



BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS ENGINEERING MANAGEMENT
NEW DELHI

DOCUMENT No.	TB-399-316-017	Rev	00		Prepared	Checked	Approved
CUSTOMER Doc. No.				NAME	MVK	SKS	AG
TYPE OF DOC.	TECHNICAL SPECIFICATION			SIGN			
TITLE LT SWITCHGEAR (415V ACDB, EDB, 220V DCDB & 48V DCDB)				DATE	20.08.19	20.08.19	20.08.19
				GROUP	TBEM		
				W.O. No	87007		
CUSTOMER	TAMIL NADU TRANSMISSION CORPORATION LIMITED (TANTRANSCO)						
PROJECT	400/230-110 kV Substation at Vellalaviduthi						

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00					First Issue		
Rev.	Date	Altered	Checked	Approved	REVISION DETAILS		
Distribution				CUSTOMER	TBMM	O/C	
				-	4	1	

CHECKLIST FOR TECHNICAL EVALUATION

Along with the Technical Bids of the offers, the Bidder should submit this checklist confirming the inclusion of the enclosures as listed below. (Shall tick as ✓)

Sr No	Documents to be enclosed	Bidder to check & confirm
1	Copy of Unpriced BOQ as enclosed in the Technical Specification to confirm that bidder has quoted as per BOQ OF SECTION-1	
2.	Schedule of Technical Deviation format duly signed.	
3.	Supporting documents as asked in the Technical PQR. (if applicable as per tender requirements)	
4.	Checklist of Technical parameters as per Section-5 duly filled and signed.	
5.	Compliance to Technical Specification	

NOTE:- If the Bidder fails to submit any of the documents as asked in the above check list, their bid is likely to be rejected / not evaluated.

The above checklist is verified for:-

NIT Ref No. :

Name of Equipment :

Name of Project :

Name of Bidder :

Signed with Seal of Bidder.

Date

SECTION - 1

SCOPE, SPECIFIC TECHNICAL REQUIREMENT AND QUANTITIES

1. SCOPE

This technical specification covers the requirements of design, manufacture, testing at works, packing and dispatch of **415V AC Distribution Boards, Emergency AC Distribution Board, 220V DC Distribution Boards and 48V DC Distribution Boards**. The switchgear shall be complete with base frames, anchoring bolts, fuses, cable lugs, etc., as required.

The offered equipment shall also comply with the General Technical Requirements for the project as detailed under section-3 of this specification. For environmental conditions, refer Section-3 carefully

The specification comprise of following sections:

Section-1: Scope, specific technical requirements & Bill of Quantities

Section-2: Equipment specifications

Section-3: General technical requirements

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

Wherever bidder offers any spare/ item/ fitment in lieu of the same being "Built-in feature" of any relay/ fitment or the same being "Not applicable" is subject to approval by TANTRANSCO. No price implication will be entertained by BHEL at contract stage if any separate item is insisted by TANTRANSCO to meet the contract requirement.

Bidder to note that the GTP, Make & type of fitments, Bill of material of the offered AC & DC Panels and their mandatory spares are subject to TANTRANSCO approval at the contract stage. No price implications will be entertained by BHEL at contract stage.

The equipment is required for the following projects:

Name of the Customer : TAMIL NADU TRANSMISSION CORPORATION LIMITED
(TANTRANSCO)

Name of the Project : 400/230-110 kV Substation at Vellalaviduthi

2. SPECIFIC TECHNICAL REQUIREMENTS

S. No.	DESCRIPTION	Technical Parameters
1.	Sheet steel thickness of panel (mm) Front, Rear and Base Frame Side, Top and Bottom	3 mm (min.) Sheet Steel CRCA 2 mm (min.) Sheet Steel CRCA
2.	Cubicle Color Finish	

	i) Interior	Glossy White
	ii) Exterior	Shade No. 631 of IS:5
3.	BUSBAR, ACB, MCCB, MCB, Switches, Fuses, Energy Meters, Indicating Meters, CT, PT, Transducers, etc.	Details shall be as per Single line diagram for LTAC/DC Boards (Refer enclosed drg. No. TB-2-399-316-009(A), R1, TB-2-399-316-009(B), R1 & TB-2-399-316-009(C), R1)
4.	Type of Boards	Metal enclosed, indoor floor mounted, compartmentalized double front construction and free standing

2.1 Power Supply

	415V ACDB	220V DCDB	48V DCDB
System	3-phase, 4 wire, solidly earthed	2 wire, unearthed	2 wire, Positive pole earthed
Voltage	415 Volts, $\pm 10\%$	220V, $+10\% - 15\%$	48V, $+10\% - 15\%$
Frequency	50Hz, $\pm 5\%$	-	-
Combined variation	$\pm 10\%$ Absolute sum in voltage and frequency.	-	-
S. C. Current withstand capability (current / duration)			
i) Short time for 1 sec (kA rms)	25	25	25

2.2 Cubicle Data

Bus bar Rating

(a) Continuous	As specified in SLD
(b) Short time (1sec. kA (rms))	As per SLD
(c) Momentary (kA) peak	As per IS
(d) Ambient Temperature	50°C
(e) One minute power frequency withstand	
(i) Power Circuit	2500 Volts (RMS)
(ii) Control Circuit	2500 Volts (RMS)

Cubicle colour finish

(i) Interior	Glossy white
(ii) Exterior	Shade No. 631 of IS:5

2.3 Circuit Breaker

(a) Type	Air break
(b) No. of Poles	3 / 4 Pole for DG Incomer
(c) Voltage & Frequency	415 $\pm 10\%$, 50 Hz $\pm 5\%$
(d) Short time with-stand current	25kA (RMS) rating for 1 Sec.
(e) Dynamic rating	52.5kAp

(f) No. of auxiliary contacts	4 NO + 4 NC contacts for purchaser's use on fixed portion of the cubicle for each of the Service & Test limit position.
(h) Short Circuit breaking current	
(i) AC Component	25kA (RMS) rating
(ii) DC Component	As per IS: 13947 Part - 2

2.4 Meters

(a) Accuracy class	1 or better
(b) Type	96X96 sq mm, 90° scale semi flush mounting.

2.5 Current Transformers

(a) Type	Cast Resin dry type
(b) Voltage class and frequency	As per SLD
(c) Class of insulation	E or better
(d) Accuracy class metering CT	0.2, 10VA
(e) Accuracy class for protection CT	5P20, 10VA

2.6 Voltage Transformer

(a) Type	Cast Resin dry type
(b) Rated Voltage	
Primary	As per SLD
Secondary	As per SLD
(d) Continuous overvoltage factor	1.2
(e) Short time overvoltage factor	1.5 for 3 seconds (for effectively earthed system)
(e) Class of insulation	E or better
(g) Accuracy class	0.5, 50 VA

2.7 Relay

(a) One minute power frequency withstand test	2kV (RMS)
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2.8 Transducers (1 Phase)

	Current	Voltage
a) Operating Voltage	220V DC	220V DC
b) I/P	1A	110V AC
c) O/P	4-20mA	4-20mA
d) Type	Analogue	Analogue

2.9 Supply Changeover

For ACDB

Auto/Manual changeover between incomer from LT Transformer-1, incomer from LT Transformer-2 and DG set incomers is to be carried out during the failure of supply in one/or both the normal supply incomers. After the restoration of the supply, system shall be restored to normal condition.

For DCDB

Bidder to insure that at any point of time not more than two (2) MCCB out of bus coupler & incomer MCCBs shall be closed.

2.10 Analogue Inputs (Display on SAS)

LT system shall have provision of following analogue inputs (4-20mA) for owner's SAS. These analogue inputs shall be generated by distinct transducers to be provided in respective modules. These inputs shall be wired up to respective terminal blocks.

415 V ACDB (Applicable for ACDB-1, ACDB-2 & ACDB-3)

- 1) Voltage R-Y, Y-B, B-R of ACDB Incomers
- 2) Voltage R-Y, Y-B, B-R of ACDB Bus Sections
- 3) ACDB Incomer Current 3 phases

220 V DCDB

- 1) 220V DCDB Incomer Voltage
- 2) 220V DCDB Bus Voltage
- 3) 220V DCDB Incomer Current

48 V DCDB

- 1) 48V DCDB Incomer Voltage
- 2) 48V DCDB Bus Voltage
- 3) 48V DCDB Incomer Current

2.11 Digital (Potential Free Inputs)

LT system shall have provision of following digital inputs for owner's SAS. These digital inputs shall be made available in the form of potential free contacts to be provided in respective modules. These potential free contacts shall be wired up to respective terminal blocks

415 V ACDB (Applicable for ACDB-1, ACDB-2 & ACDB-3)

- 1) ACDB Incomer Breaker ON/ OFF status (Display on SAS)
- 2) ACDB Bus Coupler Breaker ON/ OFF status (Display on SAS)
- 3) ACDB Incomer Breaker AUTOTRIPPED (Alarm on SAS)
- 4) ACDB Bus Coupler Breaker AUTOTRIPPED (Alarm on SAS)
- 5) Protection Operated
- 6) Bus Under-Voltage Relay operated

220 V DCDB

- 1) 220V DCDB Incomer MCCB ON/ OFF status (Display on SAS)
- 2) 220V DCDB Earth Fault (Display on SAS)
- 3) 220V DCDB under/ over voltage (Display on SAS)

48 V DCDB

- 1) 48V DCDB Incomer MCCB ON/ OFF status (Display on SAS)
- 2) 48V DCDB Earth Fault (Display on SAS)
- 3) 48V DCDB under/ over voltage (Display on SAS)

2.12 Digital (Potential Free Outputs)

LT system shall have provision of following digital outputs for owner's SAS. These digital outputs shall be made available in the form of potential free contacts to be provided in respective modules. These potential free contacts shall be wired up to respective terminal blocks

415 V ACDB (Applicable for ACDB-1, ACDB-2 & ACDB-3)

- 1) ACDB Incomer/Bus Coupler Breaker ON
- 2) ACDB Incomer/Bus Coupler Breaker OFF

For detailed equipment specification of LT Switchgear, refer Section-2 of the document.

3. BILL OF QUANTITIES

Sl. No.	Description	Unit	Qty.
1.	415V, 3-phase, 4 wire, 800A, 25kA for 1 sec AC Distribution Board (ACDB-1, 1A)	Set	1
2.	415V, 3-phase, 4 wire, 800A, 25kA for 1 sec AC Distribution Board (ACDB-2, 1B)	Set	1
3.	415V, 3-phase, 4 wire, 400A, 25kA for 1 sec Emergency AC Distribution Board (ACDB-3, 1C)	Set	1
4.	200A, 25kA for 1 sec, 220V DC Distribution Board (220V DCDB-1, 2A)	Set	1
5.	200A, 25kA for 1 sec, 220V DC Distribution Board (220V DCDB-2, 2B)	Set	1
6.	200A, 25kA for 1 sec, 220V DC Distribution Board (220V DCDB-3, 2C)	Set	1
7.	200A, 25kA for 1 sec, 220V DC Distribution Board (220V DCDB-4, 2D)	Set	1
8.	200A, 25kA for 1 sec, 48V DC Distribution Board (48V DCDB-1, 3A)	Set	1
9.	200A, 25kA for 1 sec, 48V DC Distribution Board (48V DCDB-2, 3B)	Set	1

Note:-

- a. Notwithstanding the details included in this specification, AC/DC DB shall be supplied complete with mounting arrangement, fixing hardware, Relays, Transducers, Switches for interfacing with SAS System and other accessories as required for complete installation, putting in service and satisfactory operation.
- b. The status of incomer / bus-coupler current, voltage and ON/OFF position, to be available in SAS system. Suitable facilities to be provided in the boards.
- c. All the ACBs shall be of draw out type. MCCBs and MCBs shall be fixed type.
- d. Minimum 20% spare feeders shall be considered for each type and rating of AC and DC feeders as per SLD.

- e. ACJB (i.e. Bay Marshalling Kiosk) as per SLD drawing no. TB-2-399-316-009(A), Rev -01 are **not in Bidder scope**.
- f. 3 nos. CTs (800/1A, class-1) located in DG set AMF panel for differential protection of DG set shall be in **Bidder scope of supply and same shall be supply in loose**. DG supplier will provide space provision for mounting loose supply CT in AMF panel.
- g. Incoming and outgoing cable of switchboard/distribution board indicated in SLD's shall be in BHEL scope of supply, but suitable TB's shall be provided by bidder.'
- h. Interconnection between boards ACDB-1 & ACDB-2, 220V DCDB-1 & DCDB-2, 220V DCDB-3 & DCDB-4, 48V DCDB-1 & DCDB-2 shall be with cable of suitable size, which shall be intimated during detailed engineering stage. Bidder to provide suitable cable termination arrangement in the boards.
- i. Transducers/aux. contacts required for analogue and digital input as per SLD/specification shall be an integral part of LT AC/DC boards and same shall be in bidder scope.
- j. All digital /Analogue inputs /outputs required for SAS as per SLD/Specification shall be in bidder scope.
- k. Additional spare auxiliary contact for all MCB/MCCB/ACB/Switch (i.e. incomer, outgoing and bus coupler) as per SLD/specification shall be provided for **ON/OFF status and trip alarm in SAS**. These Additional Spare auxiliary contact for group alarm shall be wired up to TB of individual board by the LT ACDB & DCDB supplier.
- l. All boards shall be suitable for ground mounting.
- m. The bill of material of each type of module as mentioned in the Single line diagram for LT AC & DC System shall be furnished.
- n. Bidder must quote addition/deletion price for each and every type of complete module (Type of modules are defined in Annexure-A). This is required to account for any changes in the Single line diagram during detailed contract engineering stage.
- o. Total quantity may vary upto $\pm 30\%$.

4. TYPE TESTING

Bidder shall submit valid type test reports (as per relevant IEC/IS Standard) for approval. The type test reports submitted shall be of tests conducted within last 10 years prior to the date of technical bid opening i.e. 21.08.2017. The bidder should have conducted type test on identical or similar equipment/ components to those offered. If these tests have been conducted more than 10 years prior from the date of technical bid opening or type test reports are found to be technically unacceptable to BHEL/TANTRANSCO, the type test shall be conducted without cost and delivery implication to BHEL. The type test if conducted shall be witnessed by BHEL/ Customer.

5. TECHNICAL QUALIFYING REQUIREMENT

Refer Annexure: PQR_LT Switchgear

6. QUALITY PLAN

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

Annexure-A

Addition/Deletion Prices of following feeders -

Refer Single line diagram for LTAC/DC Boards (Drg. No. TB-2-399-316-009(A), R1, TB-2-399-316-009(B), R1 & TB-2-399-316-009(C), R1)

SN	Feeder Rating	Unit	Qty
A	415V AC Feeders		
1	32A MCB (SPN)	Set	1
2	32A MCB (TPN)	Set	1
3	63A MCB (TPN)	Set	1
4	63A MCCB (TPN)	Set	1
5	125A MCCB (TPN)	Set	1
6	200A MCCB (TPN)	Set	1
7	400A MCCB (TPN)	Set	1
8	800A ACB	Set	1
B	220V DC Feeders		
1	200A MCCB	Set	1
2	200A SFU	Set	1
3	200A Isolator	Set	1
4	32A MCB	Set	1
C	48V DC Feeders		
1	200A MCCB	Set	1
2	200A SFU	Set	1
3	200A Isolator	Set	1
4	32A MCB	Set	1

Annexure: PQR_LT Switchgear

TECHNICAL QUALIFYING REQUIREMENT FOR LT SWITCHGEAR

The qualified manufacturer should have manufactured, type tested and supplied the entire quantity of tendered LT AC and DC Distribution Panels (with ACB/MCCB as incomer) of same or higher rating to any of the Electricity Boards/Power Utilities in India during the last Ten years. The same should have been in satisfactory# operation for a minimum period of two years as on date of technical bid opening i.e. 21.08.2017.

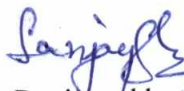
And

Bidder must be manufacturer of LT Switchboards.

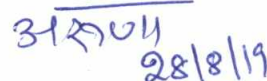
(#) Satisfactory operation means certificate issued by the Customer certifying the operation without any adverse remark.



Prepared by
M Vijay Kumar
Sr Manager / TBEM



Reviewed by 28/8/19.
S.K. Shukla
DGM/TBEM



Approved by
Aruna Gulati
AGM (Engg.)

પૃષ્ઠ ક્ર./SHEET No. 01 અગામી પૃષ્ઠ /NEXT SHEET 02



BHEL

भारत हेवी इलेक्ट्रिकल्स लिमिटेड
ट्रांसमिशन परियोजना विभाग
BHARAT HEAVY ELECTRICALS LTD.
TRANSMISSION PROJECTS DIVISION

अनुपात / SCALE

NTS

कार्ड कोड
CARD CODE

खारा DRAWN	नाम /NAME	हस्ता./SIGN.	दि./DATE
	MVK	Sd/-	09.05.19
जाँचा CHECKED	MVK	Sd/-	09.05.19
स्विकृत	SKS	Sd/-	09.05.19

APPROVED		

डाईग.क्र./DRAWING NO.	पुनः/REV.	A
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TB-2-399-316-009(A)	01
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INVENTORY No.



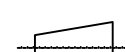
1. NECESSARY AUX. RELAYS / CONTACTORS, TIMERS, SUPPLY PRIORITY SELECTOR SWITCH ETC. SHALL BE PROVIDED TO ACHIEVE REQUIRED LOGIC.
2. BATTERY & CHARGER UNIT & INTERCONNECTING POWER CABLES FOR INCOMER & OUTGOING FEEDERS SHOWN IN THE DRAWING ARE FOR INFORMATION ONLY. THESE ARE EXCLUDED FROM THE SCOPE OF LVO/ PANEL SUPPLIER.
3. DEGREE OF PROTECTION SHALL BE:
 - a. INDOOR DISTRIBUTION BOARD - IP22
 - b. 220V DC SYSTEM IS UNGROUNDED.
4. 20% SPARE FEEDERS FOR EACH TYPE AND RATING OF FEEDER TO BE CONSIDERED AS PER THE SLD.
5. MECHANICAL INTERLOCK BETWEEN TWO DCDB CAN BE INCLUDED IN ANY ONE OF THE BOARD.
6. INTERPANEL WIRING & INTERCONNECTING CABLES BETWEEN THE BOARDS IS IN SUPPLIER SCOPE.
7. ALL ELECTRICAL PHOTOGRAPHIC REQUIREMENT AS PER TECHNICAL SPECIFICATION.
8. TABLE BEING INDICATED ARE TENTATIVE ONLY (INFORMATION PURPOSE).
9. THE SURFACE OF DC BOARDS WITH SAS SHALL BE THROUGH HARD SIGNALS.
10. ALL SAS SHALL BE NUMERICAL RELAY WITH NECESSARY FEEDBACK TO BE PROVIDED TO SAS.
11. ALL MCB'S SHALL BE DC MCB'S.
12. CUMULATIVE DCPT NOT AVAILABLE IN THE BATTERY CHARGER UNIT. SUGGESTION - 1 & 2 TO BE SEPARATED.
13. BOARD SHALL BE METAL ENCLOSED, INDOOR CONSTRUCTION AND MOUNTED ON 100MM X 100MM X 10MM STEEL RAIL.
14. ALL MODULES SHALL BE FIXED TYPE.

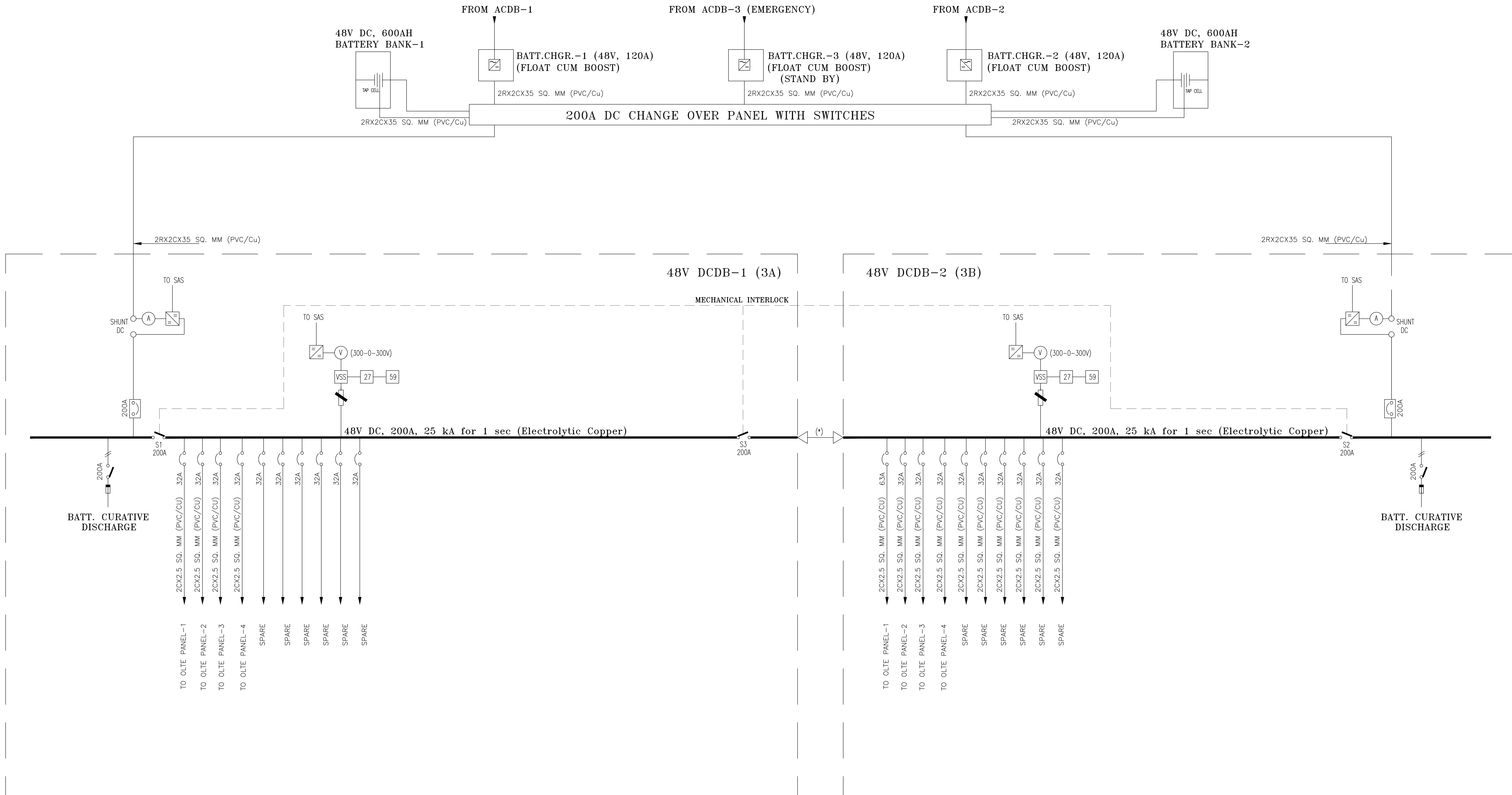
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7. NECESSARY AUX. RELAYS / CONTACTORS, THERMS, SUPPLY PRIORITY SELECTOR SWITCH ETC. SHALL BE PROVIDED TO ACHIEVE REQUIRED LOGIC FOR EACH SCHEME.
8. BATTERY & CHARGER UNIT & INTERCONNECTING POWER CABLES FOR INCOMER & OUTGOING FEEDERS SHOWN IN THE DRAWING ARE FOR INFORMATION ONLY. THEY ARE EXCLUDED FROM THE SCOPE OF A LVDC PANEL SUPPLIER.
9. DEGREE OF PROTECTION SHALL BE:
 - a. 11KV DISTRIBUTION BOARD: IP2X
 - b. 220V DC SYSTEM IS UNGROUNDED.
10. 20% SPARE FEEDERS FOR EACH TYPE AND RATING OF FEEDER TO BE CONSIDERED AS PER THE SLD.
11. MECHANICAL INTERLOCK BETWEEN TWO DCDB CAN BE INCLUDED AT ANY ONE OF THE BOARDS.
12. INTERPANEL WIRING & INTERCONNECTING CABLES BETWEEN THE BOARDS IS IN SUPPLIER SCOPE.
13. ALL DCDB PROTECTIVE REQUIREMENT AS PER TECHNICAL SPECIFICATION.
14. ALL RELAYS INDICATED ARE TENTATIVE ONLY (INFORMATION PURPOSE).
15. THE INTERFACE OF DC BOARDS WITH SAS SHALL BE THROUGH HARD SIGNALS.
16. ALL RELAYS SHALL BE NUMERICAL RELAY WITH NECESSARY FEEDBACK BE PROVIDED TO SAS.
17. ALL MCB'S SHALL BE DC MCB'S.
18. NEGATIVE I/O IF AVAILABLE IN THE BATTERY CHARGER BETWEEN SOURCE - 1 & 2 TO BE SEPARATED.
19. BOARD SHALL BE METAL ENCLOSED, INDOOR FLOOR MOUNTED, WITH PROTECTIVE COVER FOR PROTECTIVE CONSTRUCTION AND FREE STATE ALL MODULES SHALL BE FIXED TYPE.

LEGEND:-	
CHARGER	
BATTERY	
NON DRAW-OUT 2-POLE DC MCB	
VOLTMETER	
AMMETER	
VOLTAGE SELECTIVE SWITCH	
DP ISOLATOR	
DP DC MCCB	
DC INSTANTANEOUS UNDER VOLTAGE RELAY	
INSTANTANEOUS OVER VOLTAGE RELAY	
EARTH LEAKAGE RELAY	

ADDITIONAL INFORMATION W.O.No. 87007				ग्राहक/परियोजना का नाम TAMILNADU TRANSMISSION CORPORATION. LTD. 400/230-110KV SS AT VELLALAVIDUTHI			
STATUS OF DRAWING DISTRIBUTION OF PRINTS				NAME OF CUSTOMER/PROJECT			
 भारत हेवी इलेक्ट्रिकल्स लिमिटेड ट्रांसमिशन परियोजना विभाग BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION PROJECTS DIVISION				रजिस्ट्रार DRAWN	नाम /NAME MVK	हस्ता./SIGN. Sd/-	दि./DATE 09.05.19
				चेक CHECKED	MVK	Sd/-	09.05.19
				स्वीकृत APPROVED	SKS	Sd/-	09.05.19
REV.	DATE	ALTERED	MVK	विभाग	 अनुपात / SCALE NTS	कार्ड कोड CARD CODE	
01	13.08.19	CHECKED	MVK	DEPT.			
		APPROVED	SKS	कोड CODE			
ZONE	REVISED AS PER TANTRANSCO COMMENTS.			शीर्षक/TITLE SINGLE LINE DIAGRAM OF 220V DCDB FOR 400/230-110KV SUBSTATION VELLALAVIDUTHI		ड्राईंग.क्र./DRAWING NO. TB-2-399-316-009(B)	
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						पुनः/REV. 01	



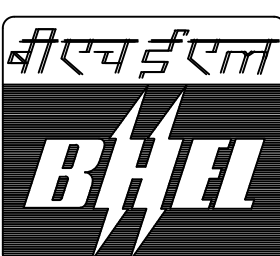
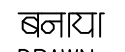
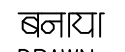
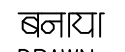
NOTES :-

- NECESSARY AUX. RELAYS / CONTACTORS, TIMERS, SUPPLY PRIORITY SELECTOR SWITCH ETC. SHALL BE PROVIDED TO ACHIEVE REQUIRED OPERATION OF SCHEME.
- BATTERY & CHARGER UNIT & INTERCONNECTING POWER CABLES FOR INCOMER & OUTGOING FEEDERS SHOWN IN THE DRAWING ARE FOR REFERENCE ONLY. THESE ARE EXCLUDED FROM THE SCOPE OF LVDC PANEL SUPPLIER.
- DEGREE OF PROTECTION SHALL BE :
INDOOR DISTRIBUTION BOARD - IP52
- 48V DC SYSTEM IS POSITIVE GROUNDED.
- 20% SPARE FEEDERS FOR EACH TYPE AND RATING OF FEEDER TO BE CONSIDERED AS PER THE SLD.
- MECHANICAL INTERLOCK BETWEEN TWO DCDB CAN BE INCLUDED IN ANY ONE OF THE BOARD.
- INTERPANEL WIRING & INTERCONNECTING CABLES BETWEEN THE BOARDS IS IN SUPPLIER SCOPE.
- METERING AND PROTECTION REQUIREMENT AS PER TECHNICAL SPECIFICATION.
- CABLE DETAIL INDICATED ARE TENTATIVE ONLY (INFORMATION PURPOSE).
- THE INTERFACE OF DC BOARDS WITH SAS SHALL BE THROUGH HARDWIRED SIGNALS.
- ALL RELAY SHALL BE NUMERICAL RELAY WITH NECESSARY FEEDBACK SHALL BE PROVIDED TO SAS.
- ALL MCB's SHALL BE DC MCB's.
- NEGATIVE LOOP IF AVAILABLE IN THE BATTERY CHARGER BETWEEN SOURCE-1 & 2 TO BE SEPARATED.
- BOARD SHALL BE METAL ENCLOSED, INDOOR FLOOR MOUNTED, COMPARTMENTALIZED DOUBLE FRONT CONSTRUCTION AND FREE STANDING.
- ALL MODULES SHALL BE FIXED TYPE.

(*) (CONNECTION THROUGH LT CABLE OF SUITABLE RATING)

LEGEND:-

CHARGER	
BATTERY	
NON DRAW-OUT 2-POLE MCB	
VOLTMETER	
AMMETER	
VOLTAGE SELECTIVE SWITCH	
DP ISOLATOR	
DP DC MCCB	
DC INSTANTANEOUS UNDER VOLTAGE RELAY	
INSTANTANEOUS OVER VOLTAGE RELAY	

ADDITIONAL INFORMATION W.O.No. 87007				ग्राहक/परियोजना का नाम  TAMILNADU TRANSMISSION CORPORATION. LTD.																	
STATUS OF DRAWING				NAME OF CUSTOMER/PROJECT 400/230-110KV SS AT VELLALAVIDUTHI																	
DISTRIBUTION OF PRINTS																					
				 भारत हेवी इलेक्ट्रिकल्स लिमिटेड द्विसंधिधान परियोजना विभाग BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION PROJECTS DIVISION		<table><tr><td rowspan="3"></td><td>नाम /NAME</td><td>हस्ता /SIGN.</td><td>दि./DATE</td></tr><tr><td>MVK</td><td>SD/-</td><td>09.05.19</td></tr><tr><td>MVK</td><td>SD/-</td><td>09.05.19</td></tr><tr><td>स्वीकृत APPROVED</td><td>SKS</td><td>SD/-</td><td>09.05.19</td></tr></table>			नाम /NAME	हस्ता /SIGN.	दि./DATE	MVK	SD/-	09.05.19	MVK	SD/-	09.05.19	स्वीकृत APPROVED	SKS	SD/-	09.05.19
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REV.	DATE	ALTERED	MVK	विभाग DEPT.	 अनुपात / SCALE	कॉड कोड CARD CODE															
01	13.08.19	CHECKED	MVK	कोड CODE																	
		APPROVED	SKS	NTS																	
ZONE	REVISED AS PER TANTRANSCO COMMENTS.			शीर्षक/TITLE		डाईग.क./DRAWING NO.															
				SINGLE LINE DIAGRAM OF 48V DCDB FOR 400/230-110KV SUBSTATION VELLALAVIDUTHI		TB-2-399-316-009(C)															
						पृष्ठ क्र./SHEET No. 01															
						अगला पृष्ठ/NEXT SHEET -															

~~SECTION - 22~~
AC & DC PANELS

A.C. PANEL

1.0. GENERAL ARRANGEMENT & STANDARDS

1.1. The medium voltage AC panels to be supplied would be of cubicle type with switches and other accessories mounted and connected to the bus suitable for 440 volts, 50 cycles, 3 phase AC supply system.

1.2. Each panel shall have the following dimensions:

Height: 2312mm (including the height of base support channel frame of size 100 x 50mm made out of not less than 3mm thick sheet)

Depth : 600 mm

Width : 800 mm

1.3. The panel shall be folded type construction and fabricated out of sheet steel of thickness as follows,

Front, Rear and Base Frame	: Not less than 3mm
Side, Top and Bottom	: Not less than 2mm

1.4. Each panel shall be provided with ventilation louvers with stainless steel / Brass wire mesh on the rear doors of the panel and should be vermin proof.

1.5. The cable gland plate at bottom should be in two halves and detachable type.

1.6. The rear side of the panel shall be provided with twin hinged doors with lever type locking handle.

1.7. Four numbers grouting holes and grouting bolts shall be provided at the bottom.

1.8. All the hardwares used shall be hot dip galvanised.

1.9. The painting of the panel should be done as per IS-6005-1970 or latest issue and finished with light grey colour, paint of shade 631 of IS-5 for outside and glossy white for inside. The base support frame shall be painted black in colour.

1.10. RED, YELLOW, BLUE colour Neon lamps shall be provided for R, Y,B phase indications at the top of the panel with 5A slide lock fuses.

1.11. One number 60 watts B.C. lamp shall be provided inside the panel for panel illumination and operated by rear door through door switch for ON/OFF operation.

1.12. Each panel comprises of three zones as detailed below:

Top Zone : Instruments
Middle Zone : Miniature circuit breakers for outlets
Bottom Zone : Main switch and CT

It shall be possible to open each zone from the front side to enable inspection of defects if any without disturbing other zone. Each zone shall be provided with hinged doors. The hinges shall be at left hand side and bolting arrangement shall be at right hand side corners for locking, Anodized Aluminium Caution Board to the following effect shall be provided on the front and rear sides of the panels.

1.13 SPD (Lightning & Switching protection device) shall be provided in the incoming side of ACDB/DCDB panels

1.14 Protection Relays shall be of Numerical type and preferably

ABB/Siemens/GE Make.

1.15 'D' type curve MCB shall be used for Battery chargers, 'C' type curve MCB shall be used for all other circuits and 'B' type curve MCB shall be used for illumination circuit.

Minimum 20 % Spare MCBs shall be provided for each section of DCDB and

ACDB panels.

CAUTION : "SWITCH OFF THE STATION TRANSFORMER SUPPLY AND GENERATOR SUPPLY BEFORE OPENING THE DOORS"

2.0. STANDARDS

All the materials and equipment shall comply in all respects with the requirements of the latest standards furnished hereunder.

a.	ISS-8623	Specification for factory built assembly of switch gear and control gear for voltages upto and including 1000V AC/1200 V AC.
b.	ISS-4237	General requirements for switchgear and control gear for voltages not exceeding 1000V
c.	ISS-2147	Degree of protection provided by enclosures for LV switchgear and control gear
d.	ISS-3072	Code of practice for installation and maintenance of switchgear
e.	ISS-2075	Current Transformer

f.	ISS-2516	AC circuit breaker (Part-I, II etc)
g.	IEC-408/1972	Short time withstand test
h.	ISS-6005	Surface treatment for M.S. sheets
i.	CBIP-Technical Report July 1996	Static Trivector Meter
j.	IS:1248	Indicating Instruments

Wherever a standard is specifically mentioned in this specifications, it is understood that the corresponding standard or standard from amongst the source mentioned above shall also apply. It is however understood that the material offered shall comply with one consistent set of standards except in so far as they are modified by the requirements of these specification.

3.0. BUS BARS

Hard drawn electrolytic grade copper bus bars of rectangular size shall be provided for phases and neutral. Bus bars shall be completely wrapped with phase identification colour PVC tapes to avoid exposed live portion. Necessary holes may be drilled in bus bars at suitable places to connect the incoming and outgoing leads, copper conductors with lugs will be connected to these holes using suitable brass bolts. The clearance of live parts between phases and to the earthed metal parts of the panel shall be adequate and conform to ISS of latest issue.

The bus bars shall be fixed inside the panel in vertical formation on the right side of the panel when viewed from rear side.

3.1. SIZE OF BUS BARS: (minimum)

<u>SL No</u>	<u>Panel for</u>	<u>For Phases</u>	<u>For Neutral</u>	<u>For Earth</u>
a.	400 KV SS	50mmx6mm	25mmx6mm	25mmx3mm

The length of the bus bars should not be less than 1000 mm.

4.0. INTERNAL WIRING

ACB Internal wiring should be done by the supplier. Internal connections from main incoming MCCB/ to the bus bars and from the bus bars to the outgoing MCBs and then to the terminal blocks from the switches should be done by electrolytic grade standard flexible copper wires with PVC insulation of 1100V grade of the following sizes. The ferrule shall be provided at the ends for identification purposes.

Rating of switches Amps	Size of insulated copper wire
400	min 150 sq.mm
200	min. 70 sq.mm.

100	min. 35 sq.mm.
60	min. 15 sq.mm.
30	min. 5 sq.mm.
15	min. 2.5 sq.mm.

All auxiliary wiring (current and voltage) for meters etc., should be done with multi stranded copper PVC wires, open live terminal inside the panel should be above 300mm from bottom of the panel.

5.0 DETAILS OF INSTRUMENTS AND SWITCHES

5.1 PANEL for 400 KV SS

5.1.1 TOP ZONE : (INSTRUMENTS)

a.	1 No.	The static trivector meter shall be of 3 phase 4wire 440V, 1A, 50 Hz capable of measuring and displaying the following electrical quantities for poly phase balanced or unbalanced loads. KWh, KVARh, KVAh, KVA MD, rising demand for elapsed time, PF, frequency count for number of MD resets, phase wise details of current and voltage, real time and segment check display. The above parameters should have scroll lock arrangements, so as to get the display of any one parameters continuously. In addition the push button display mode is also essential. The push button shall have a sealing arrangement.
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5.1.2. MIDDLE ZONE : (OUTGOING SUPPLY) (Refer SLD)

There shall be two bus sections viz., Main bus and Auxiliary bus.

Station transformer supply shall be made available in the main bus. The following outlets shall be provided from the main bus.

a.	2 Nos.	100 Amps, 3 phase, 3 pole, 440V moulded case circuit breaker.(Thermal magnetic type)
b.	7 Nos.	60 Amps, 3 phase, 3 pole, 440V miniature circuit breaker
c.	4 Nos.	30 Amps, 3 phase, 3 pole, 440V miniature circuit breaker
d.	10 Nos.	30 Amps, single phase, two pole, 230V miniature circuit breaker
e.	1 No.	Digital Type frequency meter (Display with four digits and 12mm height) to indicate 50 cycles per second

5.1.3 BOTTOM ZONE : (INCOMING SUPPLY) (Refer SLD)

a.	As per approved ACDB SLD	400 Amps, 3 phase, 3 pole, 440 Volts, moulded case circuit breaker (Thermal magnetic type) with fixed instantaneous O/L settings for controlling the incoming supply availed from station transformer. The main bus in the middle zone will be energised by this MCCB
c.	3 Nos.	LT single phase CT of ratio 200/1A shall be provided with metering class accuracy 0.2 .

6.0 OTHER DETAILS

- a. Name plate of the panel Board may be provided at the top of front side of the panel.
- b. 2 Nos. Earthing terminals shall be provided for each panel.
- c. Provision shall be made for adequate accessibility for each switch for the incoming and outgoing cable connections purposes.
- d. Each panel may be assigned with a serial number.
- e. 5A, rewirable slide lock fuses may be provided for the phase indication lamps, cubicle illuminating lamps, static trivector meter potential supply and voltmeter.
- f. All meters, crack switches, fuse units shall have circuit indicating label.

7.0. BRAND NAMES:

The brand names for various equipment and instruments shall be as per clause-16.0

8.0. INSTRUMENTS:

The Static Trivector Meter shall conform to CBIP Specification Technical Report No.88 – July 1996 or to the latest issue with 0.5 accuracy class. The current transformer secondary leads shall be provided with shorting links, test links and isolating facilities. All moulded case circuit breakers shall be of 25KA rupturing capacity and miniature circuit breakers shall be of 10KA rupturing capacity.

The voltmeters, frequency meter, shall be of flush type.

9.0 TERMINAL BLOCKS:

All terminals shall be of Disconnecting Type. Necessary clearance viz., 100mm between 2 sets of terminal block, 250mm between terminal block and associated cable gland plate ,shall be maintained.

Separate neutral terminal shall be provided at the terminal block, adjacent to the phase terminals of each outlets for terminating neutral of the respective outlets. Adequate spare terminals may be provided for future additions (20% of the terminals used).

10.0. INDICATION LAMPS: All indicating lamps shall be LED type.

11.0. DRAWINGS:

11.1. The successful tenderer shall forward within 15 days from the date of receipt of purchase order, four sets of the below mentioned drawings for the purchaser's approval. Drawings which are satisfactory for approval on the first submission will be approved and one copy of the approved print will be returned. The drawings not satisfactory for approval on the first submission will be returned to the tenderer for resubmission.

- i. Drawings showing the front elevation of the panel.
- ii. Drawings showing the bus bar arrangement.
- iii. Drawings showing the lateral cross-section indicating mounting arrangement of switches.
- iv. Drawings showing the cable entry arrangement.
- v. Drawings showing the foundation details.
- vi. Single line diagram of metering and protection arrangements.

Any shop work done prior to the approval of drawings shall be at the suppliers risk. Supplier shall make any change in the design which are considered necessary to make the equipment conform to the provisions and indent of the purchase order without any additional cost to the purchaser.

11.3. The successful tenderer shall supply the purchaser within 15 days of receiving an approved print, one reproducible master transparency and two prints of each of the approved drawings.

11.4. The supplier shall send 5 sets of approved drawings and instruction manuals to each consignee and also two sets along with the panels while despatch.

3 sets of instruction manuals shall be supplied within one week from the date of approval of drawings to Superintending Engineer/Transmission IV/Chennai-2.

All drawings, part lists assembly procedures etc., shall bear a readily identifiable number, drawing number etc., and each subsequent revision or addition to the drawing shall be identified by a revision number.

Checking and approval of the above documents by the purchaser is for the benefit of the purchaser and shall not relieve the supplier from full responsibility for ensuring correct interpretation of design, drawings and specifications or for the completeness and accuracy of the shop drawings and relevant specifications.

Supplier shall record all deviations, corrections, omissions, changes etc., occurring throughout the manufacturing, assembly and testing phases.

All drawings shall be in **English Language** and in **Metric System of Units**.

12.0. DESCRIPTIVE LITERATURE AND PAMPHLETS:

Full descriptive particulars of the items used in the A.C. panel and necessary drawings showing the connection details with pamphlets should be furnished. The details of MCBs and MCCBs that are used for assembling these panel should be furnished.

13.0. ROUTINE TESTS:

The following routine tests shall be conducted on the panels in the presence of Corporation's Engineer and Test Certificates submitted in triplicate for approval before despatch.

- a. Dimensional check.
- b. Visible and quantitative check
- c. Wiring connection and function check of meters, MCB, MCCB, switches etc.
- d. High voltage power frequency withstand test / 2KV for one minute
- e. I.R. value of all switches and cubicle.

15.0. GUARANTEED TECHNICAL PARTICULARS

The guaranteed technical particulars as per the enclosed Annexure should be furnished by the tenderer without fail.

16.0 Brand Names

The Brand Names for various equipment and Instruments shall be as below.

1.	Static Trivector Meter	ABB, L&T, SECURE/
2.	LT CT	JAYANTHI ELECTRIC / KAPPA/ PRECISION / VOLTAMPS
3.	60A, 30A, 15A miniature circuit breakers	}HAVELL'S/ STANDARD /SCHNEIDER

4.	400A, 200A, 100A and 50A moulded case circuit breakers	} }SCHNEIDER/HAVELL"S }} L&T / MDS / SIEMENS / } } STANDARD /
5.	Digital Frequency Meter	PLA/MECO.
6.	Voltmeter	AE/MECO/NIPPEN
7.	Switches	KAYCEE /SALZER / SWITRON

NOTE : Only specified make is acceptable by TANTRANSCO. The tenderers should not quote "**as equivalent**" in any case.

NOTE : 1) The copies of the Type Test Certificates for the bought out components will shall be furnished with the offer of materials for inspection.

: 2) The above Type Tests should have been conducted in a Government/ Government recognised laboratory as per relevant IS/IEC **not earlier than TEN (10) years on the date of tender opening.**

Section-22

220V D.C. Distribution Panels

1.0. SCOPE :

1.1. DC panels to be supplied would be of cubicle type with switches and other accessories mounted and connected to the bus suitable for 220V DC system.

(A) STANDARDS :

LATEST ISSUE OF :

a.	IS.6005	Surface treatment for M.S. Sheets
b.	IS.1248	Indicating instruments
c.	IS.6875	Push Button and Control Switches
d.	IS.3231	Relays
e.	IS.8623	Specification for factory built assembly of switchgear and control gear for voltages upto and including 1000V AC/1200V AC
f.	IS. 4237	General requirements for switchgear and control gear for voltages not exceeding 1000V.

2.0. (B) REQUIREMENT :

The D.C. Distribution panel is required for :

- (a) Distribution of control supply with necessary short circuit protection for outlet feeders.
- (b) Emergency D.C. Lightning as per approved design. 60 watts in case of A.C. failure, should come automatically through A.C. under voltage sensor and contactor.
- (c) Annunciation scheme for D.C. earth leakage and D.C. and A.C. under voltage and D.C. over voltage. Provision for acknowledging the fault through push button switch and cancellation of audible alarm, visual indication should persist till the rectification of fault.

3.0. GENERAL DESCRIPTION :

(a) The 220 V Distribution panels cabinet shall be of indoor type suitable for floor mounting on steel frame work on cement concrete pedestal. The dimensional size of the cabinets shall be 2312 x 600 x 600mm. The thickness of the sheet steel shall be as follows :-

Front & Base Frame :	Not less than 3mm
Top, Sides and rear :	Not less than 2mm

The cabinet shall be fabricated with the M.S. Sheet steel bu suitably folding the sheet to achieve required strength.

The panel shall be painted with two coats light greay enamel paint to Shade – 631 of IS – 5 for exterior finish and glossy white for interior finish. All hard wares shall be hot dip galvanized to avoid corrosion.

The panel shall be vermin proof. Hinged twin doors shall be provided on the rear side, vermin proof louvers with copper/brass/stainless steel wire mesh shall be provided on the rear doors, lever type locking handle shall be provided for doors. The cable entry shall be from bottom and detachable gland plates in two halves shall be provided. Rubber gasket shall be provided for joints. HRC fuses shall be provided for DC lightning circuit, A.C. supply, D.C. control and annunciation bus.

The height 2312mm is inclusive of height of 100mm base support frame.

(b) Anodised Aluminium Labels shall be provided for all instruments, switches, push buttons, lamps, fuses and for name plate details of the panel.

(c) Grouting holes and bolts shall be provided. Vermin proof ventilating louvers switch stainless steel/Copper/Brass wire mesh shall be provided on the rear doors of the panel.

(d) The wiring of space heaters shall be protected with porcelain beads for suitable thermal insulation for a safe length.

(e) In addition to earth fault relay 2 Nos. push button switches and resistors shall be provided for instant indication of positive to ground fault and negative to ground fault to check the earth leakage relay and associated audio and visual indication at a stroke.

(f) Necessary indication lamps with related accessories shall be provided to distinctly indicate the acknowledged state of annunciation scheme.

(g) EARTH FAULT RELAY :

A Centre Zero milli ammeter shall be included between the E/L relay and ground to detect the earth fault polarity, Earth leakage relay with minimum standing current drain shall be provided.

(h) The A.C. supply (230 V $\pm$ 15%) shall be wired neatly and kept separately from D.C. supply.

(i) The bus bars shall be of electrolytic grade copper only.

(j) TERMINATION OF CABLE :

Incoming and outgoing cables shall be terminated in suitable rated stud and nut type terminal block. Necessary clearance shall be maintained for easy wiring, 20% spare terminals shall be provided for future connection.

(k) INSULATION :

The cabinet wiring and all equipments shall withstand a power frequency high voltage of 2 KV for one minute between each point to ground and between circuits.

4.0. PANEL COMPONENTS :

(A) 220V DC Distribution Panel Components (Refer SLD)

Sl.No.	Description	Rating	Quantity
01.	MCCB with instantaneous O/L setting for controlling the incoming DC supply.	150 Amps	As per approved DCDB SLD
02.	D.C. double pole miniature circuit breaker	30 Amps	
03.	D.C. Earth leakage relay with sensing range from 1 mA to 5 mA suitable for 220V D.C. without shadow region of the minimum insulation resistance level to be sensed shall be 44 K. Ohms, with center zero milliammeter of 25-0-25 mA range connected between Relay and Earth.		1 set.
04.	D.C. undervoltage relay for sensing undervoltage of 80% of the battery voltage, with variable settings in steps of 5% between 80 to 100%.	220V DC	1 No.
05.	D.C. overvoltage relay for sensing overvoltage upto 120% of battery voltage, with variable settings from 100 to 120% in steps of 5%.	220V DC	1 No.
06.	A.C. undervoltage relay for sensing undervoltage of 80% of A.C. supply voltage, along with the lighting change over relay with auxiliary contacts.	A.C. 230V single phase (DC 110V lighting circuit 915 x 60W Bulbs)	
07.	D.C. voltmeter 144 x 144mm size moving coil flush mounting type with 90 degree angle deflection and conforming to IS.1248 of 1968. The sensitivity of voltmeter shall be 1000 ohms/volt.	0-300 V DC	1 No.
08.	D.C. Ammeter 0-75A 144x144mm size moving coil, flush mounting type with 90 degree deflection with accuracy $\pm 2\%$ and conforming to IS.1248 of 1968.		1 No.
09.	Annunciation scheme operating on 220V D.C. shall comprise gong bell, indication lamp, acknowledge, reset push button.		1 No.
	NOTE : 2. The annunciation scheme including gong bell should be capable of operation under D.C. U/V condition of 80% of the rated D.C. voltage and withstanding the overvoltage of 120%.		

	3. The annunciation scheme should be capable of giving both audible and visual (lamp) indication for one or more faults occurring subsequently even before normalizing the earlier fault/faults. 4. The DC for annunciation scheme shall be taped off at the incoming side of the main MCCB and provided with 2A HRC fuses and links.		
10.	Panel lamp with door switch and space heater with control switch	230V AC	1 set
11.	Size of copper D.C. bus bars of rectangular cross-section	(Length not less than 500mm)	25 x 6 mm
12.	Size of earth bus also of rectangular size	(Length not less than 500 mm)	25 x 3 mm
13.	(d) Size of the incoming and outgoing connections of MCCB		Braided / flexible copper wire 75 sq.mm
	(e) D.C. Distribution (Standard flexible copper wire)		10 Sq.mm
	(f) A.C. Circuits and D.C. lighting		2.5 Sq.mm 100 x 50 x 50mm
14.	(a) Base support frame		
	(b) Thickness and Colour of base frame	Sheet steel of not less than 3mm thick painted with black Enamel paint.	

B) 220V DC CHANGE OVER SWITCH:

Four d.c. change over switch provided for each of the two dc panels. The d.c. change over switch of reputed company confirming latest IEC should be provided.

C) 48V DC Distribution Panel Components (Refer SLD)

Sl.No.	Description	Rating	Quantity
01.	MCCB with instantaneous O/L setting for controlling the incoming DC supply. 'D' type curve MCB shall be used for Battery chargers,'C'type curve MCB shall be used for all other circuits and 'B' type curve MCB shall be used for illumination circuit	100 Amps	As per approved DCDB SLD.
02.	D.C. double pole miniature circuit breaker	16 Amps	
03.	D.C. Earth leakage relay with sensing range from 1 mA to 5 mA suitable for 48V D.C. without shadow region of the minimum insulation resistance level to be sensed shall be with center zero milliammeter of 25-0-25 mA range connected between Relay and Earth.		1 set.
04.	D.C. undervoltage relay for sensing undervoltage of 80% of the battery voltage, with variable settings in steps of 5% between 80 to 100%.	48V DC	1 No.
05.	D.C. overvoltage relay for sensing overvoltage upto 120% of battery voltage, with variable settings from 100 to 120% in steps of 5%.	48V DC	1 No.
06.	A.C. undervoltage relay for sensing undervoltage of 80% of A.C. supply voltage, along with the lighting change over relay with auxiliary contacts.	A.C. 230V single phase	
07.	D.C. voltmeter 144 x 144mm size moving	0-75 V DC	1 No.

	coil flush mounting type with 240 degree deflection and conforming to IS.1248 of 1968. The Accuracy class-1.5%		
08.	D.C. Ammeter 100-0-100A 144x144mm size moving coil, flush mounting type with 240 degree deflection with accuracy $\pm$ 1.5% and conforming to IS.1248 of 1968.	100-0-100A	1 No.
09.	Annunciation scheme operating on 48V D.C. shall comprise gong bell, indication lamp, acknowledge, reset push button.	Facia display- 1N-6Window- 75- 275VDC/AC	1 Set
NOTE : 5. The annunciation scheme including gong bell should be capable of operation under D.C. U/V condition of 80% of the rated D.C. voltage and withstanding the overvoltage of 120%. 6. The annunciation scheme should be capable of giving both audible and visual (lamp) indication for one or more faults occurring subsequently even before normalizing the earlier fault/faults. 7. The DC for annunciation scheme shall be taped off at the incoming side of the main MCCB and provided with 2A HRC fuses and links. SPD (lightning & Switching Protection device) shall be provided in the side of ACDB/DCDB panels D' type curve MCB shall be used for Battery chargers, 'C' type curve MCB shall be used for all other circuits and 'B' type curve			

	M'CB shall be used for illumination circuit		
	Panel lamp with door switch and space heater with control switch	230V AC	1 set
11.	Size of copper D.C. bus bars of rectangular cross-section and Busbar supports	150A, 10kA for 1sec ,Electrolytic Copper Busbar with Color coded heat shrinkable Sleeves as per IS:11353 Red for+ve,Blackfor-ve and Green for Earth Terminal. Busbar supports : SMC/ DMC moulded support	Min 25 x 6 mm
12.	Size of earth bus also of rectangular size	25x3 Sqmm CU with at least 2 Holes at joints running through the Panel All hinged door shall be earthed through 6sqmm flexible earthing braid	
13.	Size of the incoming and outgoing connections of MCCB	Braided / flexible copper wire 35 sq.mm	Braided / flexible copper wire 35 sq.mm
	D.C. Distribution (Standard flexible copper wire PVC Tag Ferrules	1.1kV grade 10 Sqmm, Copper 2.5Sqmm PVC with NOS	
	(f) Control Wiring with Flexible copper	Voltage:1.5 Sqmm	

	conductor PVC insulated wires 1.1kV grade	(Black) Current circuit: 2.5 Sqmm (Red, Yellow, Blue) Earthing: 2.5 Sqmm (Green) DC Circuit : 2.5 Sqmm (Grey)	
14.	(a) Base support frame (b) Thickness and of base frame (c) Painting	Base channel: ISMC-100mm Frame & Component mounting plates, Front & Rear: 3mm (HRCA) Top & Sides: 2mm (CRCA) Gland Plate: 3mm (HRCA) Treatment: Seven Tank Process Type: Powder coated Shade: 631 of IS: 5 (Exterior) and Glossy White (Interior)	

5.0. DRAWINGS :

5.1. The supplier shall forward 4 sets of the following drawings within 15 days from the date of receipt of purchase order, for according approval from this office. Drawings which are satisfactory for approval on the first submission will be so noted and signed and one copy of the signed prints will be returned. The drawings not satisfactory for approval on the first submission will have changes, noted etc. are noted in the prints, one of which will be returned to the tenderer for resubmission. The print with such addition shall not be interpreted by the supplier, to be "approved as noted", unless specifically so noted above on approving signatures.

- (i) Drawings showing the front elevation of the panel.
- (ii) Drawings showing the bus bar arrangement.
- (iii) Drawings showing the lateral cross-section indicating mounting arrangement of switches.
- (iv) Drawings and supports showing the cable entry arrangement.

- (v) Drawings showing the foundation details.
- (vi) Single line diagram of metering and protection arrangements.

Any shop work done prior to the approval of drawings shall be at the suppliers risk. Supplier shall make any change in the design which are considered necessary to make the equipment conform to the provisions and indent of the purchase order without any additional cost to the purchaser.

11.3. The successful tenderer shall supply the purchaser within 15 days of receiving an approved print, one reproducible master transparency and two prints of each of the approved drawings.

11.4. The supplier shall send 5 sets of approved drawings and instruction manuals to each consignee and also two sets alongwith the panels while despatch.

3 sets of instruction manuals shall be supplied within one week from the date of approval of drawings to Superintending Engineer/Transmission II/ Chennai-2.

All drawings, part lists assembly procedures etc., shall bear a readily identifiable number, drawing number etc., and each subsequent revision or addition to the drawing shall be identified by a revision number.

Checking and approval of the above documents by the purchaser is for the benefit of the purchaser and shall not relieve the supplier from full responsibility for ensuring correct interpretation of design, drawings and specifications or for the completeness and accuracy of the shop drawings and relevant specifications.

Supplier shall record all deviations, corrections, omissions, changes etc., occurring throughout the manufacturing, assembly and testing phases.

All drawings shall be in **English Language** and in **Metric System of Units**.
6.0. ROUTINE TESTS :

The panels shall be tested for the following at the works of manufacturer's before supply :-

- (i) Visual examination and Dimensional check.
- (ii) Quantitative check.
- (iii) Functional check of meters and relays, MCCBs, MCBs.
- (iv) Power frequency high voltage withstand test for all wiring and equipments.
- (v) I.R. Value measurement.

7.0. DESCRIPTIVE LITERATURES AND PHAMPLETS :

Full descriptive particulars of the MCCB, MCBs, relays used in the D.C. panel and necessary drawing showing the connection details with pamphlets should be furnished.

BRAND NAMES FOR 220V AND 48V DC DISTRIBUTION PANEL COMPONENTS :

01.	Voltmeters / Milli Ammeters	AE/IMP/Nippon/Meco/conforming to ISS 12438 / 1968
02.	Miniature circuit breakers	MDS/STANDARD/ SCHNEIDER/L&T/SIEMENS/ CONFORMING TO RELEVANT ISS.
03.	Incomer moulded case circuit breaker	Crompton Greaves/L&T/EE/Andrew Yule/conforming relevant ISS.
04.	D.C.U.V., D.C. – OV and A.C – UV relays	Protection Relays shall be of Numerical type and preferably ABB/Siemens/GE Make.
05.	D.C. – EL relay	EE make CAEM 21 Type / ER /C&S/SCHNEIDER conforming to relevant ISS.

NOTE : (1) Only specified "MAKE" is acceptable.
(2) Tenderers should not quote "or equivalent", which is not acceptable.

TYPE TEST CERTIFICATE :

Tenderers are requested to furnish copy of type test certificates as conforming to relevant IS / IEC standards of latest issue obtained from a Government/ Government Recognized Laboratory. The above type test certificates shall be furnished before the offer of Inspection for the first lot of materials / equipments at **no extra cost to Corporation.**

The above type test should have been conducted not earlier than **TEN years (10 years)** as on the date of Tender opening. Non submission of above type test certificates within the stipulated time will entail cancellation of Purchase Order without any further reference to supplier. The original type test certificates shall be furnished for verification on request

SECTION – 3

PROEJCT DETAILS & GENERAL TECHNICAL REQUIREMENT

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 : 400/230-110 kV Substation at Vellalaviduthi
- c) Transport facilities : Road/Rail

Physical and other parameters:

- 3.1.1 Location of the substation : Vellala viduthi, Pudukottai district
- 3.1.2 Nearest Railway station : Pudukottai
Railway : Southern Railway
- 3.1.3 Meteorological data
- (i) Maximum ambient temperature : 50°C
 - (ii) Minimum ambient temperature : 20°C
 - (iii) Maximum daily average ambient air temperature : 45° C
 - (iv) Maximum yearly average ambient air temperature : 32° C
 - (v) Maximum Humidity (%) : 100%
 - (vi) Average thunder storm days per annum : 50
 - (vii) Average rainy days per annum : 90
 - (viii) Average annual rainfall (mm) : 1000 mm
 - (ix) No. of months during which tropical monsoon condition prevail : 5
 - (x) Maximum wind pressure : 150 Kgf/Sqmm
 - (xi) Altitude above MSL : 1000M

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

MAIN ELECTRICAL PARAMETRS:		
a)	Fault Levels	400kV: 63kA for 1 sec. 230kV: 40kA for 3 sec. 110kV: 40kA for 3 sec.
a)	Creepage Distance	25mm/kV

3.1.4 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 -10% to +10%, Frequency +/- 5%,
DC supply	220V, 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.

3.0.1 The bidder shall also furnish drawings for the following:

All EQUIPMENTS and type of clamps, fittings hardware, 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-1 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 the specification.

The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to complement 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 TEST CERTIFICATE:

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

3.6 TESTS :

All the tests as per relevant IS/IEC shall be carried out.

3.7 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 IS/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 equipments should operate without undue vibration and with the least practicable amount

of noise.

3.8 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.

3.9 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.

3.10 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/ BHEL and the bidder 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.

3.11 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.

3.12 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.

3.13 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.

3.14 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.

3.15 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.

3.16 DEGREE OF PROTECTION

The supplier shall propose following Degree of protection for those equipment/Items for which the degree of protection has not been specified in the specification for the approval of BHEL/TANTRANSCO. The decision of BHEL/TANTRANSCO shall be final. The enclosures of the Control Cabinets, Junction boxes and Marshalling boxes, panels etc to be installed shall provide 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-60947 (Part-1)/ IS 12063 / IEC-60529. Type test report for degree of protection test on each type of the box shall be submitted for approval.

3.17 FIRST FILL OF CONSUMABLES, OIL AND LUBRICANTS

All the first fill of consumables such as oils, lubricants, filling compounds, touch up paints, soldering/brazing material for all copper piping of circuit breakers and essential chemicals etc. which will be required to put the equipment covered under the scope of the specifications, into operation,

shall be furnished by the Contractor unless specifically excluded under the exclusions in these specifications and documents.

3.18 RATING PLATES, NAME PLATES AND LABELS :-

The equipments shall be provided with a rating plate or plates marked with but not limited to following data whatever needs to that particular equipments (as applicable).

- (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.

Each main and auxiliary item of substation is to have permanently attached to it in a conspicuous position a rating plate of non-corrosive material upon which is to be engraved manufacturer's name, year of manufacture, equipment name, type or serial number together with details of the loading conditions under which the item of substation in question has been designed to operate, and such diagram plates as may be required by the BHEL/TANTRANSCO. The rating plate of each equipment shall be according to IEC requirement.

All such nameplates, instruction plates, rating plates of transformers, reactors, CB, CT, CVT, SA, Isolators, C & R panels and PLCC equipments shall be bilingual with Hindi inscription first followed by English. Alternatively two separate plates one with Hindi and the other with English inscriptions may be provided. During approvals drawings of Rating/name plates/labels shall also be submitted.

3.19 TERMINAL CONNECTORS :

The terminal connectors shall meet the following requirements.

- a. Terminal connectors shall be manufactured and tested as per IS : 5561.
- b. All castings shall be free from blow holes, surface blisters, cracks and cavities.

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- c. All sharp edges and corners shall be blurred and rounded off.
 - d. No part of a clamp shall be less than 10mm thick.
 - e. All ferrous parts shall be hot dip galvanized conforming to IS: 2633.
 - f. For bimetallic connectors, copper alloy liner of minimum thickness of 2mm shall be cast integral with Aluminium body. Flexible connectors shall be made from tinned copper.
 - g. All current carrying parts shall be designed and manufactured to have a minimum contact resistance.
 - h. Connectors shall be designed to be corona free in accordance with the requirements stipulated in IS : 5561.
 - i. Terminal connectors shall be for Twin Moose Conductor with a spacing of 450mm between the conductor.

3.20 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.

3.21 TERMINAL BLOCKS AND WIRING

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

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

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

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

its escape from the mounting rails.

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

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

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

3.22 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.

3.23 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.

3.24 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.

3.25 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.

3.26 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.

3.27 LIST OF DRAWINGS AND DOCUMENTS :

The drawings for the equipments provided by the TANTRANSCO/BHEL 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/BHEL.

The bidder shall furnish one set of relevant descriptive and illustrative published literature pamphlets and the following drawings/documents for preliminary study along with the Offer (as applicable). (Drawings, GTP, type test reports, list of past supplies etc. Drawings & documents submitted at the time of offer shall be subject to review at contract stage)

- (i) General outline drawings showing dimensions and shipping weights, quantity of insulating media, etc.
- (ii) Sectional views showing the general constructional features of the equipment (eg. Breaker drg includes operating mechanism, arcing chambers, contacts with lifting dimensions for maintenance).
- (iii) Schematic diagrams of equipment (eg. Breaker drg includes 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 week of placement of order submit six sets of final version of all the above drawings for TANTRANSCO/BHEL approval. The TANTRANSCO/BHEL shall communicate its comments/approval on the drawings to the supplier within reasonable period. The Supplier shall, if necessary, modify the drawings and resubmit six copies of the modified drawings for TANTRANSCO/ BHEL approval within one week from the date of comments. After receipt of TANTRANSCO/BHEL approval, the supplier shall, within two weeks, submit 8 prints and two good quality reproducible of the approved drawings for TANTRANSCO/BHEL use. 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 equipments 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 equipments.
- 4) It should be noted that if the above conditions are not fulfilled the initial payment will not be released.

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

Following Documentation schedule to be followed

S. No.	DESCRIPTION	TENDER STAGE	CONTRACT STAGE FOR APPROVAL	FINAL DOCUMENTATION	
				Prints	CDs
1	Drawings and Data Sheets	1	6	10	5
2	Drawings "As Built "	-	-	10	

3	Type Test Reports	1	6	10	
4	Erection Manuals	-	6	10	
5	Operation and Maintenance Manuals	-	6	10	
6	Manufacturing Quality Plan	-	6	10	
7	Field Quality Plan	-	6	10	
8	Inspection Test Reports	-	6	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.

3.28 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.

- (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 equipments 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/BHEL.

- 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/BHEL inspection. The quality assurance plan and hold points shall be discussed between the TANTRANSCO/BHEL 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 equipment.

3.29 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(/25) deg. C over an ambient of 45(/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.

3.30 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.

3.31 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.

3.32 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)

AFTER AGEING

1. Change in weight should not be more than 10% and change in Hardness should not be more than Shore A ± 10 after 7 days aging in transformer oil.
2. There should not be any visible damages after accelerated aging of 24 hours in transformer oil of temperature 110° C.

AC PANELS

1.	Name of the manufacturer and place of manufacture			
2.	i) Overall dimension of AC panel in mm.	Height 2312 mm	Width 800 mm	Depth 600 mm
	ii) Thickness of sheet metal proposed for use on panels in mm	Front, Rear & Base frame - not less than 3 mm. Sides, top & bottom - not less than 2 mm		
	iii) Dimensions of base support frame in mm.	100 mm x 50 mm		
	iv) Size of side supporting angles in mm	3 mm		
	v) Exterior finish	Light grey		
	vi) Interior finish	Glossy white		
3.	Switch Board wiring			
i	Power Frequency withstand level of panel wiring	2 KV for 1 minute		
ii	Insulation level of wiring	PVC Insulated, 1100 Volts Grade		
iii	Size of electrolytic grade copper wire with details of strands in sq.mm.			
	a) Incoming for 230 KV SS 400AMPS ----- 60 AMPS	As per SLD Minimum 150 Sqmm Minimum 15 Sqmm		
	b) Outgoing : As per SLD	For 230KV SS PANEL 100A 35 60A 15 30A 5		
iv	Size of earthing in mm	25 mm x 3 mm		
v	Type of terminals provided on wiring	Disconnecting type		
4.	Instruments and metering equipment			
	(i) Static Trivector Meter:			
a.	Make	ABB / L&T / SECURE		
b.	Type	Static		
c.	Voltage rating	440 V		
d.	Current rating	AC Panels for 230 KV SS- 1 Amps.		
e.	Accuracy class	0.5		
f.	Measuring and display parameters	As per Specification		
g.	Whether scroll lock arrangements to get the display of any one parameter continuously and push button display mode available	Available		

h.	Display	
i.	Whether the following facilities are provided	
i	MD reset	Yes
ii	Communication capability	Yes
iii	Time of day Tariff	Yes
iv	Tamper and Fraud monitoring	Yes
v	Load survey capability	Yes
vi	Self diagnostic feature	Yes
vii	Auto display cycling facility for essential parameters	Yes
viii	Electro Magnetic compatibility	Yes
(ii) Voltmeter		
(a)	Make	AE/MECO/NIPPEN
(b)	Type	Flush type
(c)	Accuracy class	1.5
(d)	Maximum Scale Range	
(e)	Size	144 mm x 144 mm
(iii) Frequency Meter		
(a)	Make	PLA / MECO / NIPPEN SCHNEIDER
(b)	Type	Digital
5.	a) Moulded case circuit breakers	
	i) Type and make ii) Rating (A) iii) Rupturing capacity (KA) iv) Whether O/L trip is adjustable or fixed v) If adjustable, range of adjustment vi) If fixed at what level	HAVELL"s/ STANDARD/ SCHNEIDER / L&T/ MDS/ SIEMENS / 400 A, 200 A, 100 A, 60 A (As per SLD) 25 KA
	b) Miniature Circuit Breakers	
	i) Type and make ii) Rating (A) (iii) Rupturing capacity (KA) iii) Whether O/L trip is adjustable or fixed iv) If adjustable, range of adjustment v) If fixed at what level	HAVELL"s/SCHNEIDER,/L&T/ SIEMENS / STANDARD / . 60 A, 30 A, 15 A (As per SLD) 10 KA

6.	Busbars:	
	i) Material used	Electrolytic grade copper
	ii) Size (Reactangular)	(minimum) For 230KV SS
	a) For phases (mm)	50 x 6
	b) For Neutral (mm)	25 x 6
	c) For Earth Bus (mm)	25 x 3
7.	Type and Make of crimping lugs used in the wiring	
8.	Details of drawings enclosed	
9.	Brief description of the functions of AC Panel designed for	

220V D.C. DISTRIBUTION PANEL

		As per specification
01.	Name of the manufacturer and place of manufacture	To be furnished by bidder.
02.	a. Overall dimension of the panel in mm.	Height x width x Depth 2312 mm x 600 mm x 600 mm
	b. Thickness of sheet metal in mm	
	Front	3 mm
	Sides, Top and rear	3 mm
	Rear : (i) Sheet above door	2 mm
	(ii) Door	3 mm
	c. Dimension of base support frame in mm	100 mm x 50 mm x 50 mm
	(ii) Thickness of base frame mm	3 mm
	d. Colour shade	IS 631
	(i) Exterior finish	Light Grey
	(ii) Interior finish	White
	(iii) Base frame	Black
	e. Materials of wire mesh for the louvers	Brass
	f. Whether detachable gland plate in two halves provided at bottom	Yes.
	f. Whether door with lift off hinges provided for the rear with built in locking system	Yes

	g. Whether panel designation label is provided	Yes
3.	SWITCH BOARD WIRING	
	a. Power frequency high voltage insulation level of panel	2 KV 50 HZ for one minute.
	b. Sizes of 1100V grade PVC insulated electrolytic grade flexible stranded copper wires in sq.mm.	Multi standard copper wire as per IS.
	CIRCUITS	
	(i) D.C. Distribution	10 Sq.mm.
	(ii) D.C. Annunciation / Control	2.5 Sq.mm.
	(iii) AC (230 V)	2.5 Sq.mm
	(iv) Earthing	
	(v) Size of electrolytic grade copper flat for DC positive and negative bus bars in mm	25 x 6 mm Length not less than 500 mm
	(vi) Size of electrolytic grade copper flat for earth bus in mm	25 x 3 mm
	(vii) Type of terminal provided	High dielectric phenolic moulded with insulation barrier with stud and nut type.
4.	VOLTMETER	
	a. Make	AE/IMP/Nippon/Meco.
	b. Type	Flush mounting type.
	c. Accuracy class	Class 1.0.
	d. Maximum scale range	0-150 v
	e. Rating	Continuous
	f. Size	144 mm x 144 mm
5.	D.C. EARTH LEAKAGE RELAY	
	a. Make	EE make CAEM 21 Type/ER/Schneider to ISS 3231/1965
	b. Type	Panel Mounted
	c. Rating	1 mA to 5 mA, 220V DC
	d. No. of N/O & N/C contacts	2 NO + 2 NC

	e. Minimum – Maximum settings provided for operation of relay in milli Amps	25 – 0 – 25 mA
	f. Value of mA setting in each step	Continuously adjustable with graduation at 1,2,3,4,5 milli amps.
	g. Normal condition current drain in milliamps	Nil.
	h. Whether there is any null region of operation in sensing any portion of earth leakage	Yes.
6.	VOLTAGE RELAY	
	(i) D.C. UNDER VOLTAGE RELAY	Protection Relays shall be of Numerical type and preferably ABB/Siemens/GE
	(a) Make	
	(b) Type	Panel Mounted
	© Rating	220V DC
	(d) No. of N/O & N/C contacts	2 NO + 2 NC
	(e) % setting range provided	Variable setting 5% step between 80 to 100%.
	(f) % variation to each step	5%
	II. D.C. OVER VOLTAGE RELAY	Protection Relays shall be of Numerical type and preferably ABB/Siemens/GE
	(a) Make	
	(b) Type	Panel Mounted
	© Rating	220 V DC
	(d) No. of N/O & N/C contacts	2 NO + 2 NC
	(d) % setting range provided	100% to 120%
	(f) % Variation to each step	5%
7.	AC Under Voltage Relay	

	(a) Make	Protection Relays shall be of Numerical type and preferably ABB/Siemens/GE
	(b) Type	Panel Mounted
	© Rating	230 V AC
	(d) No. of N/O & N/C contacts	2 NO + 2 NC
	(e) % setting range provided	80% to 100%
	(f) % Variation to each step	5%
8.	PUSH BUTTON	
	(i) Positive to Earth	
	(a) Type	Flush Mounting Type.
	(b) Make	Captron/Vishnow/TC/Flush Red.
	© Colour of Push Button	Black
	(d) Type of operating knob	Flush Type
9.	Whether internal wiring conform to relevant IS.	Yes.
10.	Whether industrial Siren is provided.	To be provided.
11.	Whether Pip-Pip Horn is provided.	To be provided.
12.	Whether testing facility is provided to check the operation of the DC earth fault relay.	To be provided.
13.	Rating of space heater	60 W 230 V AC
14.	Whether No. of HRC fuses as per specification.	To be provided.
15.	Whether AC and DC terminals kept separate	Yes.

SECTION - 5

CHECK LIST FOR LT SWITCHGEAR

Put a tick mark (✓) on 'YES' if the specified requirement is met, or put a tick mark on 'NO', if the specified requirement is not met and give comments in the "Remarks" column.

S. No.	Parameters	Data	YES/NO	Remarks
1.	Applicable Standards	IS 8623, IS 13947 PART II, IEC 60255, IS 2026	YES/NO	
2.	Type of Boards	Metal enclosed, indoor floor mounted, compartmentalized double front construction and free standing	YES/NO	
3.	Module type	All modules shall be fixed type except Air Circuit Breaker module, which shall be draw out type	YES/NO	
4.	Ingress Protection requirement	Shall be as per clause 1.1.5 of Section 2	YES/NO	
5.	Lightning Transformer	Not Applicable	NA	
6.	Special tools & tackles	List of special tools and tackles (which are proprietary in nature) is attached	YES/NO	
7.	Addition / deletion	Bidder has quoted addition/ deletion prices for each and every type of complete module (defined in Annexure-A, Section-1)	YES/NO	
8.	Analogue Input for SAS interface	Bidder shall offer in line with clause 2 of Section-1	YES/NO	
9.	Digital Input for SAS interface	Bidder shall offer in line with clause 2 of Section-1	YES/NO	
10.	Confirmation to the minimum indicative requirement of Analog signals, Potential Free contacts & Command signals.	This should be available at respective equipment for remote indication & control from Auxiliary BCU located in S/s control room	YES/NO	
11.	Loose supply of CT for DG set AMF panel	3 nos. CTs (800/1A, class -1) located in DG set AMF panel for differential protection of DG set shall be in bidder scope of supply	YES/NO	
12.	Additional spare auxiliary contact	Additional spare auxiliary contact for all MCB/MCCB/ACB/Switch (i.e. incomer, outgoing and bus coupler) as per SLD drawing no. TB-2-399-316-009 (A), (B) &(C), Rev-0 shall be provided for <u>ON /OFF status and trip alarm in SAS.</u> These Additional Spare auxiliary contact for group alarm shall be wired up to TB of individual board by the LT ACDB & DCDB supplier.	YES/NO	
13.	Un-priced BOQ	As per cl. No. 3, Section-1 of technical	YES/NO	

		specification		
14.	Whether OGA drawing and scheme of LT AC & DC board enclosed	Enclosed	YES/NO	
15.	Bidder to comply requirements as per technical specification	Complied	YES/NO	
16.	Bidder will be responsible of getting drawing approval from customer	Yes	YES/NO	
17.	All valid Type test reports as per clause no. 4, Section -1 are available	Yes, available	YES/NO	
18.	Conduction of type test (if any)	If type test reports are not acceptable to Customer/BHEL then above tests shall be conducted by the bidder without cost and delivery implication to BHEL	YES/NO	

Date:
Place:
Phone:
Fax:
E-mail:
Mobile:

SECTION - 6
SCHEDULE OF TECHNICAL DEVIATIONS

Bidder shall list below all technical deviation clause wise w.r.t. tender specifications:

S.No.	Page No.	Clause No.	Deviation	Reason / Justification
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Any deviation not specifically brought out in this section shall not be admissible for any commercial implication at later stage. Except to the technical deviations listed in this schedule, bidder's offer shall be considered in full compliance to the tender specifications irrespective of any such deviation indicated / taken elsewhere in the submitted offer.

Date:

Tenderer's Stamp & Signature