	FINAL DOCUMENTATION	
				Prints	CDs
1	Drawings and Data Sheets	1	7	10	5
2	Drawings "As Built "	-	-	10	
3	Type Test Reports	1	7	10	
4	Erection Manuals	-	7	10	
5	Operation and Maintenance Manuals	-	7	10	
6	Manufacturing Quality Plan	-	7	10	
7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

SECTION . 4

List of Enclosures with Technical Specification:

1. Following Single Line Diagram:
 - a) 765/400kV Ariyalur sub-station - Dwg. No. TB-0-394-510-001 Rev. No. 02
(2 SHEETS)
2. Following Layout Plan:
 - b) 765/400kV Ariyalur sub-station - Dwg. No. TB-0-394-316-002 Rev. No. 02
(1 SHEET)
3. Following Key Protection and Metering Single Line Diagrams (For tender purpose only):
 - c) 765/400kV Ariyalur sub-station - Dwg. No. TB-3-394-510-016 Rev. No. 02
(13 SHEETS)



PROJECT NO.	100-015-765-0-01	TITLE	765/400KV S/S AYIALUR IN VALLUPPAM
REFERENCE NO.		DATE	18-0-394-510-001
STATUS OF DRAWING	CONTRACT	DESIGNER	TRANSMISSION PROJECTS DIVISION
DISTRIBUTION OF PLOTS		SCALE	1:1000
REV	DATE	BY	CHKD
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DRAWING No. TB-0-394-510-001

BILL OF QTY. FOR 765kV MAIN EQUIPMENTS:

SL NO	DESCRIPTION	RATING	QTY (NO.) (ORIGINAL SCOPE)	QTY (NO.) (ADDITIONAL SCOPE) SS	SYMBOL	LEGEND
1	500 MVA (1-PH) ICT	765/400/33KV	6	-		T
2	80MVAR LINE REACTOR (1-PH) WITH NGR	765KV	6	6		LR/NGR
3	80MVAR BUS REACTOR (1-PH) WITH NGR	765KV	6	-		BR/NGR
4	SF6 CIRCUIT BREAKER WITH PIR WITH CSD (3-PH)	3150A	2	-		S2
5	SF6 CIRCUIT BREAKER WITH PIR WITHOUT CSD (3-PH)	3150A	6	-		S2
6	SF6 CIRCUIT BREAKER WITHOUT PIR WITH CSD (3-PH)	3150A	7	2		S2
7	ISOLATOR WITH ONE E/SW (3 PH) VERTICAL KNEE TYPE	3150A	30	2		89/89E
8	ISOLATOR WITH TWO E/SW (3 PH) VERTICAL KNEE TYPE	3150A	12	-		89/89E1 /89E2
9	6 CORE CURRENT TRANSFORMER (1 PH)	3000A	60	6		CT
10	CVT (1 PH) WITH SECONDARY BURDEN 50VA	4400pF	12	-		CVT
10A	CVT (1 PH) WITH SECONDARY BURDEN 100VA	4400pF	06	-		CVT
11	SURGE ARRESTER (1 PH)	624 kV	30	6		LA

BILL OF QTY. FOR 400kV MAIN EQUIPMENTS:

SL NO	DESCRIPTION	RATING	QTY (NO.) (ORIGINAL SCOPE)	QTY (NO.) (ADDITIONAL SCOPE) SS	SYMBOL	LEGEND
15	SF6 CIRCUIT BREAKER WITHOUT PIR WITHOUT CSD (3-PH)	3150A	05	-		S2
16	ISOLATOR WITH ONE E/SW (3 PH) DOUBLE BREAK TYPE	3150A	78	-		89/89E
17	ISOLATOR WITH TWO E/SW (3 PH) DOUBLE BREAK TYPE	3150A	12	-		89/89E1 /89E2
18	6 CORE CURRENT TRANSFORMER (1 PH)	3000A	54	-		CT
19	CVT (1 PH) WITH SECONDARY BURDEN 50VA	4400pF	18	-		CVT
19A	CVT (1 PH) WITH SECONDARY BURDEN 100VA	4400pF	06	-		CVT
20	SURGE ARRESTER (1 PH)	390 kV	24	-		LA
21	SF6 CIRCUIT BREAKER WITH PIR WITHOUT CSD	3150A	08	PIR FEATURE		S2

SYSTEM PARAMETERS

SL NO	DESCRIPTION	765 kV	400 kV	33 kV
01	HIGHEST SYSTEM VOLTAGE	800kV (r.m.s)	420kV (r.m.s)	36kV (r.m.s)
02	SYSTEM OPERATING VOLTAGE	765kV	400kV	33kV
03	P.F. WITHSTAND VOLTAGE	830kV (r.m.s)	630kV (r.m.s)	70kV (r.m.s)
04	LIGHTING IMPULSE WITHSTAND VOLTAGE	2100 kVP	1550 kVP	170 kVP
05	SWITCHING IMPULSE WITHSTAND VOLTAGE	1350 kVP	1050 kVP	---
06	SYSTEM FAULT LEVEL	50KA FOR 1 Sec	63KA FOR 1 Sec	25KA FOR 1 Sec
07	CREEPAGE	25MM/KV	25MM/KV	25MM/KV
08	SYSTEM EARTHING	EFFECTIVELY EARTHED	EFFECTIVELY EARTHED	EFFECTIVELY EARTHED

BILL OF QTY. FOR 132kV, 33kV & 22kV MAIN EQUIPMENTS:

SL NO	DESCRIPTION	RATING	QTY (NO.) (ORIGINAL SCOPE)	QTY (NO.) (ADDITIONAL SCOPE) SS	SYMBOL	LEGEND
25	SURGE ARRESTER (1 PH)	132 kV, 10 KA 5 KJ/KV	4	2		LA
26	NEUTRAL CT OF ICT (1 PH)	33KV	2	-		CT
27	SF6 CIRCUIT BREAKER (3 PH)	33KV, 1250A	1	-		S2
28	DOUBLE BREAK ISOLATOR WITHOUT E/S (3 PH)	33KV, 400A	1	-		89
29	CURRENT TRANSFORMER (1 PH)	33KV, 50A	3	-		CT
30	POTENTIAL TRANSFORMER (1 PH)	33KV	3	-		PT
31	NEUTRAL CT OF NGR (1 PH)	33KV	4	2		CT
32	DOUBLE BREAK ISOLATOR WITHOUT E/S (3 PH)	22KV, 400A	-	2		89
33	HORN GAP FUSE (3 PH)	22KV	-	2		HGF
34	SF6 CB FOR NGR BYPASS (1 PH)	132KV, 1250A	-	6		S2

SS ADDITIONAL SCOPE / REQUIREMENTS

"APPROVED"

Subject to the conditions stipulated vide No. CH/IR/2017/004/1A/B/C/D

23/06/17

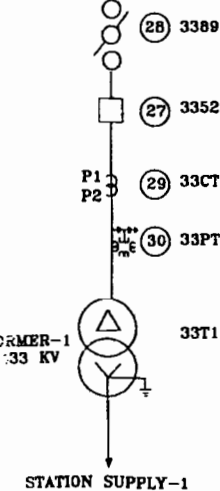
Superintending Engineer/TR-IV

Chief Engineer/Transmission

ANTRAMCO, Electric

1 Floor, ANKUR Mahal, West

144, Anna Salai, Chennai-600017

FROM ICT #1
TERTIARY LOADING
3X500MVA, 765/400/33KV

STATION SUPPLY-1

FROM SEB SUPPLY-2

22 kV
220kV CSE22 kV
220kV CSE

2289B

22HGF2

22T2

STATION SUPPLY-2

FROM SEB SUPPLY-3

22 kV
220kV CSE22 kV
220kV CSE

2289D

22HGF3

22T3

STATION SUPPLY-3

ADDITIONAL INFORMATION
W.O.No. 86009

STATUS OF DRAWING CONTRACT

DISTRIBUTION OF PRINTS

आइस/परियोजना का नाम TAMILNADU TRANSMISSION CORPORATION. LTD.

NAME OF CUSTOMER/PROJECT 765/400KV AIS S/S ARIYALUR IN VILLUPURAM

आइस/परियोजना का नाम	नाम / NAME	हस्ता / SIGN.	दि./DATE
आइस/परियोजना का नाम	PK	-SD-	24.04.17
आइस/परियोजना का नाम	SK/RD/VK	-SD-	
आइस/परियोजना का नाम	DM/RS	-SD-	

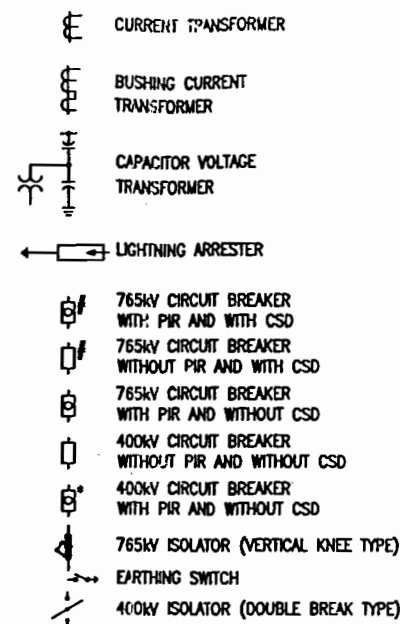
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आइस/परियोजना का नाम	SK/RD/VK	-SD-	
आइस/परियोजना का नाम	DM/RS	-SD-	

आइस/परियोजना का नाम	नाम / NAME	हस्ता / SIGN.	दि./DATE
आइस/परियोजना का नाम	PK	-SD-	24.04.17
आइस/परियोजना का नाम	SK/RD/VK	-SD-	
आइस/परियोजना का नाम	DM/RS	-SD-	

DRG. NO. TB-3-394-510-016

LEGEND

DEVICE NO.	FUNCTION
21M1	DIST. PROTECTION MAIN-I
21M2	DIST. PROTECTION MAIN-II
21R/21T	REACTOR/TRANSFORMER BACK-UP IMPEDANCE PROTECTION
79	AUTO-RECLOSE FUNCTION
25	CHECK SYNCHRONISING FUNCTION
DFL	DISTURBANCE/FAULT LOCATOR
98	CVT FUSE FAIL RELAY
59	TWO STAGE OVER VOLTAGE RELAY
67/67N	DIRECTIONAL IDMT PHASE O/C / E/F PROTECTION WITH HIGH SET FUNCTION
50 STUB	STUB PROTECTION
68	POWER SWING BLOCKING FUNCTION
46 BC	BROKEN CONDUCTOR PROTECTION
85	CARRIER-AIDED INER-TRIPPING FUNCTION
SER	SEQUENCE OF EVENT RECORDER
50/27	SOTF PROTECTION
27	UNDER VOLTAGE PROTECTION
DR	DISTURBANCE RECORDER
PMU	PHASOR MEASUREMENT UNIT
TWFL	TRAVELLING WAVE FAULT LOCATOR
51/51N	NON DIRECTIONAL IDMT PHASE O/C / E/F PROTECTION WITH HIGH SET FUNCTION
63 AX/TX	BUCHHOLZ RELAY, ALARM/TRIP
PRD TX	PRESSURE RELIEF DEVICE, TRIP
490 AX/TX	OIL TEMPERATURE HIGH, ALARM/TRIP
49W AX/TX	WINDING TEMPERATURE HIGH, ALARM/TRIP
OLAX	OIL LEVEL LOW, ALARM
63 OLTX	OLTC OIL SURGE, TRIP
FP TX	FIRE PROTECTION, TRIP
87T/87R	TRANSFORMER/REACTOR DIFFERENTIAL PROTECTION WITH BUILT-IN DR
64T/64R	TRANSFORMER/REACTOR RESTRICTED EARTH FAULT PROTECTION
99	OVER FLUXING PROTECTION
59N	NEUTRAL VOLTAGE DISPLACEMENT PROTECTION
50/50N	NON DIRECTIONAL INSTANTANEOUS PHASE O/C / E/F PROTECTION WITH HIGH SET FUNCTION
87B1/B2	BUSBAR DIFFERENTIAL PROTECTION MAIN-1/2
50 LBB	LOCAL BREAKER BACKUP PROTECTION
BCU	BAY CONTROL UNIT
ABT EM	ABT ENERGY METER
CSD	CONTROLLED SWITCHING DEVICE



* Dedicated Relay for Directional Overcurrent and Earth Fault Protection shall be provided for both HV & MV side of ICTs.

APPROVED Subject to the conditions
COMMUNICATION VIDE L No. CB/HR/SE/TR-IV/
BB4/ABB, I.E.T. 1966/D/160 1/7, dt 24.07.17

for Superintending Engineer / TR-IV
TANTRANSCO
6th Floor, N.P.M.R.R.
144, Anna Salai, Chennai - 600 002

FOR TENDER PURPOSE ONLY.

NAME OF CUSTOMER		TAMILNADU TRANSMISSION CORPORATION LTD (TANTRANSCO)	
NAME OF PROJECT		765/400kV AIS S/S ARIYALUR	
BHARAT HEAVY ELECTRICALS LIMITED TRANSMISSION BUSINESS GROUP			CARD CODE
KEY PROTECTION & METERING SINGLE LINE DIAGRAM LEGEND SHEET			NEXT SHEET 02
SCALE NTS			REV. 02
W.O. No. 86009		DRG. No. TB-3-394-510-016	

NOTE:

- 1) ALL PROTECTION FEATURES SHOWN IN THIS DRAWING SHALL BE PROVIDED IN THE OFFERED SYSTEM; HOWEVER, CLUBBING OF PROTECTION FUNCTIONS IN NUMERICAL RELAYS SHALL BE DECIDED AFTER FINALISATION OF CRP SUPPLIER.
- 2) REFERENCE DRAWING: SINGLE LINE DIAGRAM FOR 765/400KV S/S ARIYALUR DWG NO. TB-0-394-510-001, REV 02
- 3) ONE STAND-ALONE DISTURBANCE RECORDER SHALL BE PROVIDED FOR THE 765KV AND 400KV LINES. FOR ICT/REACTOR FEEDERS, DISTURBANCE RECORDER SHALL BE IN-BUILT FEATURE OF ONE NO. RESPECTIVE BAY PROTECTION NUMERICAL RELAY.
- 4) LBB PROTECTION SHALL BE BUILT-IN FUNCTION OF BUSBAR PROTECTION RELAY EXCEPT FOR THE TIE BAY OF COMPLETE DIAMETER AND LINE REACTOR BAY, WHEREIN A STAND ALONE LBB PROTECTION RELAY SHALL BE PROVIDED.

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INVENTORY NO.

REV.	DATE	ALTD.	CHD.	APPD.	REV.	DATE	ALTD.	CHD.	APPD.	NºME	SIGN.	DATE
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										CHECKED	VK	25/05/17
										APPROVED	VK	25/05/17
										DISTRIBUTION OF PRINTS		
										DEPT.	CODE	
										TBEM	422	

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DRG. NO. TB-3-394-510-016

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COMPUTER DRG. PATH NAME :

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INVENTORY NO.

REV.	DATE	ALTD.	CHD.	APPD.
02	15/06/17	RD	VK	VK

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NAME	SIGN.	DATE
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CHECKED VK	Sd/-	25/05/17
APPROVED VK	Sd/-	25/05/17

DISTRIBUTION OF PRINTS



DEPT.	CODE
TBEM	422

NAME OF CUSTOMER

TAMILNADU TRANSMISSION CORPORATION LTD
(TANTRANSCO)

NAME OF PROJECT

765/400kV AIS S/S ARIYALUR

BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS GROUP

CARD CODE

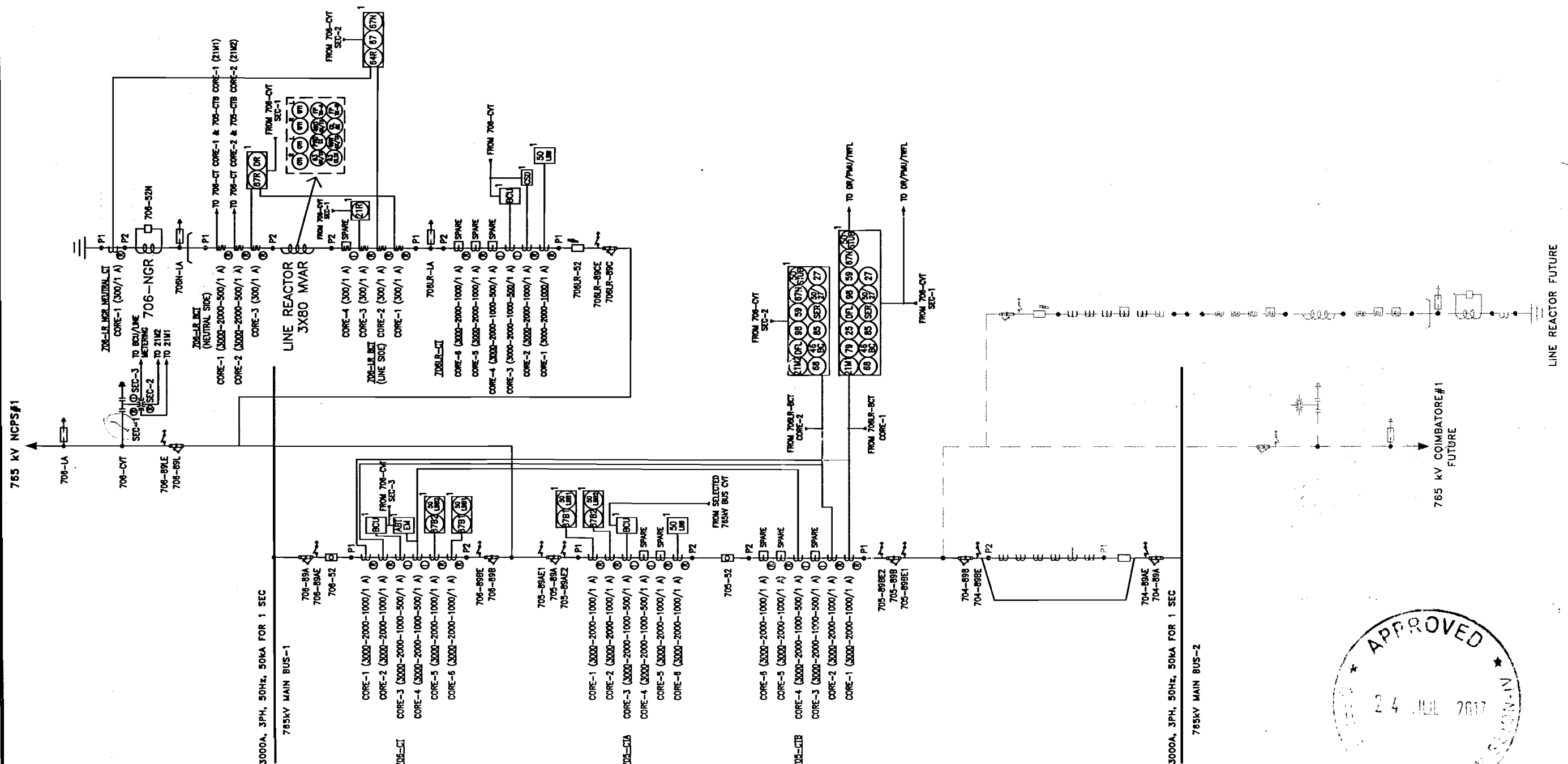
KEY PROTECTION & METERING SINGLE LINE DIAGRAM
765kV NCPS#1 LINE WITH REACTOR-TIE-FUTURE DIA

NEXT SHEET	SHEET No.
03	02

SCALE NTS W.O. No. 86009

DRG. No. TB-3-394-510-016

REV. 02



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6/17

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

DRG. NO. TB-3-394-510-016

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COMPUTER DRG. PATH NAME :

SIGN & DATE

INVENTORY NO.

REV.	DATE	ALTD.	CHD.	APPD.
02	15/06/17	RD	VK	VK

DRAWING REVISED AS PER TANTRANSCO LETTER
DATED 09/06/2017

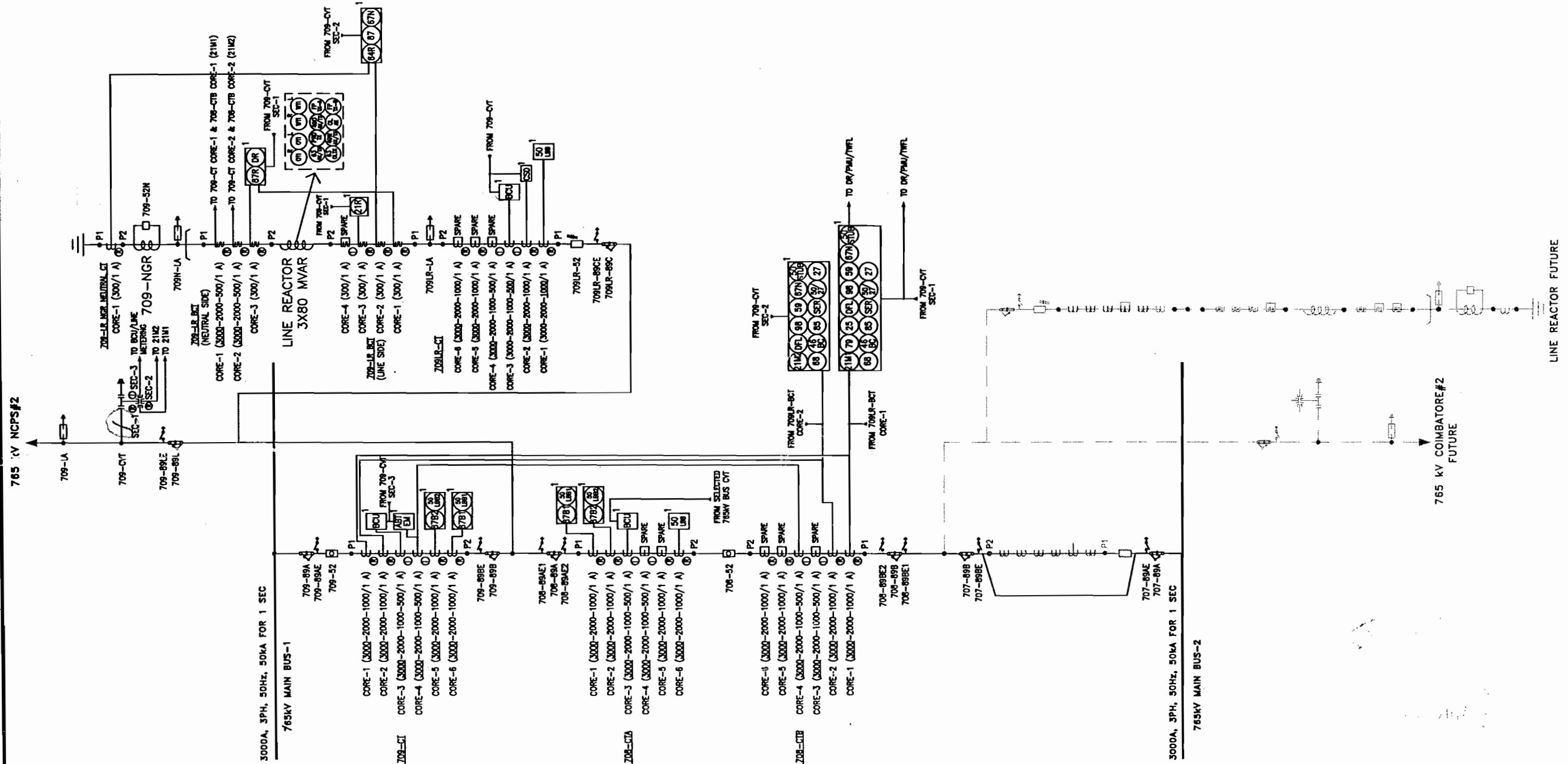
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APPROVED	VK	Sd/-	25/05/17

DISTRIBUTION OF PRINTS



DEPT.	CODE
TBEM	422

NAME OF CUSTOMER TAMILNADU TRANSMISSION CORPORATION LTD (TANTRANSCO)		NAME OF PROJECT 765/400kV AIS S/S ARIYALUR	
BHARAT HEAVY ELECTRICALS LIMITED TRANSMISSION BUSINESS GROUP		CARD CODE	
KEY PROTECTION & METERING SINGLE LINE DIAGRAM 765kV NCPS#2 LINE WITH REACTOR-TIE-FUTURE DIA		NEXT SHEET	04
SCALE NTS		W.O. No. 86009	DRG. No. TB-3-394-510-016
		REV. 02	



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INVENTORY NO.

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02	15/06/17	RD	VK	VK

DRAWING REVISED AS PER TANTRANSCO LETTER
DATED 09/06/2017

	NAME	SIGN.	DATE
DRAWN	RD	Sd/-	25/05/17
CHECKED	VK	Sd/-	25/05/17
APPROVED	VK	Sd/-	25/05/17

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DEPT.	CODE
TBEM	422

BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS GROUP

KEY PROTECTION & METERING SINGLE LINE DIAGRAM
765kV BUS#1 REACTOR-TIE-BUS#2 REACTOR DIA AND BUS CVT

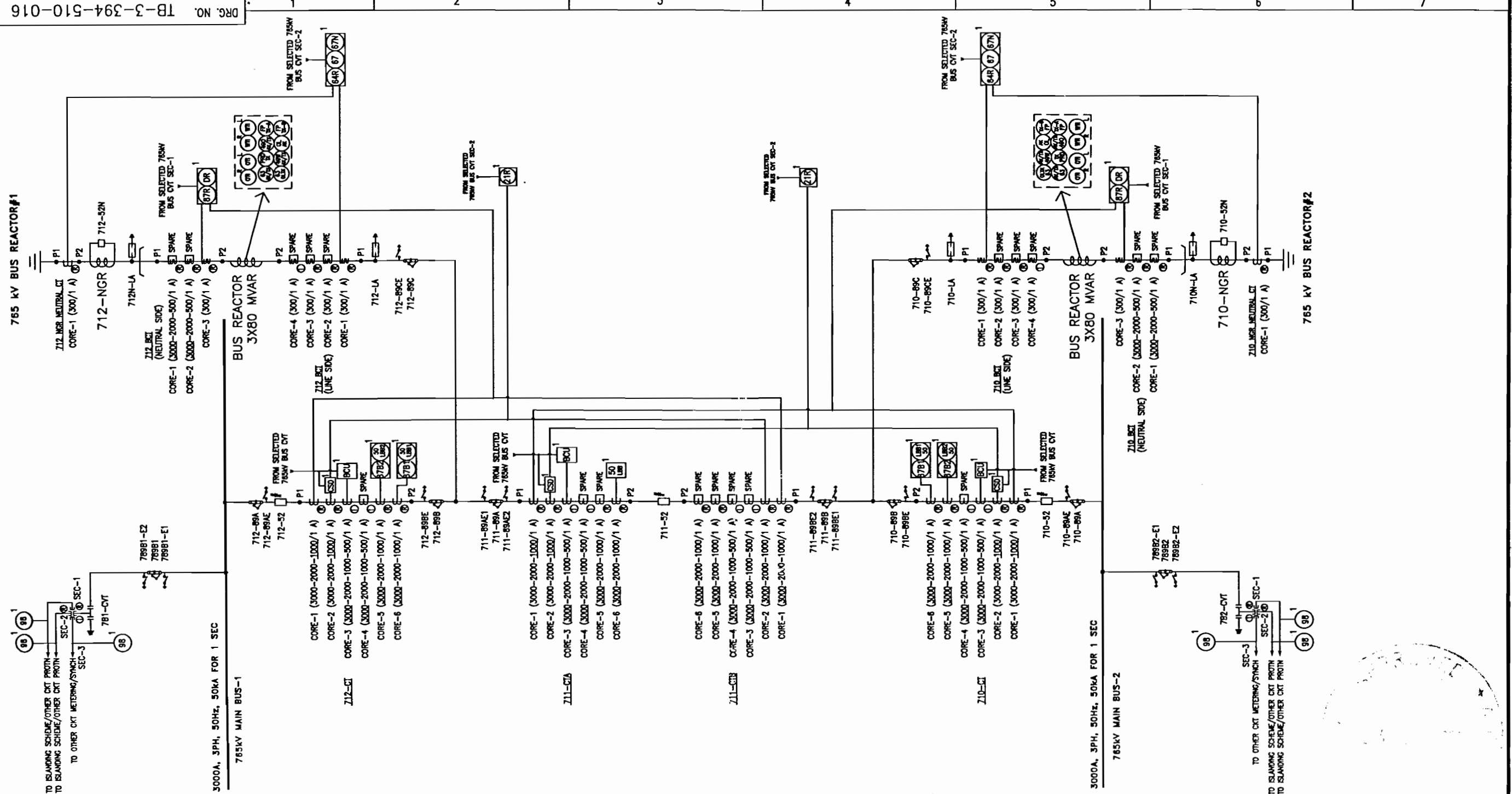
SCALE NTS W.O. No. 86009

DRG. No. TB-3-394-510-016

CARD CODE

NEXT SHEET 05
SHEET No. 04

REV. 02



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NAME OF CUSTOMER		TAMILNADU TRANSMISSION CORPORATION LTD (TANTRANSCO)	
NAME OF PROJECT		765/400kV AIS S/S ARIYALUR	
INVENTORY NO.		CARD CODE	
SIGN & DATE		NEXT SHEET 05	
COMPUTER DRG. PATH NAME :		SHEET No. 04	
REV. 02		REV. 02	

8/17

COMPUTER DRG. PATH NAME :

SIGN & DATE

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INVENTORY NO.

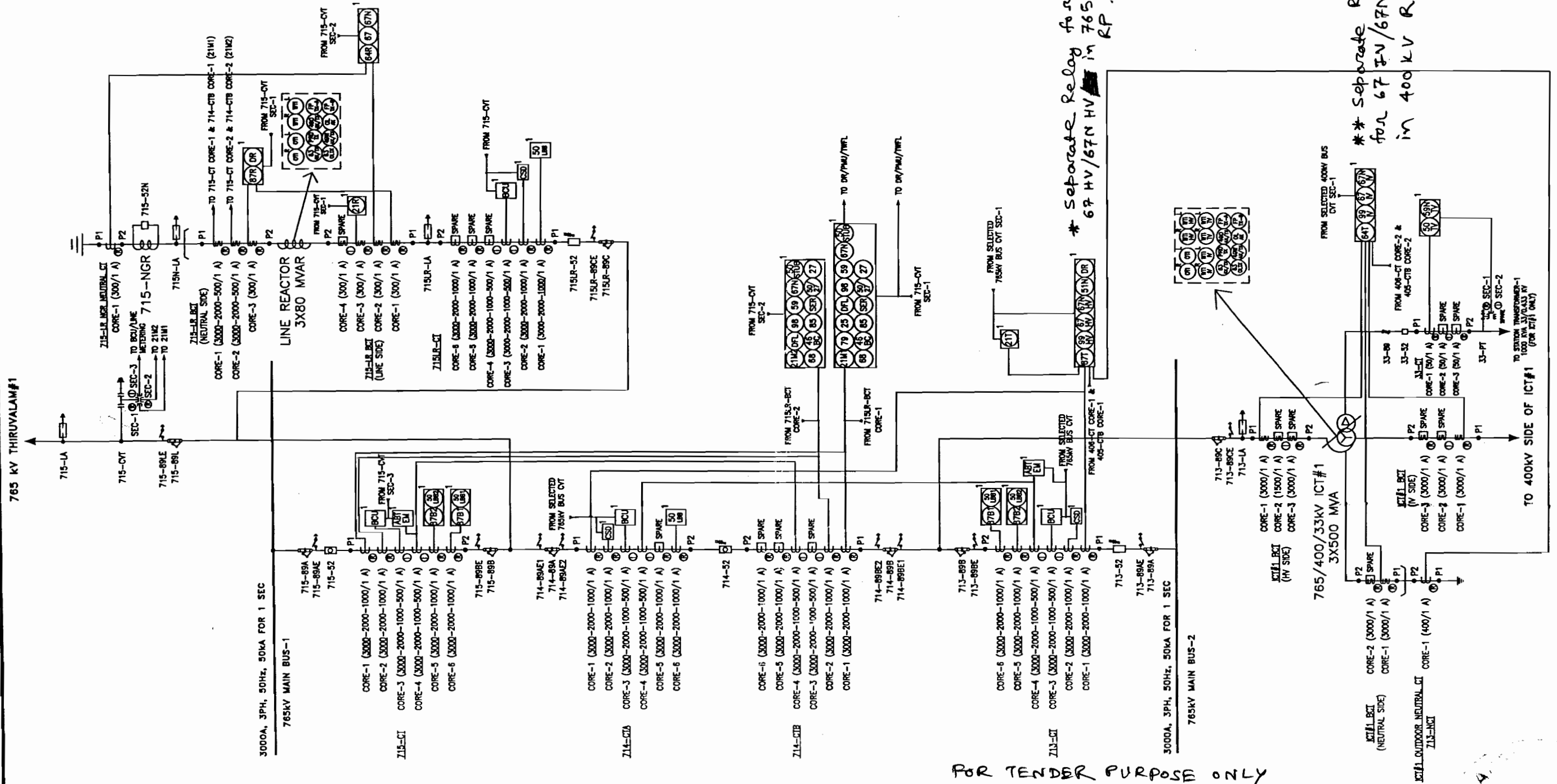
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										DEPT.	CODE	
										TBEM	422	

DEPT. TBEM
CODE 422

NAME OF CUSTOMER		TAMILNADU TRANSMISSION CORPORATION LTD (TANTRANSO)	
NAME OF PROJECT		765/400KV AIS S/S ARIYALUR	
BHARAT HEAVY ELECTRICALS LIMITED		TRANSMISSION BUSINESS GROUP	
KEY PROTECTION & METERING SINGLE LINE DIAGRAM		765KV THIRUVALAM#1 LINE WITH REACTOR-TIE-ICT#1 DIA	
SCALE NTS	W.O. No. 86009	DRG. No. TB-3-394-510-016	REV. 02
CARD CODE		NEXT SHEET 06	SHEET No. 05

DRG. NO. TB-3-394-510-016

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)



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9/17

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DRAWING REVISED AS PER TANTRANS CO LETTER DATED 09/06/2017										DISTRIBUTION OF PRINTS		
										DEPT.	CODE	
										TBEM	422	



DEPT. TBEM
CODE 422

NAME OF CUSTOMER

TAMILNADU TRANSMISSION CORPORATION LTD
(TANTRANS CO)

NAME OF PROJECT

765/400kV AIS S/S ARIYALUR

BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS GROUP

KEY PROTECTION & METERING SINGLE LINE DIAGRAM
765kV THIRUVALAM#2 LINE WITH REACTOR-TIE-ICT#2 DIA

SCALE NTS W.O. No. 86009

DRG. No. TB-3-394-510-016

CARD CODE

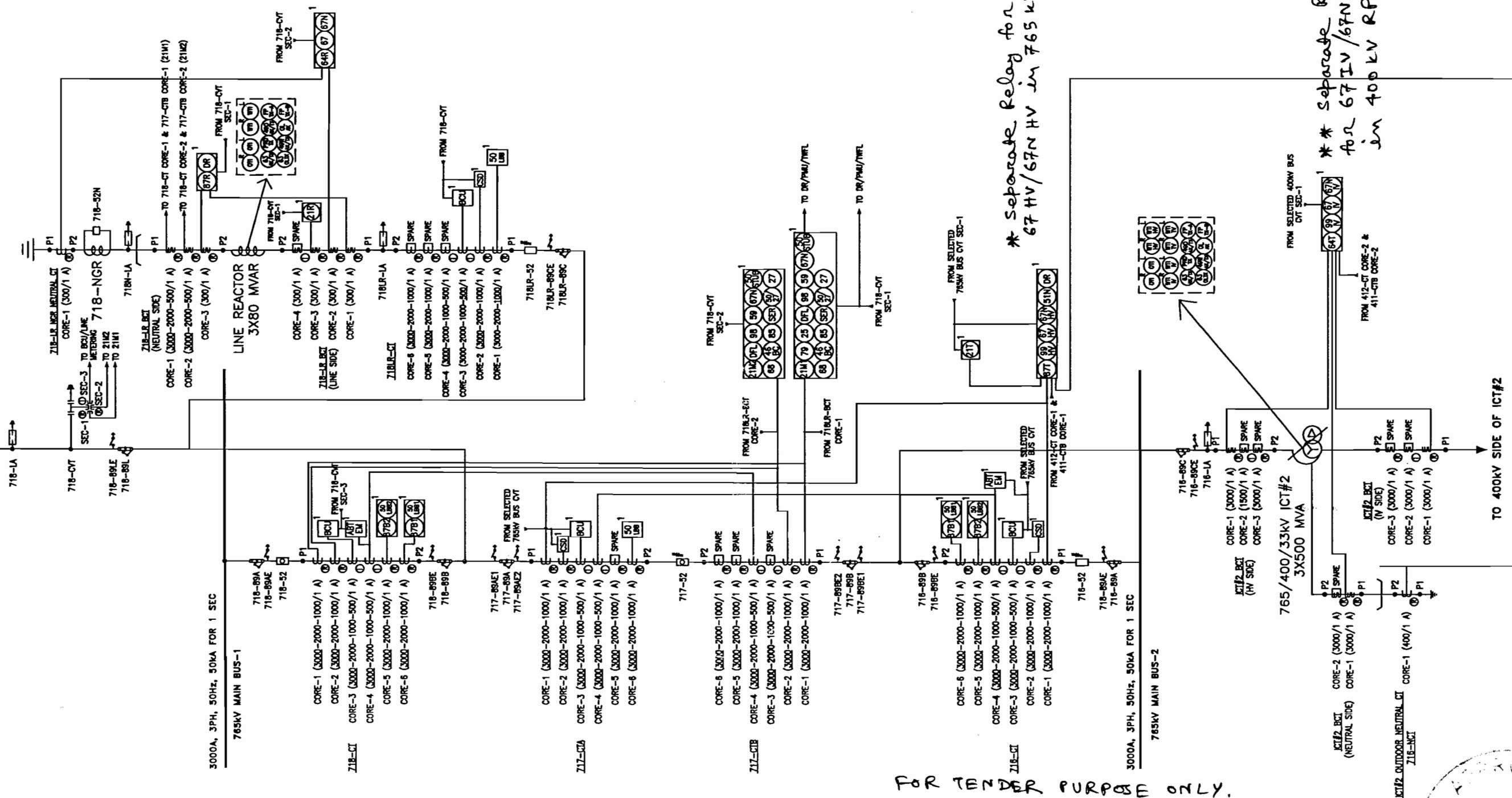
NEXT SHEET 07
SHEET No. 06

REV. 02

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

DRG. NO. TB-3-394-510-016

765 kV THIRUVALAM#2



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24 JUN 2017

10/17

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REV.	DATE	ALTD.	CHD.	APPD.
02	15/06/17	RD	VK	VK

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DISTRIBUTION OF PRINTS



DEPT. CODE
TBEM 422

BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS GROUP

KEY PROTECTION & METERING SINGLE LINE DIAGRAM
400kV ICT#1-TIE-PUGALUR#1 LINE DIA AND BUS CVT

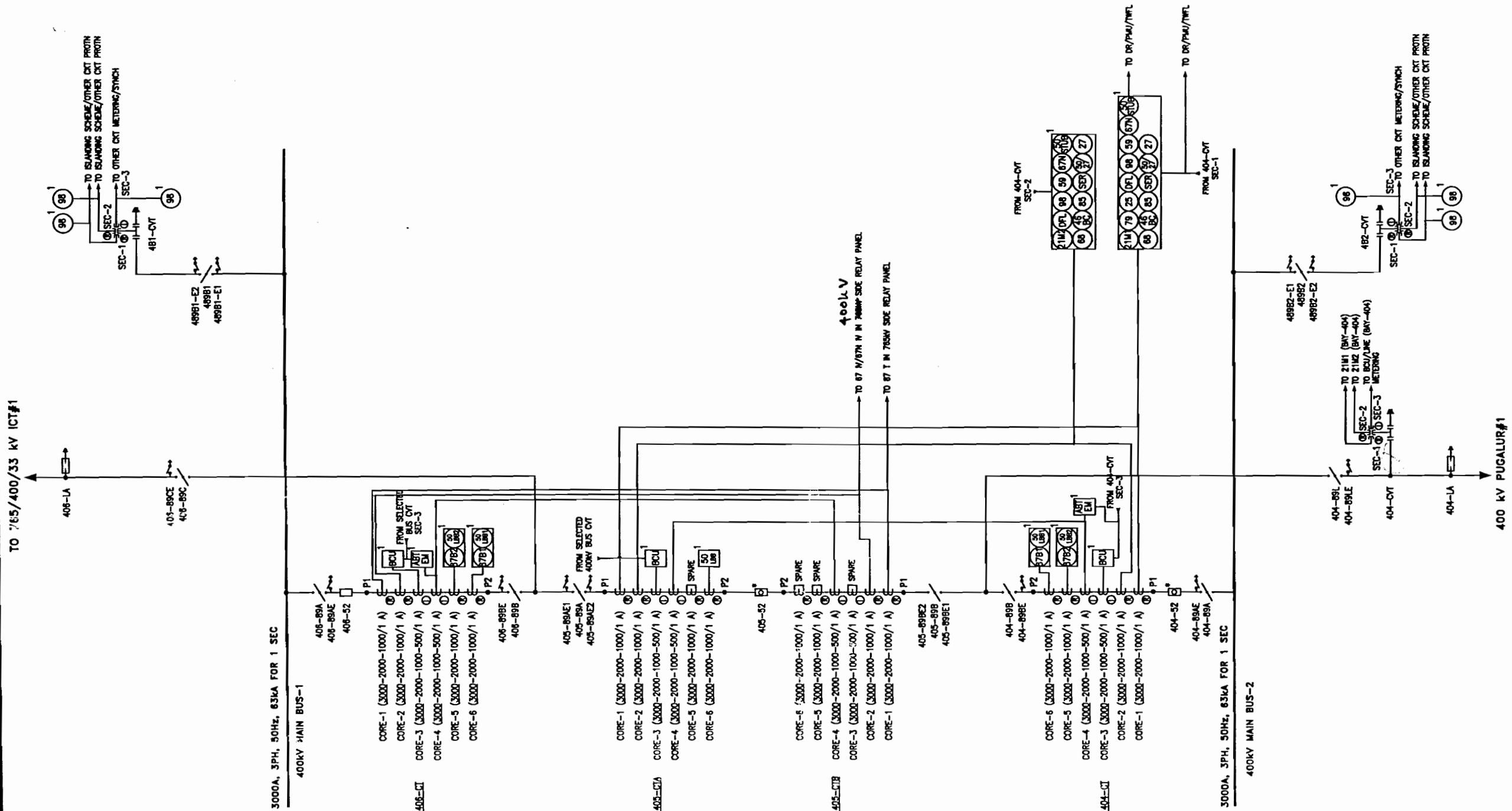
SCALE NTS W.O. No. 86009

DRG. No. TB-3-394-510-016

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NEXT SHEET 08
SHEET No. 07

REV. 02



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NAME OF CUSTOMER

TAMILNADU TRANSMISSION CORPORATION LTD
(TANTRANSCO)

NAME OF PROJECT

765/400kV AIS S/S ARIYALUR

DRG. NO. TB-3-394-510-016

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INVENTORY NO.

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NAME OF CUSTOMER

TAMILNADU TRANSMISSION CORPORATION LTD.
(TANTRANSCO)

NAME OF PROJECT

765/400kV AIS S/S ARIYALUR

BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS GROUP

KEY PROTECTION & METERING SINGLE LINE DIAGRAM
400kV ICT#2-TIE-KALIVANTHAPATTU#1 LINE DIA

CARD CODE

NEXT SHEET 09
SHEET No. 08

SCALE NTS W.O. No. 86009

DRG. No. TB-3-394-510-016

REV. 02

TO 765/400/33 kV ICT#2

412-LA

412-89CE
412-89C

3000A, 3PH, 50Hz, 63kA FOR 1 SEC

400kV MAIN BUS-1

412-89A
412-89AE
412-32

CORE-1 (3000-2000-1000/1 A)
CORE-2 (3000-2000-1000/1 A)
CORE-3 (3000-2000-1000-500/1 A)
CORE-4 (3000-2000-1000-500/1 A)
CORE-5 (3000-2000-1000-500/1 A)
CORE-6 (3000-2000-1000/1 A)

412-CT

412-89BE
412-89B411-89AE1
411-89A
411-89AE2FROM SELECTED
400kV BUS C/T

CORE-1 (3000-2000-1000/1 A)
CORE-2 (3000-2000-1000/1 A)
CORE-3 (3000-2000-1000-500/1 A)
CORE-4 (3000-2000-1000-500/1 A)
CORE-5 (3000-2000-1000-500/1 A)
CORE-6 (3000-2000-1000/1 A)

411-CTA

411-32

CORE-5 (3000-2000-1000/1 A)
CORE-6 (3000-2000-1000/1 A)
CORE-1 (3000-2000-1000-500/1 A)
CORE-2 (3000-2000-1000-500/1 A)
CORE-3 (3000-2000-1000-500/1 A)
CORE-4 (3000-2000-1000/1 A)

411-CTB

411-89BE2
411-89B
411-89BE1FROM SELECTED
400kV BUS C/T

CORE-5 (3000-2000-1000/1 A)
CORE-6 (3000-2000-1000/1 A)
CORE-1 (3000-2000-1000-500/1 A)
CORE-2 (3000-2000-1000-500/1 A)
CORE-3 (3000-2000-1000-500/1 A)
CORE-4 (3000-2000-1000/1 A)

410-CT

FROM 410-CVT
SEC-2

21M 21M 21M 21M 21M 21M
21M 21M 21M 21M 21M 21M
21M 21M 21M 21M 21M 21M
21M 21M 21M 21M 21M 21M

FROM 410-CVT
SEC-3

21M 21M 21M 21M 21M 21M
21M 21M 21M 21M 21M 21M
21M 21M 21M 21M 21M 21M
21M 21M 21M 21M 21M 21M

FROM 410-CVT
SEC-1

21M 21M 21M 21M 21M 21M
21M 21M 21M 21M 21M 21M
21M 21M 21M 21M 21M 21M
21M 21M 21M 21M 21M 21M

FROM 410-CVT
SEC-1

3000A, 3PH, 50Hz, 63kA FOR 1 SEC

400kV MAIN BUS-2

TO DR/PAU/TWL

TO DR/PAU/TWL

TO 21M1 (BAY-410)
TO 21M2 (BAY-410)
TO BCU/LINE (BAY-410)
TO SEC-2
TO SEC-3
TO SEC-1

410-89L
410-89LE

410-CVT

410-LA

400 kV KALIVANTHAPATTU#1

DRG. NO. TB-3-394-510-016

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COMPUTER DRG. PATH NAME :

SIGN & DATE

INVENTORY NO.

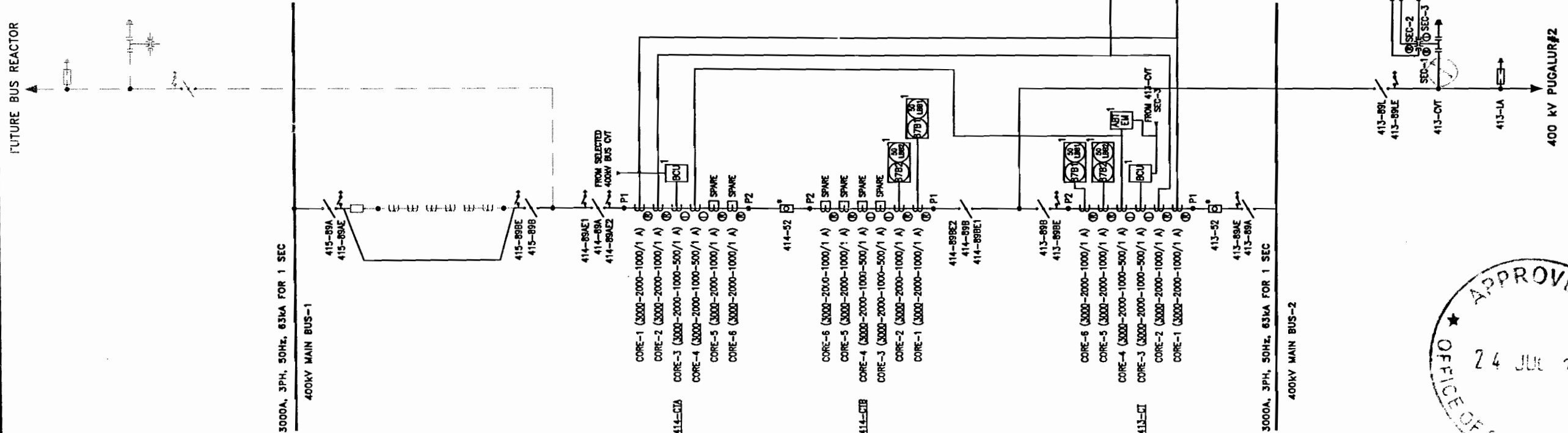
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DEPT. TBEM
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NAME OF CUSTOMER TAMILNADU TRANSMISSION CORPORATION LTD (TANTRANSO)	
NAME OF PROJECT 765/400KV AIS S/S ARIYALUR	
BHARAT HEAVY ELECTRICALS LIMITED TRANSMISSION BUSINESS GROUP	
KEY PROTECTION & METERING SINGLE LINE DIAGRAM 400KV FUTURE-TIE-PUGALUR#2 LINE DIA	
SCALE NTS	W.O. No. 86009
DRG. No.	TB-3-394-510-016
CARD CODE	
NEXT SHEET	10
SHEET No.	09
REV. 02	



FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

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COMPUTER DRG. PATH NAME :

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INVENTORY NO.

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DATED 09/06/2017

NAME	SIGN.	DATE
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APPROVED VK	Sd/-	25/05/17

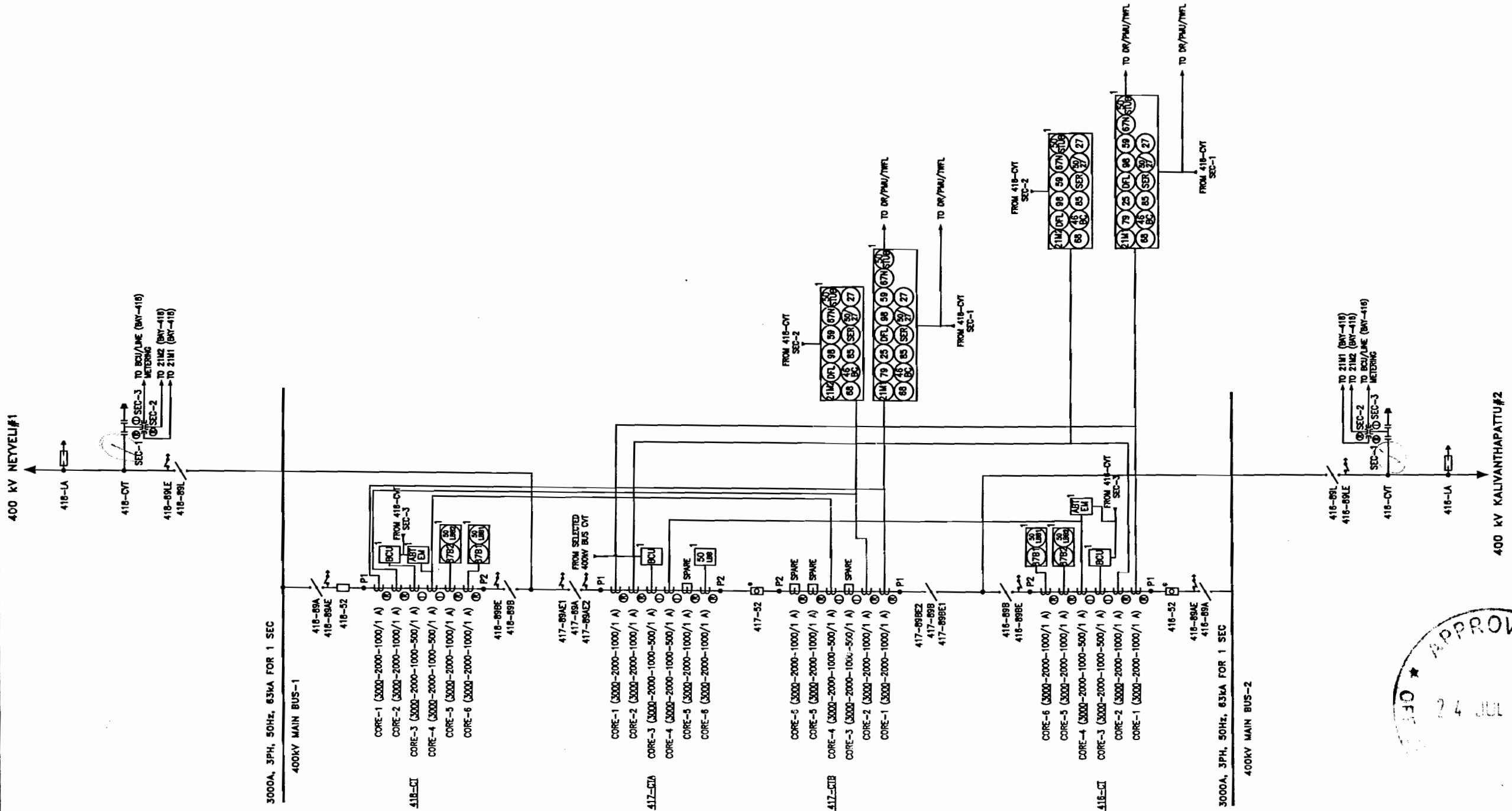
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NAME OF CUSTOMER TAMILNADU TRANSMISSION CORPORATION LTD (TANTRANSCO)		CARD CODE	
NAME OF PROJECT 765/400KV AIS S/S ARIYALUR		NEXT SHEET 11	
BHARAT HEAVY ELECTRICALS LIMITED TRANSMISSION BUSINESS GROUP		SHEET No. 10	
KEY PROTECTION & METERING SINGLE LINE DIAGRAM 400KV NEYVELI#1 LINE-TIE-KALIVANTHAPATTU#2 LINE DIA		REV. 02	
SCALE NTS	W.O. No. 86009	DRG. No.	TB-3-394-510-016



14/17

REV.	DATE	ALTD.	CHD.	APPD.	REV.	DATE	ALTD.	CHD.	APPD.		NAME	SIGN.	DATE
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										APPROVED	VK	Sd/-	25/05/17
										DISTRIBUTION OF PRINTS			



DEPT.	CODE
TBEM	422

FOR TENDER PURPOSE ONLY.

NAME OF CUSTOMER TAMILNADU TRANSMISSION CORPORATION LTD
(TANTRANSCO)

NAME OF PROJECT 765/400kV AIS S/S ARIYALUR

BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS GROUP

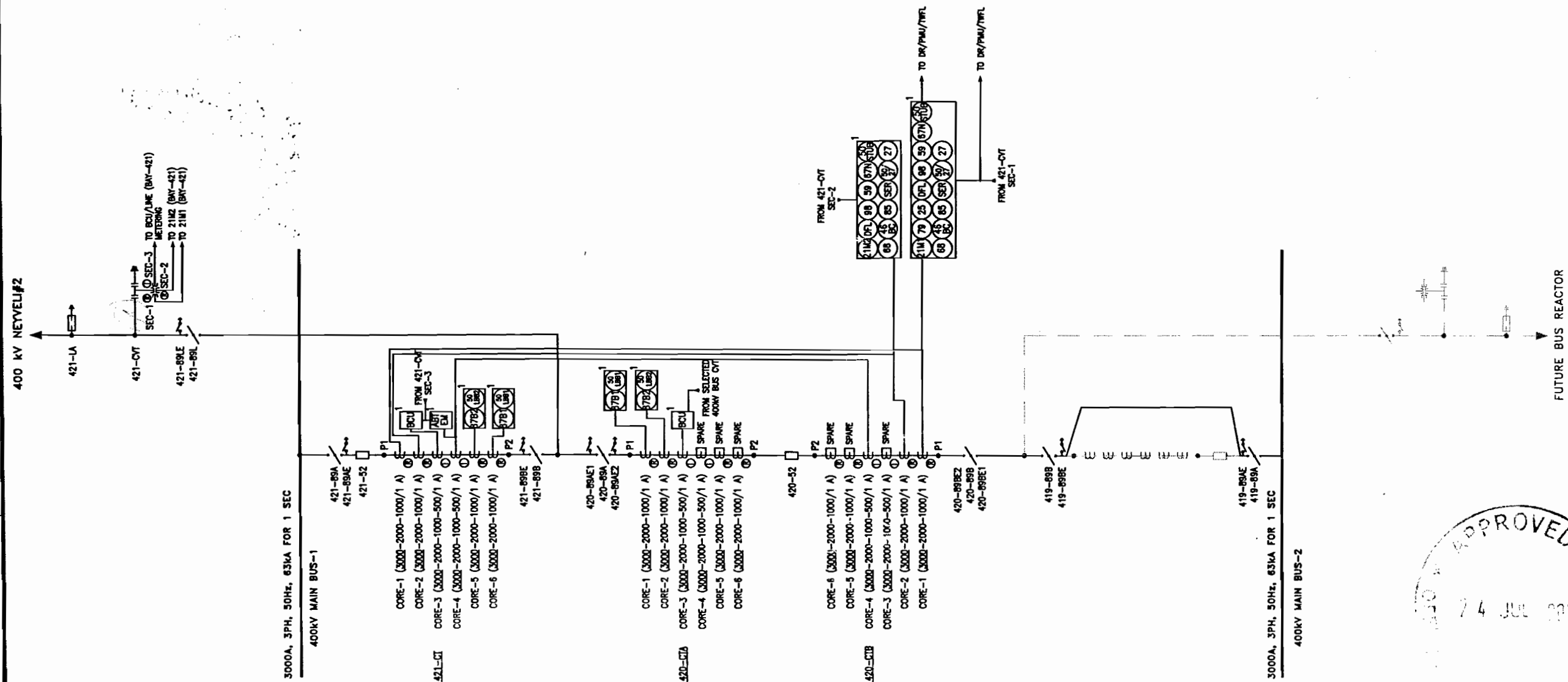
CARD CODE

KEY PROTECTION & METERING SINGLE LINE DIAGRAM
400kV NEYVELLI#2 LINE-TIE-FUTURE DIA

NEXT SHEET	12
SHEET No.	11

SCALE NTS	W.O. No. 86009
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DRG. No.	TB-3-394-510-016
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REV.
02

APPROVED
24 JUL 2017

DRG. NO. TB-3-394-510-016

765kV MAIN CT DETAILS

Core No.	Current Ratio	Output Burden (VA) at lowest	Minimum KPV (Volts)	Max Ie (mA) at KPV	Maximum Rct (Ohms)	Accuracy Class	Purpose
1	3000-2000-1000/1 A	-	3000-2000-1000	20-30-60	15-10-5	PS	Protection
2	3000-2000-1000/1 A	-	3000-2000-1000	20-30-60	15-10-5	PS	Protection
3	3000-2000-1000-500/1 A	20	-	-	-	0.2s, ISF ≤ 5	Metering
4	3000-2000-1000-500/1 A	20	-	-	-	0.2s, ISF ≤ 5	Metering
5	3000-2000-1000/1 A	-	3000-2000-1000	20-30-60	15-10-5	PS	Protection
6	3000-2000-1000/1 A	-	3000-2000-1000	20-30-60	15-10-5	PS	Protection

765kV, 4400pF (+10%, -5%) BUS CVT DETAILS (6 Nos.) \$

Winding No.	Ratio	Accuracy Class	Rated Burden (VA)	Purpose
1	(765 kV/√3) / (110V/√3)	3P	100 \$\$	Protection
2	(765 kV/√3) / (110V/√3)	3P	100 \$\$	Protection
3	(765 kV/√3) / (110V/√3)	0.2	100 \$\$	Metering

\$ Rated total simultaneous burden of CVT shall be 100VA (for 0.2 accuracy in winding-3) and rated total thermal burden of CVT shall be 300VA.

\$\$ Additional Requirement

765kV, 4400pF (+10%, -5%) LINE CVT DETAILS (12 Nos.) \$

Winding No.	Ratio	Accuracy Class	Rated Burden (VA)	Purpose
1	(765 kV/√3) / (110V/√3)	3P	50	Protection
2	(765 kV/√3) / (110V/√3)	3P	50	Protection
3	(765 kV/√3) / (110V/√3)	0.2	50	Metering

\$ Rated total simultaneous burden of CVT shall be 100VA (for 0.2 accuracy in winding-3) and rated total thermal burden of CVT shall be 300VA.

ICT BUSHING CT DETAILS**765kV SIDE BUSHING CT (On Each Single Phase ICT)**

Core No.	Current Ratio	Output Burden (VA) at lowest	Minimum KPV (Volts)	Max Ie (mA) at KPV/2	Maximum Rct (Ohms)	Accuracy Class	Purpose
1	3000/1 A	-	3000	20	12	PS	REF
2	1500/1 A	30	-	-	-	0.2, ISF ≤ 5	Metering
3 \$	3000/1 A	-	3000	20	12	PS	Differential

\$# Additional requirement and subject to design feasibility (space in bushing turret).

400kV SIDE BUSHING CT (On Each Single Phase ICT)

Core No.	Current Ratio	Output Burden (VA) at lowest	Minimum KPV (Volts)	Max Ie (mA) at KPV/2	Maximum Rct (Ohms)	Accuracy Class	Purpose
1	3000/1 A	-	3000	20	12	PS	REF
2	3000/1 A	30	-	-	-	0.2, ISF ≤ 5	Metering
3 \$	3000/1 A	-	3000	20	12	PS	Differential

\$# Additional requirement and subject to design feasibility (space in bushing turret).

NEUTRAL SIDE BUSHING CT (On Each Single Phase ICT)

Core No.	Current Ratio	Output Burden (VA) at lowest	Minimum KPV (Volts)	Max Ie (mA) at KPV/2	Maximum Rct (Ohms)	Accuracy Class	Purpose
1	3000/1 A	-	3000	20	12	PS	REF
2 \$	3000/1 A	-	3000	20	12	PS	Differential

\$# Additional requirement and subject to design feasibility (space in bushing turret).

NEUTRAL SIDE OUTDOOR CT

(1 No. for Each Bank of 3 Nos. Single Phase ICT), after Neutral formation

Core No.	Current Ratio	Output Burden (VA) at lowest	Minimum KPV (Volts)	Max Ie (mA) at KPV/4	Maximum Rct (Ohms)	Accuracy Class	Purpose
1	400/1 A	-	400	60	1.6	PS	E/F

SHUNT REACTOR BUSHING CT DETAILS**765kV SHUNT REACTOR (LINE SIDE, On Each Single Phase Reactor)**

Core No.	Current Ratio	Output Burden (VA) at lowest	Minimum KPV (Volts)	Max Ie (mA) at KPV/4	Maximum Rct (Ohms)	Accuracy Class	Purpose
✓ 1	✓ 300/1 A	-	✓ 300	✓ 40	✓ 1	✓ PS	REACTOR DIFF
✓ 2	✓ 300/1 A	-	✓ 300	✓ 40	✓ 1	✓ PS	REF
✓ 3	✓ 300/1 A	-	✓ 300	✓ 40	✓ 1	✓ PS	REACTOR BACK UP
✓ 4	✓ 300/1 A	✓ 10	-	-	-	0.2, ISF ≤ 5 \$\$	METERING

\$\$ Additional requirement.

FOR TENDER PURPOSE ONLY.

NAME OF CUSTOMER

TAMILNADU TRANSMISSION CORPORATION LTD
(TANTRANSO)

NAME OF PROJECT

765/400kV AIS S/S ARIYALUR

APPROVED

BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS GROUP

CARD CODE

KEY PROTECTION & METERING SINGLE LINE DIAGRAM
CT/PT DETAILS

NEXT SHEET

13

SHEET No.

12



DEPT. CODE

TBEM 422

SCALE NTS W.O. No. 86009

DRG. No. TB-3-394-510-016

REV. 02

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02	15/06/17	RD	VK	VK						DRAWN	RD	25/05/17
										CHECKED	VK	25/05/17
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765kV SHUNT REACTOR (NEUTRAL SIDE, On Each Single Phase Reactor)

Core No.	Current Ratio	Output Burden (VA) at lowest	Minimum KPV (Volts)	Max Ie (mA) at KPV/4	Maximum Rct (Ohms)	Accuracy Class	Purpose
1	3000-2000-500/1	20	3000-2000-500	40 at highest tap	12-8-2	PS	Distance Protection
2	3000-2000-500/1 A	-	3000-2000-500	40 at highest tap	12-8-2	PS	DISTANCE PROT/SPARE
3	300/1 A	-	300	40	1	PS	REACTOR DIFF

REACTOR NGR NEUTRAL SIDE OUTDOOR CT

Core No.	Current Ratio	Output Burden (VA) at lowest	Minimum KPV (Volts)	Max Ie (mA) at KPV/4	Maximum Rct (Ohms)	Accuracy Class	Purpose
1	300/1 A	-	300	60	1.2	PS	REF

ICT DELTA SIDE CT DETAILS (FOR ICT-1 ONLY)

Core No.	Current Ratio	Output Burden (VA) at lowest	Minimum KPV (Volts)	Max Ie (mA) at KPV/4	Maximum Rct (Ohms)	Accuracy Class	Purpose
1	50/1 A	10	-	-	-	5P10	O/C & E/F
2	50/1 A	10	-	-	-	0.5, ISF ≤ 5	Metering
3	50/1 A	-	50	40	0.25	PS	Differential

ICT DELTA SIDE PT DETAILS (FOR ICT-1 ONLY)

Winding No.	Ratio	Accuracy Class	Rated Burden (VA)	Purpose
1	(33 kV/√3) / (110V/√3)	3P	10	Protection
2	(33 kV/√3) / (110V/√3)	0.2	10	Metering

400kV MAIN CT DETAILS

Core No.	Current Ratio	Output Burden (VA) at lowest	Minimum KPV (Volts)	Max Ie (mA) at KPV	Maximum Rct (Ohms)	Accuracy Class	Purpose
1	3000-2000-1000/1 A	-	3000-2000-1000	20-30-60	15-10-5	PS	Protection
2	3000-2000-1000/1 A	-	3000-2000-1000	20-30-60	15-10-5	PS	Protection
3	3000-2000-1000-500/1 A	20	-	-	-	0.2s, ISF ≤ 5	Metering
4	3000-2000-1000-500/1 A	20	-	-	-	0.2s, ISF ≤ 5	Metering
5	3000-2000-1000/1 A	-	3000-2000-1000	20-30-60	15-10-5	PS	Protection
6	3000-2000-1000/1 A	-	3000-2000-1000	20-30-60	15-10-5	PS	Protection

\$\$ Additional requirement.

400kV, 4400pF (+10%, -5%) BUS CVT DETAILS (6 Nos.) \$

Winding No.	Ratio	Accuracy Class	Rated Burden (VA)	Purpose
1	(400 kV/√3) / (110V/√3)	3P	100 \$\$	Protection
2	(400 kV/√3) / (110V/√3)	3P	100 \$\$	Protection
3	(400 kV/√3) / (110V/√3)	0.2	100 \$\$	Metering

\$ Rated total simultaneous burden of CVT shall be 100VA (for 0.2 accuracy in winding-3) and rated total thermal burden of CVT shall be 300VA.

\$\$ Additional Requirement

400kV, 4400pF (+10%, -5%) LINE CVT DETAILS (18 Nos.) \$

Winding No.	Ratio	Accuracy Class	Rated Burden (VA)	Purpose
1	(400 kV/√3) / (110V/√3)	3P	50	Protection
2	(400 kV/√3) / (110V/√3)	3P	50	Protection
3	(400 kV/√3) / (110V/√3)	0.2	50	Metering

\$ Rated total simultaneous burden of CVT shall be 100VA (for 0.2 accuracy in winding-3) and rated total thermal burden of CVT shall be 300VA.

FOR TENDER PURPOSE ONLY.

NAME OF CUSTOMER		TAMILNADU TRANSMISSION CORPORATION LTD. (TANTRANSO)	
NAME OF PROJECT		765/400kV AIS S/S ARIYALUR	
Bharat Heavy Electricals Limited TRANSMISSION BUSINESS GROUP		CARD CODE	
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		SHEET No.	13
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		REV.	02



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