

**STANDARD NOTES FOR SCOPE OF T&C**

Sl. No.	DESCRIPTION
1	Brief scope of Testing & Commissioning agency work shall include all tests as per Technical Specifications / Indian Standards, including but not limited to verification of erection/ installation of associated systems/ equipment and carrying out the testing & commissioning work to the satisfaction of BHEL/ Customer as per approved FQP and indicatives list of Tests as per specification.
2	All safety rules and codes applied by the Customer/BHEL at site shall be followed by the contractor without exception. The contractor shall be responsible for the safety of the equipment/material and works to be performed by him and shall maintain other protection necessary for the purpose. Contractor shall also take such additional precautions as may be indicated from time to time by the Engineer with a view to prevent accidents, fire hazards. Due precautions shall be taken against fire hazards and atmospheric conditions.
2	Following Manpower shall be provided by Erection Agency for T&C Work. All other manpower is in scope of bidder. i) Electricians ii) Fitters iii) Welders
3	Following T&P shall be provided by Erection Agency for T&C Work. i) 80feet Manlift ii) Farana
4	Bidders to assess the requirement of tools & tacks/testing instrument required for complete scope of T&C Work. Cost of the same shall be inclusive of unit rate. Any additional cost of Tools/testing instrument shall not be payable. Indicative list is given in Annexure-A & B.
5	Automatic Relay Test Kit along with Laptop and Testing engineer shall be provided by OEM . (NOT in Bidder's scope). Necessary manpower support, tools, tackles, wiring, BUS wiring and other testing equipment to be in scope of Bidder
6	Power Supply for testing & Commissioning work shall be provide by Erection Agency.
7	All pre/commissioning activities for substation equipment shall be carried out in accordance "Pre- Commissioning procedures for Switchyard Equipments (Doc. No. D-2-01-03-01-03)".
8	Refer attached scope Matrix for detailed scope.

**Scope Matrix between Erection Agency and Testing & Commissioning Agency (Scope Matrix 1 of 3)**

Rev.0

Brief scope of Testing & Commissioning agency work shall include all tests as per Technical Specifications / Indian Standards, including but not limited to verification of erection/ installation of associated systems/ equipment and carrying out the testing & commissioning work to the satisfaction of BHEL/ Customer as per approved FQP and indicative list of Tests as mentioned below. The list is indicative only hence, any other test/ repetition of test, if required as per Customer TS/ IS / IEC / Site requirement shall be applicable and deemed to be included in the scope of Testing Agency).

SR_NO	Description_of_Item (testing and Commissioning)	BHEL / Customer	OEM	Erection Agency	Testing & Commissioning Agency
1	<b>Transformer / Reactor</b> with all accessories, fittings, control cabinets, Turret CT, Bushings, Online DGA, onlien Insulating oil drying system complete in all respect		Supervision shall be extended by OEM	Pre-Erection Tests, which includes the followings: -Core tank and limb isolation test using Megger - Transformer oil testing as per OEM recommendations - Turrent CT testing by CT analyser - Bushing Tan Delta mesurement - Dew Point Testing - Online Particle Test	Balance and Post-Erection Tests/Pre-Charging are to be carried out, which include but are not limited to the following: - Insulation Resistance (IR) testing at 5kV Megger -Capacitance & Tan Delta measurement on bushings -Turret CT testing: Complete CT testing using CT Analyzer -All pre-erection tests, during erection stage & insulation oil tests - Bushing Tan Delta measurement - Sweep Frequency Response Analysis (SFRA) - Magnetising current test - Core tank and limb isolation test using Megger - Ratio test - Polarity check - Magnetization characteristics - Checking of earthing - Dissolved Gas Analysis (DGA) - Dew point testing -Post Charging vibration measurement.
2	<b>Circuit Breaker with &amp; without closing resistor</b> (Remark - Supplier will bring Breaker timing kit and Gas leak detector only. Necessary manpower support, tools, tackles and testing kits is in the scope of ETC contractor).		Supervision shall be extended by OEM. OEM shall bring CRM Kit/ <b>Breaker timing kit</b> and Gas leak detector only.	Pre-Erection Tests, which includes the followings: - SF6 Gas Processing Unit shall be arranged by erection agency. - Insulation resistance (IR) test for Post Insulator - Dew Point measurement.	Balance and Post-Erection/Pre-Charging Tests are to be carried out, which include but are not limited to the following: - Insulation Resistance – CB contacts and control circuit - Functional checks - SF <sub>6</sub> gas dew point measurement - Auxiliary contacts (NO/NC) functional check - Dynamic contact resistance measurement (DCRM) with CB analyzer - Closing and opening time measurement - Speed curve analysis - Close/trip coil resistance measurement - Pick-up and drop-off test for coils - Motor resistance and operational check - Capacitance and tan delta test - Contact resistance test - Overall integration level test
3	<b>Isolator with &amp; without earth switch</b>		Supervision shall be extended by OEM	Pre-Erection Tests, which includes the followings: - Insulation resistance (IR) test for Post Insulator	Balance and Post-Erection/Pre-Charging Tests are to be carried out, which include but are not limited to the following: - Contact Resistance Measurement (CRM) - Timing test - Open/Close (OC/CC) pick-up test - Auxiliary NO/NC contact checking - Mechanical operation test - Motor operation and interlock check - IR measurement of motor windings - Auxiliary contact function checks

**Scope Matrix between Erection Agency and Testing & Commissioning Agency (Scope Matrix 1 of 3)**

Rev.0

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SR_NO	Description_of_Item (testing and Commissioning)	BHEL / Customer	OEM	Erection Agency	Testing & Commissioning Agency
4	<b>CT - Current Transformer</b>			Pre-Erection Tests, which includes the followings: - Oil Level / Nitrogen pressure checking - Insulation resistance (IR) test - SF6 pressure and dew point (if applicable) - CT oil BDV	Balance and Post-Erection/Pre-Charging Tests are to be carried out, which include but are not limited to the following: (To be done with Automatic CT analyser only) - Ratio test - Winding resistance test - Capacitance and tan delta test - Knee point voltage testing - Polarity check - Magnetization characteristics test - Dissolved Gas Analysis (DGA) (if required) - CT Primary Injection Test with primary injection Kit
5	<b>CVT - Capacitive Voltage Transformer</b>			Pre-Erection Tests, which includes the followings: - Oil Level / Nitrogen pressure checking - Insulation resistance (IR) test - Earth resistance with and with out grid - CVT oil BDV	Balance and Post-Erection/Pre-Charging Tests are to be carried out, which include but are not limited to the following: - Ratio test (To be done with automatic ratio test kit only like CPC100) - Polarity check - IR measurement - Phasing test - Tan delta test - Capacitance measurement (Individual stack as well as complete assembly) - Secondary wiring checks - Winding resistance test
6	<b>Surge Arrester</b>			Pre-Erection Tests, which includes the followings: - Insulation resistance (IR) test for individual stack - Earth resistance with and with out grid	Balance and Post-Erection/Pre-Charging Tests are to be carried out, which include but are not limited to the following: - Leakage current counter testing - tan delta testing - Capacitance Measurement of individual stacks and complete assembly - Third harmonic resistive current Measurement - Insulation Resistance (IR) test
7	<b>Line Trap</b>			Pre-Erection Tests, which includes the followings: - Insulation resistance (IR) test of Post Insulator	Balance and Post-Erection/Pre-Charging Tests are to be carried out, which include but are not limited to the following: - Insulation resistance (IR) test - Inductance and capacitance measurement for tuning circuit
8	<b>LT Transformer</b>			Pre-Erection Tests, which includes the followings: - Transformer oil testing including processing of oil, if required	Balance and Post-Erection/Pre-Charging Tests are to be carried out, which include but are not limited to the following: - Winding resistance Test - Polarity Test - Magnetizing Current Test - Insulation Resistance Test - Ratio Test - Hi pot of HV cable , if applicable
9	<b>415V Main Switchboard</b>			Pre-Erection Tests, which includes the followings: - Insulation resistance (IR) test	Balance and Post-Erection/Pre-Charging Tests are to be carried out, which include but are not limited to the following: - Complete testing and Scheme Checking including CT, PT, VCB/ ACB/ MCB and Numeric Relay Testing - Insulation resistance (IR) test - Bus joint contact resistance

**Scope Matrix between Erection Agency and Testing & Commissioning Agency (Scope Matrix 1 of 3)**

Rev.0

Brief scope of Testing & Commissioning agency work shall include all tests as per Technical Specifications / Indian Standards, including but not limited to verification of erection/ installation of associated systems/ equipment and carrying out the testing & commissioning work to the satisfaction of BHEL/ Customer as per approved FQP and indicative list of Tests as mentioned below. The list is indicative only hence, any other test/ repetition of test, if required as per Customer TS/ IS / IEC / Site requirement shall be applicable and deemed to be included in the scope of Testing Agency).

SR_NO	Description_of_Item (testing and Commissioning)	BHEL / Customer	OEM	Erection Agency	Testing & Commissioning Agency
10	415V AC Distribution Board (ACDB)			Pre-Erection Tests, which includes the followings: - Insulation resistance (IR) test	Balance and Post-Erection/Pre-Charging Tests are to be carried out, which include but are not limited to the following: - Complete testing and Scheme Checking including CT, PT, VCB/ ACB/ MCB and Numeric Relay Testing - Insulation resistance (IR) test - Bus joint contact resistance
11	415V MLDB along with Isolation transformers			Pre-Erection Tests, which includes the followings: - Insulation resistance (IR) test	Balance and Post-Erection/Pre-Charging Tests are to be carried out, which include but are not limited to the following: - Complete testing and Scheme Checking including CT, PT, VCB/ ACB/ MCB and Numeric Relay Testing - Insulation resistance (IR) test - Bus joint contact resistance
12	415V Emergency Lighting DB along with Isolation Transformer			Pre-Erection Tests, which includes the followings: - Insulation resistance (IR) test	Balance and Post-Erection/Pre-Charging Tests are to be carried out, which include but are not limited to the following: - Complete testing and Scheme Checking including CT, PT, VCB/ ACB/ MCB and Numeric Relay Testing - Insulation resistance (IR) test - Bus joint contact resistance
13	DC DISTRIBUTION BOARD			Pre-Erection Tests, which includes the followings: - Insulation resistance (IR) test	Balance and Post-Erection/Pre-Charging Tests are to be carried out, which include but are not limited to the following: - Complete testing and Scheme Checking including CT, PT, VCB/ ACB/ MCB and Numeric Relay Testing - Insulation resistance (IR) test - Bus joint contact resistance
14	BATTERY		Supervision shall be extended by OEM	Manpower & Electrician support including testing instruments Multimeter, Megger, DC clamp on meter etc. - Arrangement and manpower for 24x7 Charging-discharging cycle (3 charging-2 discharging cycle per battery bank)	
15	BATTERY CHARGER		Supervision shall be extended by OEM	Manpower & Electrician support including testing instruments Multimeter, Megger etc. -Manpower and arrangement for Load Tests of battery bank	
16	BMK, CTJB, CVT JB			Pre-Erection Tests, which includes the followings: - Insulation resistance (IR) test	Balance and Post-Erection/Pre-Charging Tests are to be carried out, which include but are not limited to the following: - Complete testing and Scheme Checking - Insulation resistance (IR) test - Function test
17	String Insulator & Hardware			Pre-Erection Tests, which includes the followings: - Insulation resistance (IR) test	
18	LT POWER AND CONTROL CABLE			Pre-Erection Tests, which includes the followings: - Insulation resistance (IR) test -Contnuity test	
19	AI Tube (CRM testing of contact post installation, and CRM testing of the joint pre-installation after welding)			Pre-Erection Tests, which includes the followings: - Contact Resistance Measurement of all connection - die penetration test, - radiography (x-ray and gama ray) test	

**Scope Matrix between Erection Agency and Testing & Commissioning Agency (Scope Matrix 1 of 3)**

Rev.0

Brief scope of Testing & Commissioning agency work shall include all tests as per Technical Specifications / Indian Standards, including but not limited to verification of erection/ installation of associated systems/ equipment and carrying out the testing & commissioning work to the satisfaction of BHEL/ Customer as per approved FQP and indicative list of Tests as mentioned below. The list is indicative only hence, any other test/ repetition of test, if required as per Customer TS/ IS / IEC / Site requirement shall be applicable and deemed to be included in the scope of Testing Agency).

SR_NO	Description_of_Item (testing and Commissioning)	BHEL / Customer	OEM	Erection Agency	Testing & Commissioning Agency
20	<b>Resistance Measurement</b> -Earth Resistance Measurement of Main Earthgrid, Pipe & Rod electrodes etc -Contact Resistance Measurement			-Earth Resistance Measurement of Main Earthgrid, Pipe & Rod electrodes, etc -Earth Resistance Measurement of LA/CVT/PT/Tower as applicable etc. -Contact Resistance Measurement of all Connections (Al Tube/Conductor etc)	
21	Testing of PLCC system equipments (except wave traps): (Supervision of Testing will be done by OEM).		All Test in OEM Scope.		Testing agency shall coordinate with OEM for smooth conduction of test. Manpower & Electrician support including testing instruments Multimeter, Megger etc.
22	<b>Testing &amp; Commissioning of S/S bays including wiring check, scheme checking, support to OEM for CRP, SAS, FOTE, operation &amp; interlock, ladder logic, current circuit &amp; voltage circuit testing, readiness for commissioning.</b>				
22.1	765kV Bays		Relay test Kit & Relay Testing in OEM scope		Complete testing and Scheme Checking including arrangement of Manpower & Electrician support including testing instruments Multimeter, Megger etc.
22.2	765kV 1 Phase (spare bay)		Relay test Kit & Relay Testing in OEM scope		Complete testing and Scheme Checking including arrangement of Manpower & Electrician support including testing instruments Multimeter, Megger etc.
22.3	400kV Bays		Relay test Kit & Relay Testing in OEM scope		Complete testing and Scheme Checking including arrangement of Manpower & Electrician support including testing instruments Multimeter, Megger etc.
22.4	220kV Bays		Relay test Kit & Relay Testing in OEM scope		Complete testing and Scheme Checking including arrangement of Manpower & Electrician support including testing instruments Multimeter, Megger etc.
22.5	72.5kV Bay		Relay test Kit & Relay Testing in OEM scope		Complete testing and Scheme Checking including arrangement of Manpower & Electrician support including testing instruments Multimeter, Megger etc.
22.6	33kV Bay		Relay test Kit & Relay Testing in OEM scope		Complete testing and Scheme Checking including arrangement of Manpower & Electrician support including testing instruments Multimeter, Megger etc.
22.7	CSD		Relay test Kit & Relay Testing in OEM scope		Complete testing and Scheme Checking including arrangement of Manpower & Electrician support including testing instruments Multimeter, Megger etc.

Note:

- 1 The test to be carried out shall be done as per approved FQP/Technical Specifications.

Scope Matrix between Erection Agency and Testing & Commissioning Agency (Scope Matrix 2 of 3)					Rev.0
Sl. No.	Description	BHEL	OEM	Erection Agency	Testing & Commissioning Agency
1	Availability of all the testing equipment's as per Annexure of required capacity having valid calibration certificate 1. Specific Testing Equipment (Annex-A), 2. General Testing Equipment (Annex-B), to be retained at site through out the course of execution of work at site.				√
2	Availability of all the testing equipment's as of required capacity having Valid calibration certificate for the pre erection test is under scope of erection bidder			√	
3	Scheme interface checking between equipment like Circuit Breaker, CT, CT JB, PT JB, Isolator, C & R panel etc.				√
4	Relay setting calculation for Auxillary Relay	√			
5	Relay setting calculation for Main Relays	√			
6	Testing of numerical relays with test kit (the scope includes relay test kit supply at site for testing) <u>* Relay Test Kit shall be in the scope of Testing &amp; Commissioning Agency for BHEL make Panels. Other than BHEL make panel it shall be in OEM Scope.</u>		√		√
7	Preparation of Reports in BHEL/Customer approved Format and submission to the Customer			√	√
8	ERECTION PROTOCOL			√	
9	TESTING and COMMISSIONING PROTOCOL				√
a	OEM PROTOCOL (Scope of OEM)	√	√		
b	Necessary correction & preparation of 'As-Built' cable schedule				√
c	Assistance/Skilled manpower support for Testing and Commissioning Work			√	
9	Safety Compliance of testing & commissioning according to the BHEL/CUSTOMER standard				√
10	Workmen (of Testing Agency) compensation insurance				√
11	Arrangement for Access to the equipment to be tested			√	
12	Accommodation, fooding & Local conveyance for testing team				√
13	Arrangement of Gate Pass for testing team	√			√
14	Extension of Power Supply to the Equipment Testing Activities from nearby available power source to Testing Agency			√	
15	Preparation and submission of hand corrected 'As-Built' drawing (min 3 set/copies)				√
16	Facility arrangement				
17	Sitting Arrangement including one table & two chair	√			
18	Storage of testing equipment	√			√
19	Watch and Ward of Erection\Erected Material			√	
20	Site In charge/Co-ordinator for co-ordination/Planning of resources/T&P for testing work at site				√
21	Laisoning for Electrical Charging clearance from Statutory Authority			√	

Note :

- 1 Joint Verification for manpower and resources: The JMC for activities having involvement of Erection, Testing & Commissioning agencies is applicable shall be signed/verified by all three parties (BHEL, Erection Agency and Testing & Commissioning agency).
- 2 Multiple mobilisation: The multiple mobilization has been envisaged for testing & commissioning work at site, and price in BOQ are with consideration of multiple mobilization for lot/individual items.
- 3 Checklist prior to mobilisation of Testing Agency: The check list along with requisite input to commence testing work shall be provided by site (Jointly signed by BHEL, Erection Agency and Incharge/Co-ordinator of testing agency) to testing & Commissioning agency prior to mobilization of T&P at site.
- 4 The Site in charge/Co-ordinator of testing agency shall be deployed at site in advance stage, and shall co-ordinate all necessary inputs as per Project/BHEL requirement at site.

**Scope matrix between OEM and Testing & Commissioning Agency (Scope Matrix 3 of 3)**

SYSTEM	EQUIPMENT/ SUB SYSTEM	TESTING & COMMISSIONING REQUIREMENT	TESTING & FINAL COMMISSIONING REQUIREMENT	SCOPE OF WORK	
				OEM of Equipment/ Package	TESTING AGENCY
CRP	BUS WIRING	BUS WIRING CONNECTION AS PER SCHEME			√ (wiring schedule will be provided by BHEL)
	STANDALONE & SCHEME CHECKING	EACH CRP STANDALONE WIRING CHECKING			√ (01 set hard copy of Scheme will be provided by BHEL)
	PLCC/FOTE	Testing of system (excluding manpower support)		√	√
		Testing of system (manpower support i.e Testing Engineer & Technician)			√
	PMU	Testing of system (excluding manpower support)		√	√
		Testing of system (manpower support i.e Testing Engineer & Technician)			√
	RELAY	RELAY CONFIGURATION, RELAY TESTING SAS INTEGRATION (as per customer check list and Technical Specification)		√	√
		Relay functional check with system (manpower support i.e Technician)			√
OUTDOOR	CT	CT TEST BY OMICRON(OR EQUIVALENT) CT ANALYSER	PRIMARY INJECTION, POLARITY & CORE IDENTIFICATION AT FINAL STAGE SEPARATELY		√
	CVT/PT/EMVT	CVT/PT/EMVT Testing	Secondary injection and phasing out at final stage		√
	CB	Complete CB testing as per approved FQP/TS		√	√
	CB-CSD	CSD FOR Circuit Breaker (excluding manpower support)		√	
		Testing of system (manpower and test instrument support i.e Technician and Omicron 356 or equivalent kit)			√
	LA	Complete LA testing as per approved FQP/TS			√
	ISO/ES	Complete testing as per approved FQP and Technical Specification.		√	√
WAVE TRAP	INSULATION RESISTANCE AND INDUCTANCE TESTING/ VERIFICATION.			√	
Battery Chargers	220V and 48V Battery Charger	Support to OEM for testing and Commissioning (manpower support i.e Technician/T&P).		√	As per scope matrix 1 of 3, these are under erection agency)
Battery Bank	220V and 48V Battery Bank	Support to OEM for testing and Commissioning (manpower support i.e Technician T&P).		√	
LT Switchgear	Complete AC LT Switchgear	ACDB: Complete testing as per approved FQP including aux. relays, bus change over scheme.		√	√
	Complete DC LT Switchgear	DCDB: Complete testing as per approved FQP		√	√
MK	MK	Complete testing work, Power & Control block			√

BHMS	Battery Health Monitoring System	Support to OEM for testing and Commissioning.(manpower support i.e Technician T&P).		√	√
REACTOR/ICT/ST	ONLINE DGA	Support to OEM for testing and Commissioning.(manpower support i.e Technician T&P).		√	√
REACTOR/ICT/ST	ONLINE DRYOUT SYSTEM	Support to OEM for testing and Commissioning.(manpower support i.e Technician T&P).		√	√
REACTOR/ICT/ST	ONLINE PD MONITORING	Support to OEM for testing and Commissioning.(manpower support i.e Technician T&P).		√	√
REACTOR/ICT/ST	ONLINE TEMPERATURE	Support to OEM for testing and Commissioning.(manpower support i.e Technician T&P).		√	√
REACTOR/ICT/ST	ONLINE BUSHING MONITORING	Support to OEM for testing and Commissioning.(manpower support i.e Technician T&P).		√	√
DG		Support to OEM for testing and Commissioning.(manpower support i.e Technician T&P).		√	√
		Testing of CT, if any			√
AUX Transformer		Complete testing as per approved FQP and Technical Specification.			√

NOTE:

1. The package item including Illumination , Fire Fighting, Air Conditioning & Ventillation System etc. Shall be dealt as per its PO and hence same is not included here.
2. Fuel for DG commissioning is not in scope of vendor.

**Annexure-A: Special Tool & tackles and testing instruments to be arranged by Testing Agency**

<b>C. Special Test Instruments</b>		<b>Unit</b>
1	CB Operational Analyser (with graphical result) with DCRM	1
2	Testing of CB with Operational Analyser (with graphical result) without DCRM	1
3	Variable frequency Automatic Capacitance & Tan Delta test Kit	1
4	Automatic Relay Test kit Omicrom CMC 356 or equivalent	1
5	Sweep Frequency Response Analysis (SFRA Kit)	1
6	Oil BDV kit	1
7	PPM test kit	1
8	On line particle test kit	1
9	Automatic CT testing Kit	1
10	Automatic CVT ratio testing Kit	1
11	Dew point meter	1
12	Automatic Transformer/Reactor Winding res measurement kit (25-50A)	1
13	Automatic Trafo/Reactor Ratio measurement kit	1
14	Battery Discharging Resistor	1
15	Hi-pot kit (60/75KV ac)	1
16	Thermo Vision Camera	1
17	Third harmonics current measurement kit	1
18	RLC bridge (inductance measurement)	1
19	Single Phase variac	1
20	5kV/1kV Insulation Tester	1

Notes:

1. The above tools & tackles To be brought by testing agency on returnable basis only.
2. The above list is only indicative and any other test instrument, required for completion of testing activities complete in all reaspect shall be included in bidder's scope.

**Annexure-B: General Tool & tackles and testing instruments to be arranged by Testing Agency**

Sl. No.	Description	Unit
<b>A. Workman Compulsory Tool Kit (per team)</b>		
1	Allen Key Set	1
2	Screw driver Set	1
3	Continuty Tester	
3	Wire Stripper	1
4	Crimper	1
5	Banana clip	1
6	Crocodile clip	6
<b>B. General Test Equipments</b>		
1	Analog multimeter	1
2	Digital multimeter	2
3	Clamp on meter 0-3000A	1
4	Leakage current meter (0-1A)	2
5	Variable DC power pack (0-20A)	1
6	Earth Resistance meter	1
7	SF6 Gas leakage detector	1
8	Automatic Transformer/Reactor Winding res measurement kit (25-50A)	1
9	Contact Resistance meter (200A DC)	1
10	Automatic Trafo/Reactor Ratio measurement kit	1
11	Digital megger (500V-5KV)	1
12	Phase sequence meter	1
13	LAN tester (for checking healthiness of ethernet cable crimping)	1

Note:

1. The above tooles & tackles To be brought by testing agency on returnable basis only.
2. The above list is only indicative and any other test instrument, required for completion of testing activities complete in all reaspect shall be included in bidder's scope.

DRG. NO. TB-1-431-510-001

# INDEX

**DESCRIPTION** **SHEET**

**SINGLE LINE DIAGRAM FOR 765KV  
MANDSAUR S/S** **1**

**BOQ & TECHNICAL PARAMETERS  
765KV S/S** **2**

**ARRANGEMENT OF AUX BUS FOR  
ICT 765/400KV MANDSAUR S/S** **3**

**ARRANGEMENT OF AUX REACTOR  
765/400KV MANDSAUR S/S** **4**

**SINGLE LINE DIAGRAM FOR 400KV  
MANDSAUR S/S** **5**

**SINGLE LINE DIAGRAM FOR 220KV  
MANDSAUR S/S** **6**

NOA NO. : CC/TW-AIS/DOM/A06/23/11955/NOA-1/24-108670/01 & NOA-2/24-108670/02 Dated 09/07/2024	
ADDITIONAL INFORMATION W.O.No.	ग्राहक/परियोजना का नाम POWERGRID CORPORATION OF INDIA LTD. NAME OF CUSTOMER/CONSULTANT:- ESTABLISHMENT OF 3X1500MVAR, 765/400KV AND 5X500MVA, 400/220KV MANDSAUR POOLING STATION ALONG WITH NAME OF PROJECT:- 2X330MVAR (765KV) BUS REACTOR AND 2X125MVAR 420KV BUS REACTOR.
STATUS OF DRAWING	
DISTRIBUTION OF PRINTS	
विभाग DEPT.	अनुपात / SCALE
कोड CODE	कार्ड कोड CARD CODE
शीर्षक/TITLE	सिंगल लाइन डायग्राम फॉर मंडसावर एस/एस
ड्राइंग. क्र./DRAWING NO.	पुनः/REV.
TB-1-431-510-001	03
पृष्ठ क्र./SHEET No. --	अगला पृष्ठ/NEXT SHEET 01

REV.	DATE	ALTERED	PC	REV.	DATE	ALTERED	PC	REV.	DATE	ALTERED	PC	REV.	DATE	ALTERED	PC
04	04-12-25	CHECKED	JK	03	24-01-25	CHECKED	JK	02	14-11-24	CHECKED	JK	01	06.11.24	CHECKED	JK
		APPROVED	VK			APPROVED	VK			APPROVED	VK			APPROVED	VK
ZONE	ADDITIONAL REQUIREMENT OF 400KV CSD (05NOS.) VIDE EMAIL DTD:29.10.25			ZONE	AS PER POWERGRID COMMENTS VIDE EMAIL DTD:24.01.25			ZONE	AS PER POWERGRID COMMENTS			ZONE	REVISED IN LINE WITH OGA		

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COMPUTER DRG. PATH NAME :

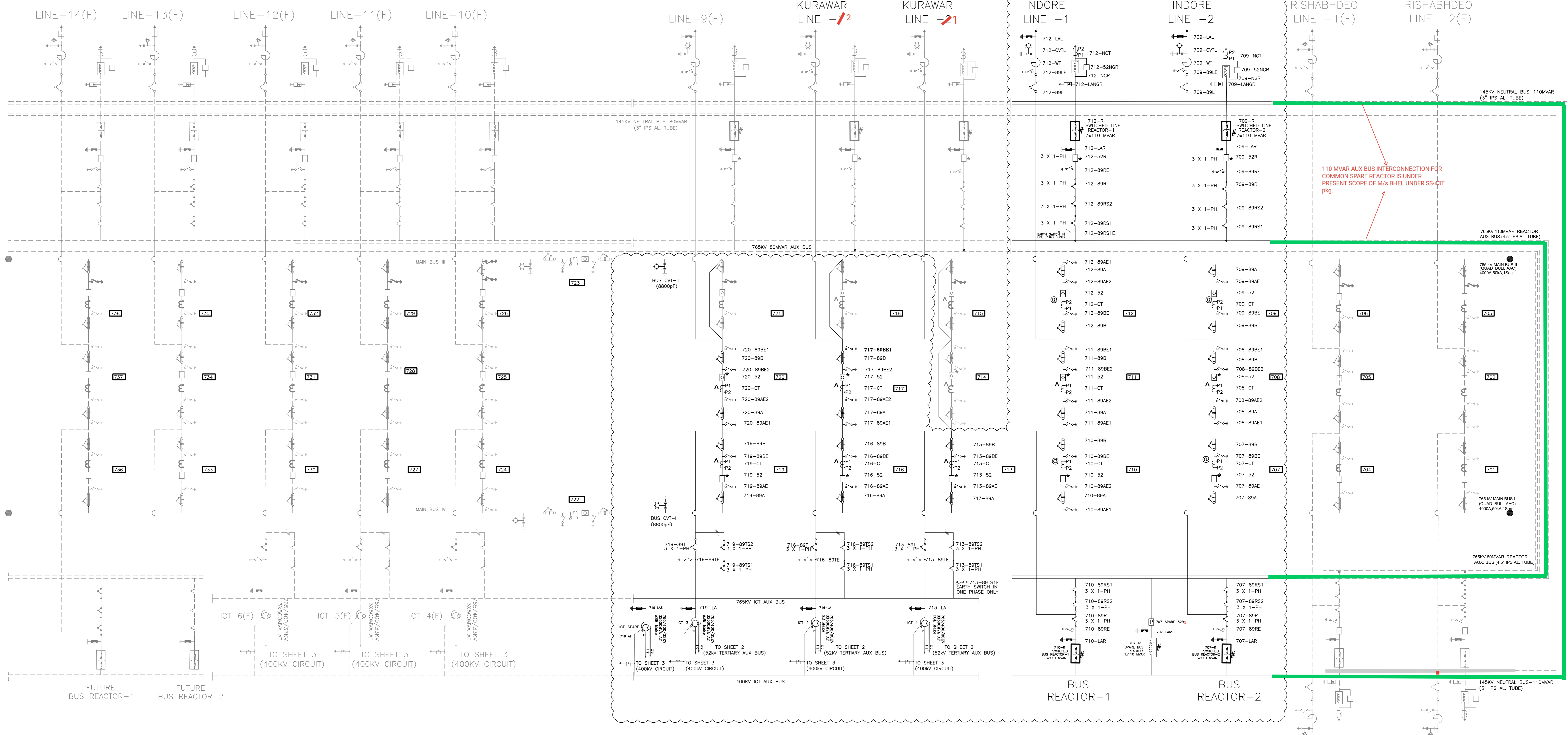
REF. DRG. NO.

SIGN. AND DATE

INVENTORY NO

DRG. NO. TB-1431-510-001

SCOPE UNDER 43T  
MANDSAUR (NEW)



110 MVAR AUX BUS INTERCONNECTION FOR COMMON SPARE REACTOR IS UNDER PRESENT SCOPE OF M/S BHEL UNDER SS-43T pkg.

NOTES:-  
1. SYSTEM 765kV, 50kA FOR 1 SEC., 50Hz, 3Ph, SOLIDLY EARTHED  
2. PRESENT FUTURE

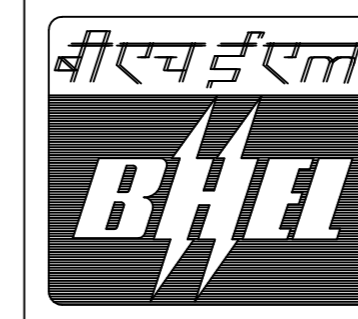
3. PHASE LOCATION OF WAVE TRAPS TO BE DECIDED DURING DETAILED ENGINEERING  
4. 765kV EQUIPMENTS FOR ICT AND REACTOR SWITCHING ARE ALSO INCLUDED IN THE BOQ OF QTY. FOR 765kV MAIN EQUIPMENTS.

NOTE : NO COMMERCIAL SETTLEMENT APPLICABLE. COMPLETE AUX BUS CONNECTION FOR 110 MVAR REACTOR ( AS MARKED IN SLD) IS UNDER PRESENT SCOPE OF BHEL. FURTHER ALL GANTRIES SHALL BE PROVIDED FOR COMPLETE CONNECTION OF THE BAYS UNDER PRESENT SCOPE TO MAIN BUSES.

NOA NO. : CC/T/W-AIS/DOM/A06/23/11955/NOA-1/24-108670/01 & NOA-2/24-108670/02 Dated 09/07/2024

ADDITIONAL INFORMATION W.O.No.  
STATUS OF DRAWING  
DISTRIBUTION OF PRINTS

ग्राहक/परियोजना का नाम POWERGRID CORPORATION OF INDIA LTD.  
NAME OF CUSTOMER/CONSULTANT: ESTABLISHMENT OF 3X1500MVAR, 765/400KV AND 5X500MVA, 400/220KV MANDSAUR POOLING STATION ALONG WITH 2X330MVAR (765KV) BUS REACTOR AND 2X125MVAR 420KV BUS REACTOR.  
NAME OF PROJECT:-



भारत हेवी इलेक्ट्रिकल्स लिमिटेड  
Bharat Heavy Electricals Ltd.  
TRANSMISSION PROJECTS DIVISION

क्रमांक / NAME	हस्ता /SIGN.	दि./DATE
कनारा / PC	-SGD-	30.08.24
जांचा / JK	-SGD-	30.08.24
स्वीकृत / VK	-SGD-	30.08.24

REV.	DATE	ALTERED	PC	REV.	DATE	ALTERED	PC	REV.	DATE	ALTERED	PC
03	24-01-25	CHECKED APPROVED	JK VK	02	04-01-25	CHECKED APPROVED	JK VK	01	14-11-24	CHECKED APPROVED	JK VK
ZONE	AS PER POWERGRID COMMENTS VIDE EMAIL DTD:24.01.25			ZONE	AS PER POWERGRID COMMENTS			ZONE	AS PER POWERGRID COMMENTS		

विभाग DEPT. अनुपात / SCALE कार्ड कोड / CARD CODE  
कोड CODE  
शीर्षक/TITLE SINGLE LINE DIAGRAM FOR 765kV MANDSAUR S/S  
ड्राईंग.क./DRAWING NO. TB-1431-510-001 पुनः/REV. 03  
पृष्ठ क./SHEET No. 01 अगला पृष्ठ/NEXT SHEET 02

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COMPUTER DRG. PATH NAME :

REF. DRG. NO.

SIGN. AND DATE

INVENTORY NO

100-015-51-13-1-1-1-1

2

3

4

5

6

7

8

DRG. NO.

BILL OF QTY. FOR 765KV MAIN EQUIPMENTS:

Table with columns: SL.NO., DESCRIPTION, RATING, S. C. RATING, NOA QTY. (NO.), SLD QTY. (NO.), SYMBOL, SCOPE OF SUPPLY, LEGEND, MAKE. Includes items like 500 MVA AUTOTRANSFORMER, SF6 CIRCUIT BREAKER, ISOLATOR, etc.

800KV CT DETAILS

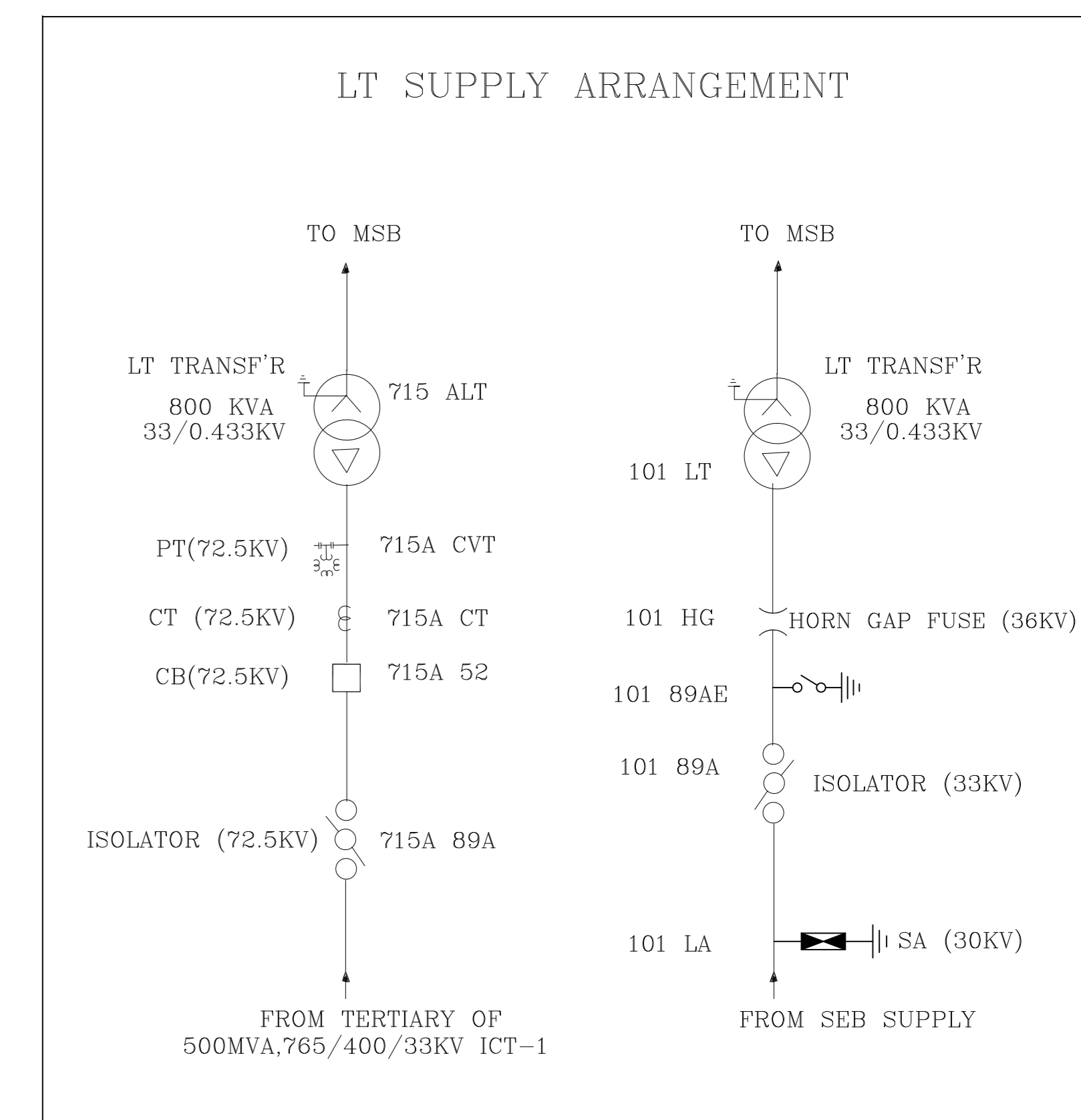
Table with columns: CORE, CURRENT RATIO, ACCURACY CLASS, OUTPUT BURDEN (VA), MIN KPV (V), MAX RCT (OHMS), MAX IM AT KPV(MA), PURPOSE. Includes items for BUS DIFF. MAIN-1, MAIN-2, METERING, and TRAFO DIFF./LINE PROTN.

765KV CVT DETAILS

Table with columns: APPLICATION, PRIMARY (KV), SECONDARY (KV), OUTPUT (VA), ACCURACY. Includes PROTECTION and METERING details.

BILL OF QTY. FOR LT SUPPLY (BHEL'S SCOPE)

Table with columns: SL.NO., RATING, DESCRIPTION, SYMBOL, SLD QTY. (NO.), NOA QTY. (NO.), MAKE. Includes items like 72.5KV CIRCUIT BREAKER, ISOLATOR, CVT, LA, WT, and 800kVA LT TRANSFORMER.



ITEM SL NO. 8 IS INCLUDING CONTROLLED SWITCHING DEVICE.

# POWERGRID TO ISSUE SUITABLE BOQ AMMENDMENT FOR CHANGE IN QUANTITY

BILL OF QTY. FOR 132 & 33KV MAIN EQUIPMENTS:

Table with columns: SL.NO., DESCRIPTION, RATING, NOA QTY. (NO.), SLD QTY. (NO.), SYMBOL, SCOPE OF SUPPLY, LEGEND, MAKE. Includes SURGE ARRESTER, CURRENT TRANSFORMER, and CIRCUIT BREAKER.

72.5KV CT DETAILS

Table with columns: CORE, RATIO, APPLICATION, ACCURACY, OUTPUT BURDEN. Includes items for O/C & E/F and METERING.

72.5KV VT DETAILS

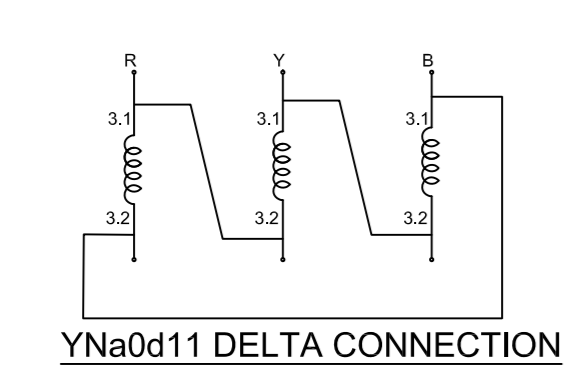
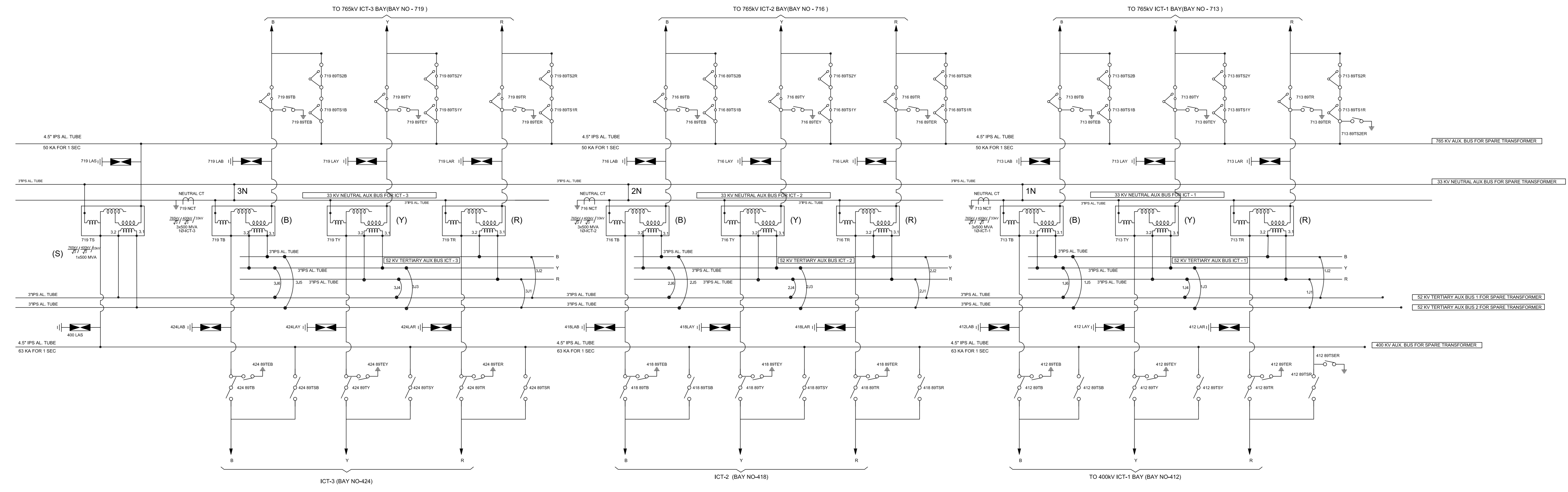
Table with columns: RATIO, CLASS, SEC-I, SEC-II. Includes CLASS-3P, 10VA and CLASS-0.5, 10VA.

Revision table and drawing information block containing revision dates, checked/approved names, drawing title 'SINGLE LINE DIAGRAM FOR 765KV MANDSAUR S/S', and drawing number 'TB-1431-510-001'.

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COMPUTER DRG. PATH NAME : REF. DRG. NO. SIGN. AND DATE INVENTORY NO

DRG. NO. TB-1-431-510-001



(ARRANGEMENT OF 765/400kV ICT AND AUX. BUS.)

MANUAL JUMPERING NEED TO BE DONE BETWEEN TERTIARY BUS AND AUX.TERTIARY BUS TO CONNECT THE SPARE TRANSFORMER IN PLACE OF FAULTY TRANSFORMER. WITH RESPECT TO PHASE (EITHER R-Y, Y-B, B-R) ONLY TWO CONNECTIONS TO BE MADE AT ANY TIME.

MANUAL JUMPERING NEED TO BE DONE BETWEEN NEUTRAL BUS AND AUX.NEUTRAL BUS. WHILE TAKING OUT ANY 1-PH AUTO TRANSFORMER FOR MAINTENANCE. ONLY ONE CONNECTION TO BE MADE AT A TIME.

SL NO	AUTO TRANSFORMER -3 ANY PHASE OUT OF SERVICE			AUTO TRANSFORMER -2 ANY PHASE OUT OF SERVICE			AUTO TRANSFORMER -1 ANY PHASE OUT OF SERVICE			CONNECTIONS TO BE MADE
	B-PHASE	Y-PHASE	R-PHASE	B-PHASE	Y-PHASE	R-PHASE	B-PHASE	Y-PHASE	R-PHASE	
1										1J1
2										1J2
3										1J3
4										1J4
5										1J5
6										1J6
7										2J1
8										2J2
9										2J3
10										2J4
11										2J5
12										2J6
13										3J1
14										3J2
15										3J3
16										3J4
17										3J5
18										3J6

SL NO	AUTO TRANSFORMER -3 ANY PHASE OUT OF SERVICE	AUTO TRANSFORMER -2 ANY PHASE OUT OF SERVICE	AUTO TRANSFORMER -1 ANY PHASE OUT OF SERVICE	CONNECTIONS TO BE MADE
1			✓	1N
2		✓		2N
3	✓			3N

NOTE: EQUIPMENTS SHOWN IN THIS SWITCHING SCHEME IS INCLUDED IN THE BILL OF QTY. OF RESPECTIVE 765KV AND 400KV SLD.

NOA NO. : CC/TW-AIS/DOM/A10/23/01956/NOA-1/24-102643/01

ADDITIONAL INFORMATION W.O.No.	NAME OF CUSTOMER POWERGRID CORPORATION OF INDIA LIMITED LTD
STATUS OF DRAWING	NAME OF CONSULTANT Establishment of 6x1500 MVA, 765/400 kV & 5x500 MVA 400/220 kV Mandasaur Pooling Station Along With 2x330MVAR (765KV) Bus Reactor And 2x125MVAR 420KV Bus Reactor.
DISTRIBUTION OF PRINTS	NAME OF PROJECT

क्रमांक	नाम / NAME	हस्ता / SIGN.	दि./DATE
ड्रॉइंग	PC	-SGD-	30.08.24
जांचा	JK	-SGD-	30.08.24
स्वीकृत	VK	-SGD-	30.08.24

REV. 02	DATE 24-01-25	ALTERED CHECKED APPROVED	PC JK VK
REV. 01	DATE 14-11-24	ALTERED CHECKED APPROVED	PC JK VK

AS PER POWERGRID COMMENTS VIDE EMAIL DTD:24.01.25

AS PER POWERGRID COMMENTS

श्रीमती/टी/ TITLE  
ARRANGEMENT OF AUX. BUS ICT 765/400KV MANDSAUR SIS

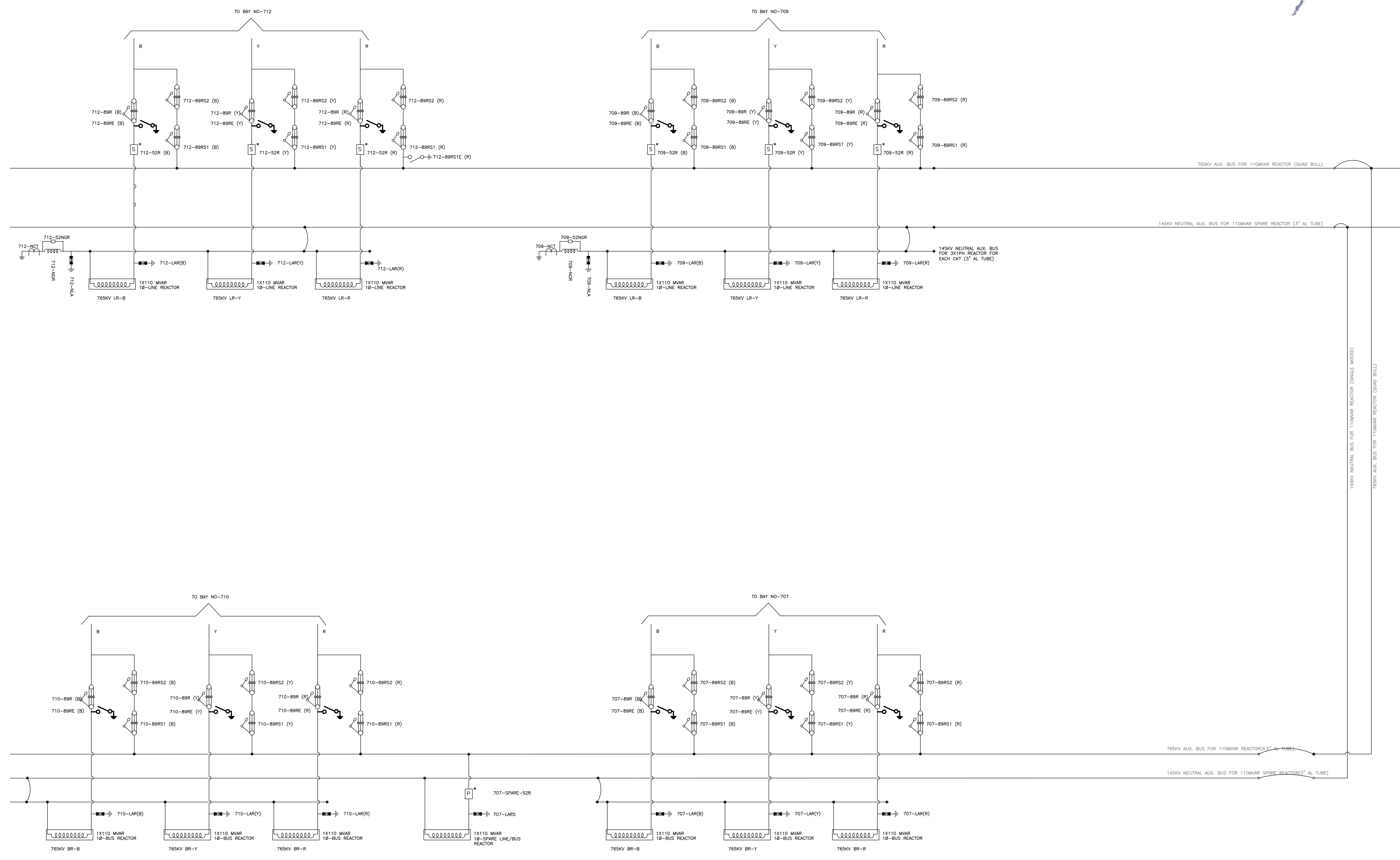
ड्राईंग. क्र./DRAWING NO.  
TB-1-431-510-001

पृष्ठ क्र./SHEET No. 03

पुनः/REV. 02

उपगत पृष्ठ/NEXT SHEET 04

DRG. NO. TB-1-431-510-001



(ARRANGEMENT OF 765kV, 110MVAR LINE/BUS REACTOR AND AUX. BUS)

AUXILIARY BUS ROUTING OF 110MVAR REACTOR SHALL BE SUBJECT TO COMMERCIAL SETTLEMENT AND TO BE READ IN CONJUNCTION WITH LETTER Ref:BHEL/TBEM/Mandsaur/01 Dtd:15.10.2024 & 22.01.2024

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COMPUTER DRG. PATH NAME :

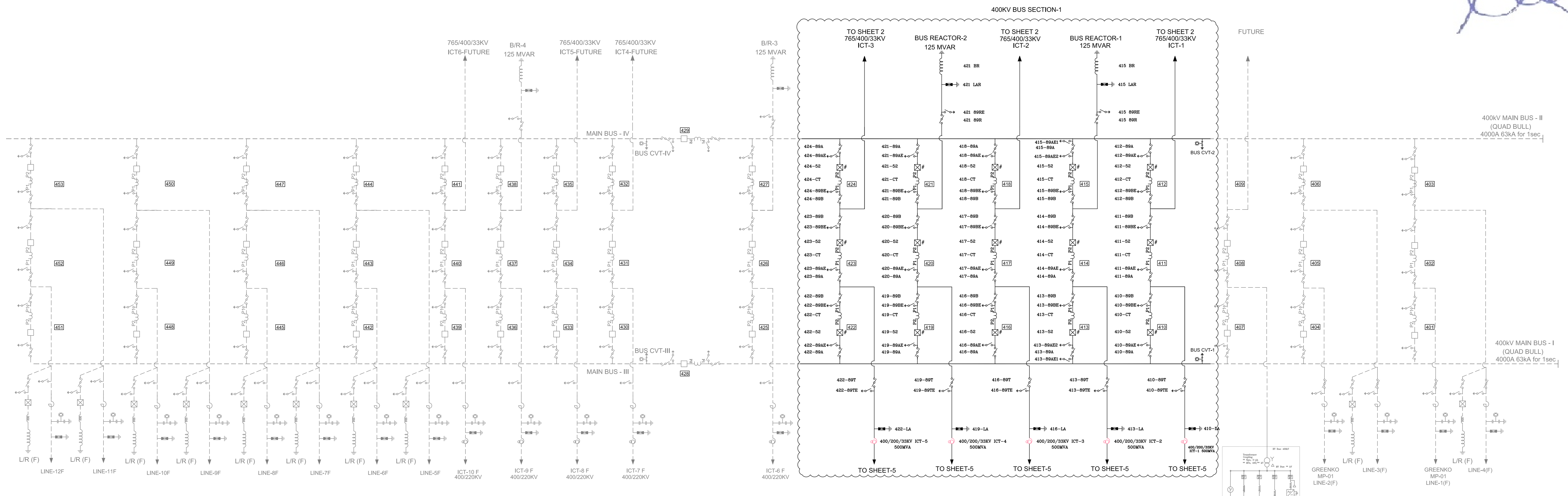
REF. DRG. NO.

SIGN. AND DATE

INVENTORY NO

NOA NO. : CC/TW-AIS/DOMA/10/23/01956/NOA-1/24-102643/01		NAME OF CUSTOMER POWERGRID CORPORATION OF INDIA LIMITED LTD																	
ADDITIONAL INFORMATION W.O.No.		NAME OF CONSULTANT																	
STATUS OF DRAWING		NAME OF PROJECT Establishment of 6x1500 MVA, 765/400 kV & 5x500 MVA 400/220 kV Mandsaur Pooling Station Along With 2x330MVAR (765KV) Bus Reactor And 2x125MVAR 420KV Bus Reactor.																	
DISTRIBUTION OF PRINTS		<table border="1"> <tr> <th>क्रमांक / NO.</th> <th>नाम / NAME</th> <th>हस्ता./SIGN.</th> <th>दि./DATE</th> </tr> <tr> <td>ड्राइंग</td> <td>PC</td> <td>-SGD-</td> <td>30.08.24</td> </tr> <tr> <td>जांचा</td> <td>JK</td> <td>-SGD-</td> <td>30.08.24</td> </tr> <tr> <td>मंजूर</td> <td>VK</td> <td>-SGD-</td> <td>30.08.24</td> </tr> </table>		क्रमांक / NO.	नाम / NAME	हस्ता./SIGN.	दि./DATE	ड्राइंग	PC	-SGD-	30.08.24	जांचा	JK	-SGD-	30.08.24	मंजूर	VK	-SGD-	30.08.24
क्रमांक / NO.	नाम / NAME	हस्ता./SIGN.	दि./DATE																
ड्राइंग	PC	-SGD-	30.08.24																
जांचा	JK	-SGD-	30.08.24																
मंजूर	VK	-SGD-	30.08.24																
REV. 01	DATE 24-01-25	ALTERED CHECKED APPROVED	PC JK VK	भारत हेवी इलेक्ट्रिकल्स लिमिटेड दूरसंचालन परियोजना विभाग BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION PROJECTS DIVISION	जलपात / SCALE कर्ह कोड / CARD CODE														
ZONE	AS PER POWERGRID COMMENTS VIDE EMAIL DTD:24.01.25	शीर्षक/TITLE ARRANGEMENT OF AUX. REACTOR 765/400KV MANDSAUR SIS	ड्राइंग. क्र./DRAWING NO. TB-1-431-510-001	पृष्ठ क्र./SHEET No. 04 उगता पृष्ठ/NEXT SHEET 05	पुनः/REV. 00														

DRG. NO. TB-1-431-510-001



**BILL OF QTY. FOR 400kV MAIN EQUIPMENTS (BHEL'S SCOPE):**

SL.NO.	DESCRIPTION	RATING	S. C. RATING	NOA QTY. (NO.)	SLD QTY. (NO.)	SYMBOL	LEGEND	MAKE
1	125MVAR BUS REACTOR (3-PH)	420 kV	63 KA FOR 1 S.	2	2		BR	BHEL
2	SF6 CIRCUIT BREAKER WITHOUT CR (3-PH) WITH SUPPORT STRUCTURE	3150A	63 KA FOR 1 S.	10 (WITH CSD)	10 (WITH CSD)		52	SIEMENS
3	SF6 CIRCUIT BREAKER WITHOUT CR (3-PH) WITH SUPPORT STRUCTURE	3150A	63 KA FOR 1 S.	5 (W/O CSD)	5 (WITH CSD)		52	SIEMENS
4	ISOLATOR WITH ONE E/S (3 PH) DOUBLE BREAK TYPE	3150A	63 KA FOR 1 S.	35	35		89/89E	ELEKTROLITE
5	ISOLATOR WITH TWO E/S (3 PH) DOUBLE BREAK TYPE	3150A	63 KA FOR 1 S.	2	2		89/89E1/89E2	ELEKTROLITE
6	ISOLATOR WITH ONE E/S (1 PH) DOUBLE BREAK TYPE	3150A	63 KA FOR 1 S.	10	10		89/89E	ELEKTROLITE
7	ISOLATOR WITHOUT E/S (1 PH) DOUBLE BREAK TYPE	3150A	63 KA FOR 1 S.	8	8		89	ELEKTROLITE
8	CURRENT TRANSFORMER (1 PH.) WITH 120% EXTENDED CURRENT RATING.	3000A	63 KA FOR 1 S.	45	45		CT	BHEL
9	SURGE ARRESTER (1 PH.)	336 kV	NA	31	31		LA	OBLUM
10	500MVA, 400/220/33KV ICT	400KV	NA	5	5		ICT	TOSHIBA
11	CVT (1-Ph)	400KV	4400pF	6	6		CVT	BHEL
12	CONTROLLED SWITCHING DEVICE	400KV	NA	10	15 #		CSD	SIEMENS

# POWERGRID TO ISSUE SUITABLE BOQ AMMENDMENT FOR CHANGE IN QUANTITY

- NOTES:-
- SYSTEM 400kV, 63ka FOR 1 SEC., 50Hz, 3Ph, SOLIDLY EARTHED
  - PRESENT FUTURE
  - 400kV EQUIPMENTS FOR 765/400/33kV ICT SWITCHING ARE ALSO INCLUDED IN THE BOQ OF QTY. FO 400KV MAIN EQUIPMENTS.

**400kV CT DETAILS**

CORE	CURRENT RATIO	ACCURACY CLASS	OUTPUT BURDEN(VA)	MIN KPV (V)	MAX RCT (OHMS)	MAX IM AT KPV (MA)	PURPOSE
1	3000/2000/500/1	PX	-	3000-2000-500	15-10-2.5	20mA on 3000/1 Tap 30mA on 2000/1 Tap 120mA on 500/1 Tap	BUS DIFF. MAIN-1
2	3000/2000/500/1	PX	-	3000-2000-500	15-10-2.5	20mA on 3000/1 Tap 30mA on 2000/1 Tap 120mA on 500/1 Tap	BUS DIFF. MAIN-2
3	3000/2000/500/1	0.2S 0.2S 0.2S	20 20 20	-	-	-	METERING
4	3000/2000/500/1	0.2S 0.2S 0.2S	20 20 20	-	-	-	METERING
5	3000/2000/500/1	PX	-	3000-2000-500	15-10-2.5	20mA on 3000/1 Tap 30mA on 2000/1 Tap 120mA on 500/1 Tap	LINE PROT.N.MAIN-2/ TRAFO BACKUP
6	3000/2000/500/1	PX	-	3000-2000-500	15-10-2.5	20mA on 3000/1 Tap 30mA on 2000/1 Tap 120mA on 500/1 Tap	LINE PROT.N.MAIN-1/ TRAFO DIFF

**400kV, 4400 PF CVT DETAILS**

CORE DETAILS	APPLICATION	VOLTAGE RATIO	OUTPUT (VA)	ACCURACY
SEC-I	PROTECTION	400kV / 0.11kV	50	3P
SEC-II	PROTECTION	400kV / 0.11kV	50	3P
SEC-III	METERING	400kV / 0.11kV	50	0.2

NOA NO. : CC/TW-AIS/DOMA/10/23/01956/NOA-1/24-102643/01 POWERGRID CORPORATION OF INDIA LIMITED LTD

NAME OF CUSTOMER: Establishment of 6x1500 MVA, 765/400 kV & 5x500 MVA  
 NAME OF CONSULTANT: 400/220 kV Mandasaur Pooling Station Along With 2x330MVAR (765KV) Bus Reactor And 2x125MVAR 420KV Bus Reactor.  
 NAME OF PROJECT:

STATUS OF DRAWING	DISTRIBUTION OF PRINTS	REVISIONS
REV. 01	DATE 14-11-24	ALTERED PC CHECKED JK APPROVED VK
REV. 02	DATE 04-01-25	ALTERED PC CHECKED JK APPROVED VK
REV. 03	DATE 21-01-25	ALTERED PC CHECKED JK APPROVED VK
REV. 04	DATE 04-12-25	ALTERED PC CHECKED JK APPROVED VK

**भारत हेवी इलेक्ट्रिकल्स लिमिटेड**  
 भारत हेवी इलेक्ट्रिकल्स लिमिटेड  
 TRANSMISSION PROJECTS DIVISION

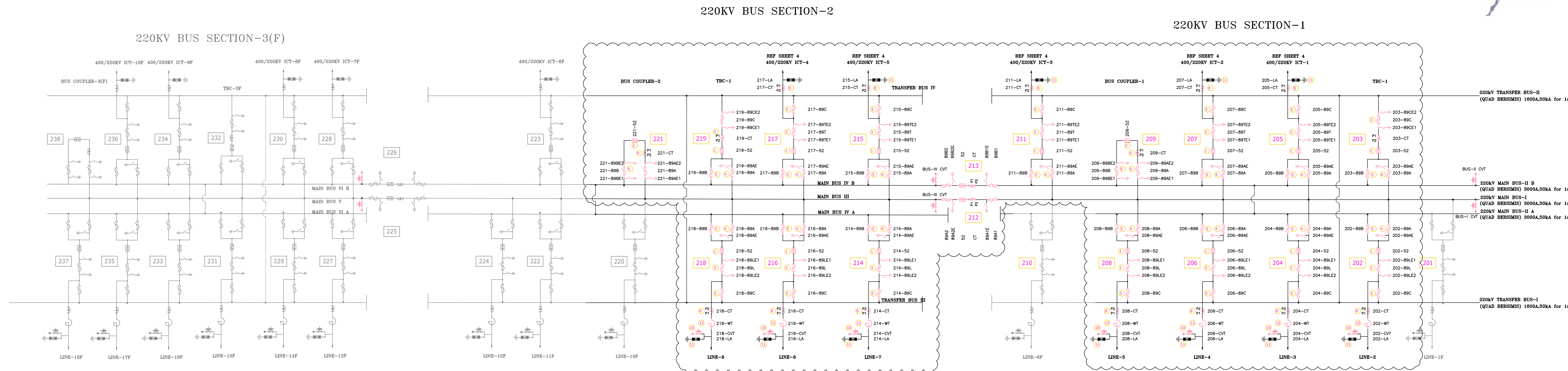
DEPT.	SCALE	CARD CODE	DATE
DEPT.	जुलुवात / SCALE	कॉड कोड	30.08.24
DEPT.			30.08.24

REV.	DATE	ALTERED	PC	REV.	DATE	ALTERED	PC	REV.	DATE	ALTERED	PC	REV.	DATE	ALTERED	PC
04	04-12-25	CHECKED	JK	03	21-01-25	CHECKED	JK	02	04-01-25	CHECKED	JK	01	14-11-24	CHECKED	JK

शीर्षक/TITLE: SINGLE LINE DIAGRAM FOR 400KV MANDSAUR S/S  
 ड्रॉइंग.क./DRAWING NO. TB-1-431-510-001  
 पृष्ठ नं./SHEET No. 05 अगला पृष्ठ/NEXT SHEET 06

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DRG. NO.



**BILL OF QUANTITY FOR 220kV EQUIPMENTS (BHEL SCOPE)**

ITEM CODE	SCHEDULE OF EQUIPMENT (OUTDOOR)	SYMBOL	NOA QTY. (NOS.)	SLD QTY. (NOS.)	LEGEND	MAKE
1	245KV, 1600A, 50kA/1s CIRCUIT BREAKER (3-Ph) WITH SUPPORT STRUCTURE		14	14	52	SIEMENS
2	245KV, 3150A, 50kA/1s CIRCUIT BREAKER (3-Ph) WITH SUPPORT STRUCTURE (BUS COUPLER & BUS SECTIONALISER BAYS)		4	4	52	SIEMENS
3	245KV, 1600A, 50kA/1s HDB ISOLATOR WITH 2E/S (3-Ph)		14	14	89/89E1/89E2	ELEKTROLITE
4	245KV, 1600A, 50kA/1s HDB ISOLATOR WITH 1E/S (3-Ph)		14	14	89/89E1	ELEKTROLITE
5	245KV, 1600A, 50kA/1s HDB TANDEM ISOLATOR WITHOUT E/S (3-Ph)		26	26	89	ELEKTROLITE
6	245KV, 3150A, 50kA/1s HDB ISOLATOR WITH 2E/S (3-Ph) (BUS COUPLER BAYS)		04	04	89/89E1/89E2	ELEKTROLITE
7	245KV, 3150A, 50kA/1s HDB ISOLATOR WITH 1E/S (3-Ph) (BUS SECTIONALISER BAYS)		04	04	89/89E1	ELEKTROLITE
8	245KV, 1600A (120%), 50kA/1s CURRENT TRANSFORMER (1-Ph)		42	42	CT	BHEL
9	245KV, 2500A (150%), 50kA/1s CURRENT TRANSFORMER (1-Ph) (BUS COUPLER & BUS SECTIONALISER BAYS)		12	12	CT	BHEL
10	245KV CAPACITIVE VOLTAGE TRANSFORMER (4400 pF) (1-Ph)		33	33	CVT	BHEL
11	216KV SURGE ARRESTER (1-Ph)		36	36	LA	OBLUM
12	220KV, 1600A, 0.5mH, 50kA/1s LINE TRAP (1-Ph)		14	14	WT	GE

**220kV, 1600A, 50kA/1s CT DETAILS**

CORE	RATIO	MAX. EXCITING (mA) CURRENT AT V <sub>k</sub>	KNEE POINT VOLTAGE (V <sub>k</sub> )	ACCURACY	OUTPUT BURDEN	RCT
1	1600-800/1A	25 ON 1600/1 TAP 50 ON 800/1 TAP	1600/800V	PX	8/4	8/4
2	1600-800/1A	25 ON 1600/1 TAP 50 ON 800/1 TAP	1600/800V	PX	8/4	8/4
3	1600-800/1A	-	-	0.2S	20VA	-
4	1600-800/1A	25 ON 1600/1 TAP 50 ON 800/1 TAP	1600/800V	PX	8/4	8/4
5	1600-800/1A	25 ON 1600/1 TAP 50 ON 800/1 TAP	1600/800V	PX	8/4	8/4

**220kV, 2500A, 50kA/1s CT DETAILS**

CORE	RATIO	MAX. EXCITING (mA) CURRENT AT V <sub>k</sub>	KNEE POINT VOLTAGE (V <sub>k</sub> )	ACCURACY	OUTPUT BURDEN	RCT
1	2500-1600-800/1A	16-25-50mA	2500-1600-800V	PX	12.5-8-4	12.5-8-4
2	2500-1600-800/1A	16-25-50mA	2500-1600-800V	PX	12.5-8-4	12.5-8-4
3	2500-1600-800/1A	-	-	0.2S	20VA	-
4	2500-1600-800/1A	16-25-50mA	2500-1600-800V	PX	12.5-8-4	12.5-8-4
5	2500-1600-800/1A	16-25-50mA	2500-1600-800V	PX	12.5-8-4	12.5-8-4

**220kV, 4400 PF CVT DETAILS**

CORE DETAILS	APPLICATION	VOLTAGE RATIO	OUTPUT (VA)	ACCURACY
SEC-I	PROTECTION	220kV / 0.11kV	50	3P
SEC-II	PROTECTION	220kV / 0.11kV	50	3P
SEC-III	METERING	2200kV / 0.11kV	50	0.2

- NOTES:-**
- SYSTEM 220kV, 50kA FOR 1 SEC., 50Hz, 3Ph, SOLIDLY EARTHED
  - PRESENT \_\_\_\_\_ FUTURE \_\_\_\_\_
  - PHASE LOCATION OF WAVE TRAPS TO BE DECIDED DURING DETAILED ENGINEERING

NOA NO. : CC/T/W-AIS/DOM/A06/23/11955/NOA-1/24-108670/01 & NOA-2/24-108670/02 Dated 09/07/2024

ADDITIONAL INFORMATION W.O.No. \_\_\_\_\_

STATUS OF DRAWING \_\_\_\_\_

DISTRIBUTION OF PRINTS \_\_\_\_\_

NAME OF CUSTOMER/CONSULTANT: POWERGRID CORPORATION OF INDIA LTD.  
 NAME OF PROJECT:- ESTABLISHMENT OF 3X1500MVAR, 765/400KV AND 5X500MVA, 400/220KV MANDSAUR POOLING STATION ALONG WITH 2X330MVAR (765KV) BUS REACTOR AND 2X125MVAR 420KV BUS REACTOR.

कनारा ड्रॉइंग	जाम /NAME	हस्ता /SIGN.	दि./DATE
PC	JK	-SGD-	30.08.24
जांचा CHECKED	JK	-SGD-	30.08.24
स्वीकृत APPROVED	VK	-SGD-	30.08.24

विभाग DEPT. \_\_\_\_\_  
 कोड CODE \_\_\_\_\_  
 शीर्षक/TITLE SINGLE LINE DIAGRAM FOR 220kV MANDSAUR S/S

अनुपात / SCALE \_\_\_\_\_  
 कार्ड कोड CARD CODE \_\_\_\_\_

ड्राईंग.क./DRAWING NO. TB-1431-510-001  
 पुनः/REV. 03

पृष्ठ क./SHEET No. 06 अगला पृष्ठ/NEXT SHEET --

REV. 03	DATE 24-01-25	ALTERED CHECKED APPROVED	PC JK VK	REV. 02	DATE 04-01-25	ALTERED CHECKED APPROVED	PC JK VK	REV. 01	DATE 14-11-24	ALTERED CHECKED APPROVED	PC JK VK
ZONE	AS PER POWERGRID COMMENTS VIDE EMAIL DTD:24.01.25			ZONE	AS PER POWERGRID COMMENTS			ZONE	AS PER POWERGRID COMMENTS		

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DRG. NO. TB-1431-510-001



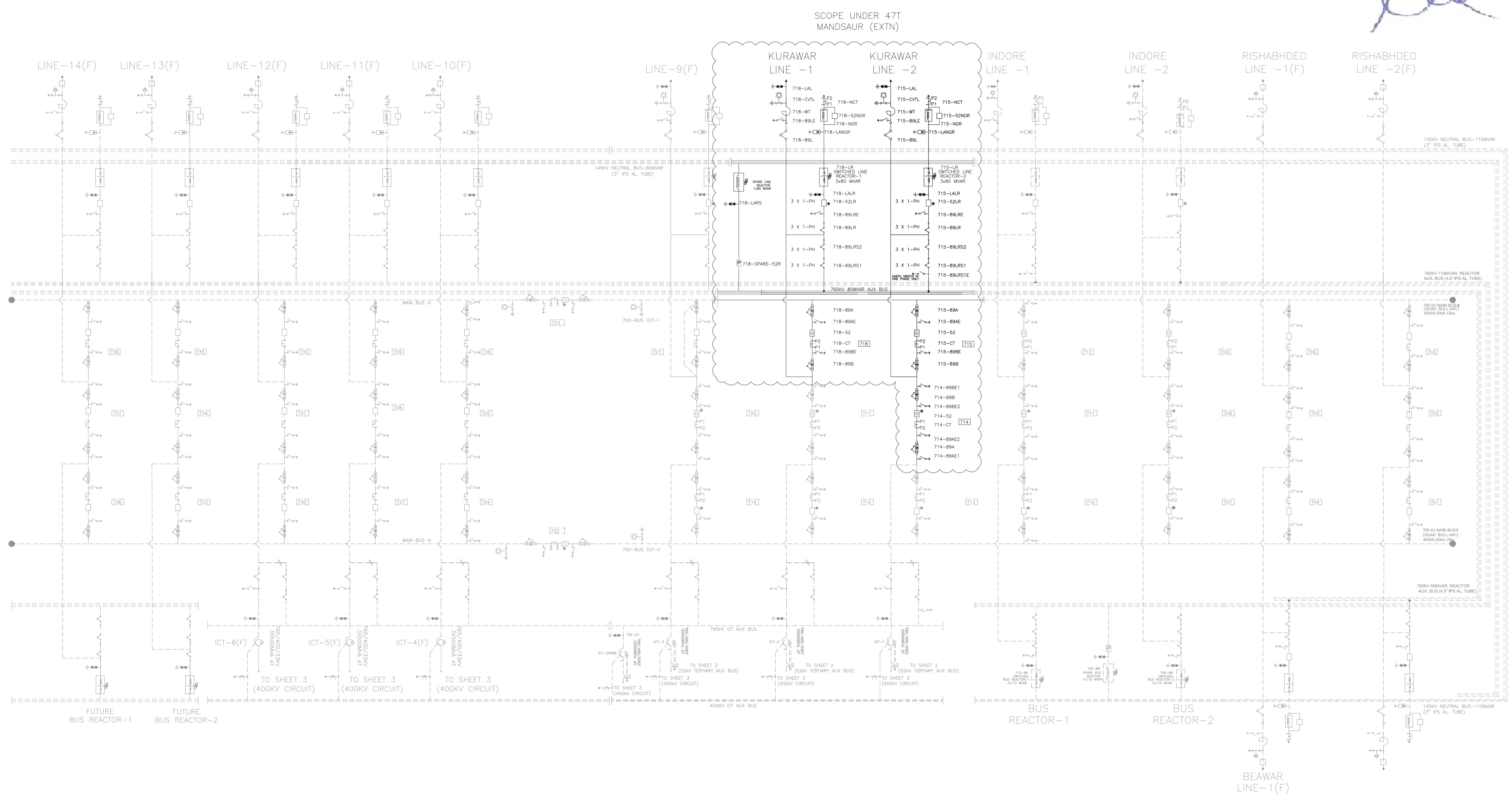
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COMPUTER DRG. PATH NAME :

REF. DRG. NO.

SIGN. AND DATE

INVENTORY NO

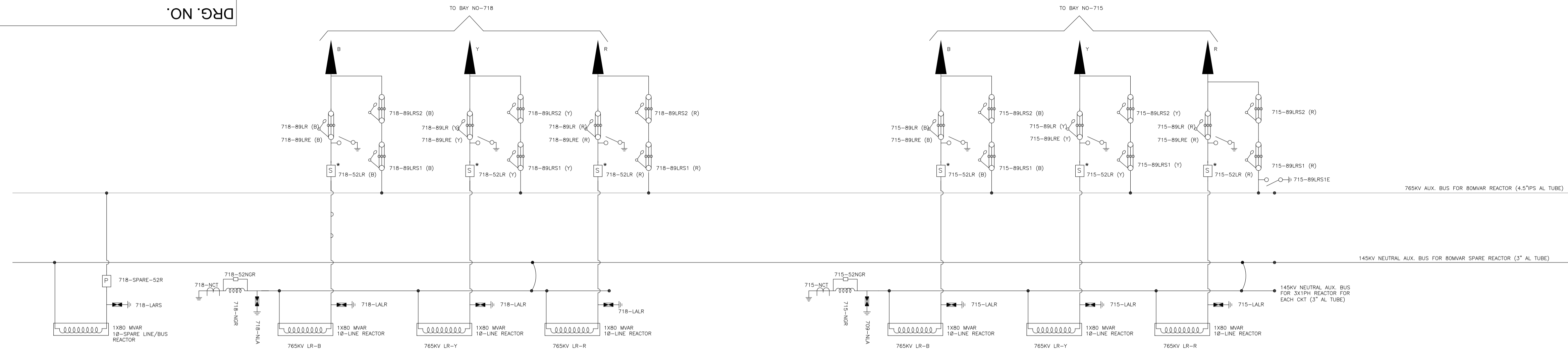


NOTES:-  
 1. SYSTEM 765kV, 50KA FOR 1 SEC., 50Hz, 3Ph, SOLIDLY EARTHED  
 2. PRESENT FUTURE  
 3. PHASE LOCATION OF WAVE TRAPS TO BE DECIDED DURING DETAILED ENGINEERING  
 4. 765kV EQUIPMENTS FOR ICT AND REACTOR SWITCHING ARE ALSO INCLUDED IN THE BOQ OF QTY. FOR 765kV MAIN EQUIPMENTS.

NOA NO. : CC/T/WAIS/DOM/A06/23/12236/ NOA-1/24-114234/01 DTD 27-11-2024															
ADDITIONAL INFORMATION W.O.No.		ग्राहक/परियोजना का नाम NAME OF CUSTOMER/CONSULTANT- POWERGRID CORPORATION OF INDIA LIMITED NAME OF PROJECT- <b>765kV AIS PKG SS-47T FOR (I) ESTABLISHMENT OF 765/400/220/132KV KURAWAR (NEW) SUBSTATION (II) EXTN. OF 400KV SHUJALPUR S/S (III) EXTN. OF 400KV ASHTHA S/S (IV) EXTN. OF 765KV MANDSAUR S/S</b>													
STATUS OF DRAWING		भारत हेवी इलेक्ट्रिकल्स लिमिटेड భారత్ హెవీ ఇलेక్ట్రిकల్స్ లిమిటెడ్ భారత్ హెవీ ఇलेक्ट्रिकल्स लिमिटेड BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION PROJECTS DIVISION													
DISTRIBUTION OF PRINTS		<table border="1"> <tr> <th>खण्ड/ DRAWN</th> <th>नाम /NAME</th> <th>हस्ता./SIGN.</th> <th>दि./DATE</th> </tr> <tr> <td>जांचा/ CHECKED</td> <td>JK</td> <td>-SGD-</td> <td>10.01.25</td> </tr> <tr> <td>स्वीकृत/ APPROVED</td> <td>VK</td> <td>-SGD-</td> <td>10.01.25</td> </tr> </table>		खण्ड/ DRAWN	नाम /NAME	हस्ता./SIGN.	दि./DATE	जांचा/ CHECKED	JK	-SGD-	10.01.25	स्वीकृत/ APPROVED	VK	-SGD-	10.01.25
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REV. 02	DATE 06.03.25	ALTERED CHECKED APPROVED	PC JK VK												
REV. 01	DATE 24.02.25	ALTERED CHECKED APPROVED	PC JK VK												
ZONE	POWERGRID COMMENTS INCORPORATED. CSD IS INCLUDED FOR TIE BAY CB OF ICT AS PER 6.8.2 OF SPECIFIC REQUIREMENTS	ZONE	POWERGRID COMMENTS INCORPORATED. CSD IS INCLUDED FOR TIE BAY CB OF ICT												
AS PER POWERGRID COMMENTS		विभागा/ DEPT. कोड/ CODE शीर्षक/TITLE	अनुपात / SCALE कार्ड कोड/ CARD CODE ड्राइंग नं./DRAWING NO. TB202447-1002655-SC3540-SLD पृष्ठ नं./SHEET No. अगला पृष्ठ/NEXT SHEET												
		पुनः/REV. 02													

REV. 03	DATE 11.03.25	ALTERED CHECKED APPROVED	PC JK VK
REV. 02	DATE 06.03.25	ALTERED CHECKED APPROVED	PC JK VK
REV. 01	DATE 24.02.25	ALTERED CHECKED APPROVED	PC JK VK
ZONE	POWERGRID COMMENTS INCORPORATED. CSD IS INCLUDED FOR TIE BAY CB OF ICT	ZONE	POWERGRID COMMENTS INCORPORATED. CSD IS INCLUDED FOR TIE BAY CB OF ICT

विभागा/ DEPT. :  
 कोड/ CODE :  
 शीर्षक/TITLE : SINGLE LINE DIAGRAM FOR 765kV MANDSAUR EXTN S/S  
 ड्राइंग नं./DRAWING NO. : TB202447-1002655-SC3540-SLD  
 पृष्ठ नं./SHEET No. :  
 अगला पृष्ठ/NEXT SHEET :



(ARRANGEMENT OF 765kV, 80MVAR LINE REACTOR AND AUX. BUS)

**BILL OF QTY. FOR 765kV MAIN EQUIPMENTS:**

SL.NO.	DESCRIPTION	RATING	S. C. RATING	NOA QTY. (NO.)	SLD QTY. (NO.)	SYMBOL	SCOPE OF SUPPLY	LEGEND	MAKE
1	80MVAR LINE REACTOR (1-PH) WITH NGR	765KV	50 KA FOR 1 S.	07	07		POWERGRID	LR/NGR	TBD
2	SF6 CIRCUIT BREAKER WITH CR. (3-PH)	765KV,3150A	50 KA FOR 1 S.	03	02 W/O CSD 01 WITH CSD		BHEL	52	TBD
3	SF6 CIRCUIT BREAKER (3-PH) WITHOUT CLOSING RESISTOR WITH CONTROL SWITCHING SUITABLE FOR 1-PH REACTOR SWITCHING	765KV, 3150A	50 KA FOR 1 S.	02	02		BHEL	52	TBD
4	SF6 CIRCUIT BREAKER WITHOUT CR,WITH CSD (1-PH) PROVISION	765KV, 3150A	50 KA FOR 1 S.	01	01		BHEL	52	TBD
5	ISOLATOR WITH ONE E/S (3 PH) VERTICAL KNEE TYPE	765KV, 3150A	50 KA FOR 1 S.	06	06		BHEL	89/89E	TBD
6	ISOLATOR WITH TWO E/S (3 PH) VERTICAL KNEE TYPE	765KV, 3150A	50 KA FOR 1 S.	02	02		BHEL	89/89E1 /89E2	TBD
7	ISOLATOR WITH ONE E/S (1 PH) VERTICAL KNEE TYPE	765KV, 2000A	50 KA FOR 1 S.	07	07		BHEL	89/89E1	TBD
8	ISOLATOR WITHOUT E/S	765KV, 2000A	50 KA FOR 1 S.	11	11		BHEL	89	TBD
9	CURRENT TRANSFORMER (1 PH.) WITH 120% EXTENDED CURRENT RATING.	3000A	50 KA FOR 1 S.	09	09		BHEL	CT	TBD
10	CVT (1 PH.)	8800pF	NA	06	06		BHEL	CVT	BHEL
11	SURGE ARRESTER (1 PH.)	624 kV	NA	13	13		BHEL	LA	TBD
12	WAVE TRAP (1 PH.) PEDESTAL TYPE.	1mH, 3150A	50 KA FOR 1 S.	04	04		BHEL	WT	TBD
13	CONTROLLED SWITCHING DEVICE	765KV	50 KA FOR 1 S.	02	03#		BHEL	CSD	TBD

# POWERGRID TO ISSUE SUITABLE BOQ AMENDMENT FOR 765KV BREAKER QUANTITY

**800kV CT DETAILS**

CORE	CURRENT RATIO	ACCURACY CLASS	OUTPUT BURDEN (VA)	MIN KP/V (V)	MAX RCT (OHMS)	MAX IM AT KP/V(MA)	PURPOSE
1	3000/2000/500/1	PX	-	3000-2000-500	15-10-2.5	20mA on 3000/1 Tap 30mA on 2000/1 Tap 120mA on 500/1 Tap	BUS DIFF. MAIN-1
2	3000/2000/500/1	PX	-	3000-2000-500	15-10-2.5	20mA on 3000/1 Tap 30mA on 2000/1 Tap 120mA on 500/1 Tap	BUS DIFF. MAIN-2
3	3000/2000/500/1	0.2S 0.2S 0.2S	20 20 20	-	-	-	METERING
4	3000/2000/500/1	0.2S 0.2S 0.2S	20 20 20	-	-	-	METERING
5	3000/2000/500/1	PX	-	3000-2000-500	15-10-2.5	20mA on 3000/1 Tap 30mA on 2000/1 Tap 120mA on 500/1 Tap	TRAFD DIFF./LINE PROT
6	3000/2000/500/1	PX	-	3000-2000-500	15-10-2.5	20mA on 3000/1 Tap 30mA on 2000/1 Tap 120mA on 500/1 Tap	LINE PROT/LBB PROT.

**765kV CVT DETAILS**

APPLICATION	PRIMARY (KV)	SECONDARY (KV)	OUTPUT (VA)	ACCURACY
PROTECTION	765KV/√3	0.11KV/√3	50VA	0.5/3P
PROTECTION	765KV/√3	0.11KV/√3	50VA	0.5/3P
METERING	765KV/√3	0.11KV/√3	50VA	0.2

CORE UTILIZATION SHALL BE AS PER APPROVED PROTECTION SCHEMATIC DRAWINGS

NOA NO. : CC/T/WAIS/DOM/A06/23/12236/ NOA-1/24-114234/01 DTD 27-11-2024

आहक/परियोजना का नाम  
NAME OF CUSTOMER/CONSULTANT- POWERGRID CORPORATION OF INDIA LIMITED

NAME OF PROJECT:-  
765KV AIS PKG SS-47T FOR (I) ESTABLISHMENT OF 765/400/220/132KV KURAWAR (NEW) SUBSTATION (II) EXTN. OF 400KV SHUJALPUR S/S (III) EXTN. OF 400KV ASHTHA S/S (IV) EXTN. OF 765KV MANDSAUR S/S

STATUS OF DRAWING

DISTRIBUTION OF PRINTS

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जांचा CHECKED	JK	-SGD-	10.01.25
स्वीकृत APPROVED	VK	-SGD-	10.01.25

भारत हेवी इलेक्ट्रिकल्स लिमिटेड  
Bharat Heavy Electricals Ltd.  
TRANSMISSION PROJECTS DIVISION

पिभागा DEPT. कोड CODE

अनुपात / SCALE

कार्ड कोड CARD CODE

शीर्षक/TITLE

आवृत्त क./SHEET No.

अगला पृष्ठ/NEXT SHEET

पुनः/REV. 02

REV.	DATE	ALTERED	PC	REV.	DATE	ALTERED	PC	REV.	DATE	ALTERED	PC
03	11.03.25	CHECKED	JK	02	06.03.25	CHECKED	JK	01	24.02.25	CHECKED	JK
		APPROVED	VK			APPROVED	VK			APPROVED	VK

ZONE POWERGIRD COMMENTS INCORPORATED. CSD IS INCLUDED FOR TIE BAY CB OF ICT AS PER 6.8.2 OF SPECIFIC REQUIREMENTS

ZONE POWERGIRD COMMENTS INCORPORATED. CSD IS INCLUDED FOR TIE BAY CB OF ICT

ZONE AS PER POWERGIRD COMMENTS

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COMPUTER DRG. PATH NAME :

REF. DRG. NO.

SIGN. AND DATE

INVENTORY NO

DRG. NO. TB-1-424-510-002

**BHEL SCOPE**

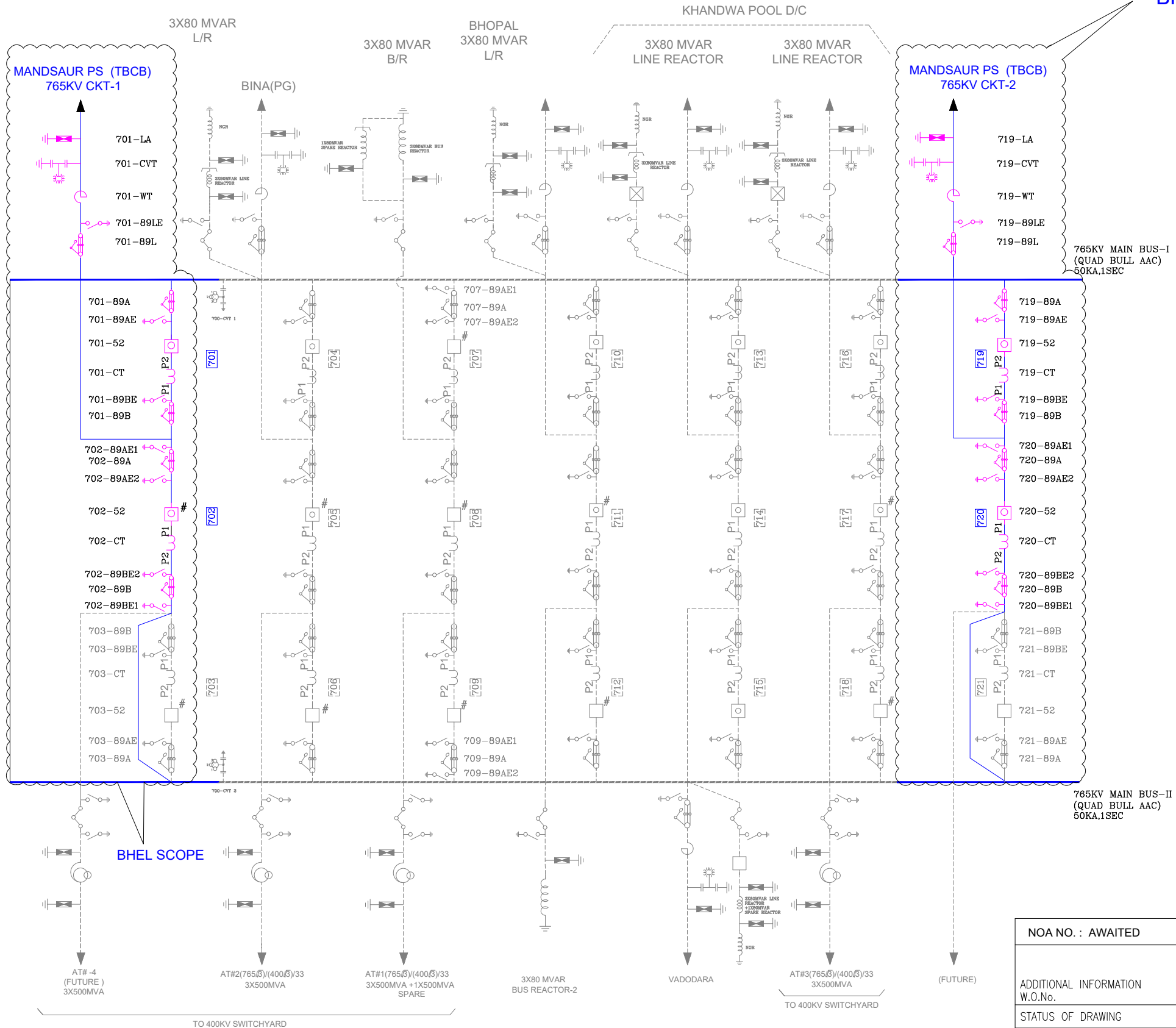
**BILL OF QTY. FOR 765KV MAIN EQUIPMENTS:**

SL.NO.	DESCRIPTION	RATING	S. C. RATING	SLD QTY. (NO.)	NOA QTY. (NO.)	SYMBOL	SCOPE OF SUPPLY	LEGEND	MAKE
1	SF6 CIRCUIT BREAKER WITH CR. WITH CSD (3-PH)	3150A	50 KA FOR 1 S.	2	1		BHEL	52	TBD
2	SF6 CIRCUIT BREAKER WITH CR. WITHOUT CSD (3-PH)	3150A	50 KA FOR 1 S.	2	3		BHEL	52	TBD
3	ISOLATOR WITH ONE E/S (3 PH) VERTICAL KNEE TYPE	3150A	50 KA FOR 1 S.	6	6		BHEL	89/89E	TBD
4	ISOLATOR WITH TWO E/S (3 PH) VERTICAL KNEE TYPE	3150A	50 KA FOR 1 S.	4	4		BHEL	89/89E1/89E2	TBD
5	ISOLATOR WITH ONE E/S (1 PH) VERTICAL KNEE TYPE	3150A	50 KA FOR 1 S.	-	-		-	89/89E	-
6	ISOLATOR WITH TWO E/S (1 PH) VERTICAL KNEE TYPE	3150A	50 KA FOR 1 S.	-	-		-	89/89E	-
7	CURRENT TRANSFORMER (1 PH.) WITH 120% EXTENDED CURR. RATING.	3000A	50 KA FOR 1 S.	12	12		BHEL	CT	TBD
8	CVT (1 PH.)	8800pF	NA	6	6		BHEL	CVT	BHEL
9	SURGE ARRESTER (1 PH.)	624 KV	NA	6	6		BHEL	LA	TBD
10	WAVE TRAP (1 PH.) PEDESTAL TYPE.	1mH, 3150A	50 KA FOR 1 S.	04	04		BHEL	WT	TBD

CORE	CURRENT RATIO	ACCURACY CLASS	OUTPUT BURDEN (VA)	MIN KP.V (V <sub>k</sub> )	MAX RCT (OHMS)	MAX IM AT KP.V (mA)	PURPOSE
1	3000/2000/500/1	PX	-	3000-2000-500	15-10-2.5	20mA on 3000/1 Tap 30mA on 2000/1 Tap 120mA on 500/1 Tap	BUS DIFF. CHECK
2	3000/2000/500/1	PX	-	3000-2000-500	15-10-2.5	20mA on 3000/1 Tap 30mA on 2000/1 Tap 120mA on 500/1 Tap	BUS DIFF. MAIN
3	3000/2000/500/1	0.2S	20	-	-	-	METERING
4	3000/2000/500/1	0.2S	20	-	-	-	METERING
5	3000/2000/500/1	PX	-	3000-2000-500	15-10-2.5	20mA on 3000/1 Tap 30mA on 2000/1 Tap 120mA on 500/1 Tap	LINE PROT.N.MAIN-2/ TRAFO BACKUP
6	3000/2000/500/1	PX	-	3000-2000-500	15-10-2.5	20mA on 3000/1 Tap 30mA on 2000/1 Tap 120mA on 500/1 Tap	LINE PROT.N.MAIN-1/ TRAFO DIFF.

**765kV CVT DETAILS**

APPLICATION	PRIMARY (KV)	SECONDARY (KV)	OUTPUT (VA)	ACCURACY
PROTECTION	765kV <sub>3</sub>	0.11kV <sub>3</sub>	50VA	3P
PROTECTION	765kV <sub>3</sub>	0.11kV <sub>3</sub>	50VA	3P
METERING	765kV <sub>3</sub>	0.11kV <sub>3</sub>	50VA	0.2



**BHEL SCOPE**

- NOTES:-**
- SYSTEM 765kV, 50kA FOR 1 SEC., 50Hz, 3Ph, SOLIDLY EARTHED
  - PRESENT EXISTING

NOA NO. : AWAITED

ग्राहक/परियोजना का नाम  
 NAME OF CUSTOMER/PROJECT POWERGRID CORPORATION OF INDIA LIMITED  
 NAME OF CONSULTANT EXTENSION OF 765KV INDORE (PG) S/S FOR TERMINATION OF 765KV D/C MANDSAUR (NEW) PS-INDORE (PG) LINE

STATUS OF DRAWING  
 DISTRIBUTION OF PRINTS

क्रमांक / NO.	नाम / NAME	हस्ता. / SIGN.	दि./DATE
डिजाइन	PC	-SGD-	04.09.24
जांचा	JK	-SGD-	04.09.24
स्वीकृत	VK	-SGD-	04.09.24

भारत हेवी इलेक्ट्रिकल्स लिमिटेड  
 BHARAT HEAVY ELECTRICALS LTD.  
 TRANSMISSION BUSINESS GROUP

जुनुपात / SCALE  
 कर्ड कोड / CARD CODE

पिभाग DEPT.  
 कोड CODE

पिभाग DEPT.  
 कोड CODE

REV. 0 DATE 16.09.24  
 CHECKED JK  
 APPROVED VK

PC  
 JK  
 VK

ZONE CUSMTOR COMMENTS INCORPORATED

शीर्षक/TITLE  
**SINGLE LINE DIAGRAM FOR 765 KV INDORE (EXTN.) S/S**

TB202407-1002453-SC1616-765KV-SY-SLD

ड्राईंग.क./DRAWING NO.  
 TB-1-424-510-002

पृष्ठ क्र./SHEET No. उगलत पृष्ठ /NEXT SHEET

पुनः/REV. 01

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 COMPUTER DRG. PATH NAME :  
 REF. DRG. NO.  
 SIGN. AND DATE  
 INVENTORY NO

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## PRE-COMMISSIONING CHECKS/TESTS FOR OTHER SWITCHYARD EQUIPMENTS

Once erection is completed, various pre-commissioning checks/ tests are performed to ensure the healthiness of the switchyard equipments prior to their energisation. Various major electrical tests to be performed and their significance are given below:

Sr. No.	Name of Test / Check point	Purpose of test/ check
6.1	Tan $\delta$ & Capacitance measurement of CT, each stack of CVT & total capacitance, CB voltage grading capacitor & each stack of Surge Arresters	The purpose of the dissipation factor measurement of high voltage insulation is to detect incipient weaknesses in HV insulation. The most important benefit to be gained from this measurement is to obtain a “benchmark reference reading” on costly and high voltage equipment when the equipment is new and insulation is clean, dry and free from impurities. Tan delta & Capacitance values shall be comparable with factory test results and in no case shall be more than 0.5 %.
6.2	<b>Checks/ Tests applicable for CTs</b>	
6.2.1	Polarity test for CT	To ascertain whether the polarity markings are correct or not as per drawing.
6.2.2	Magnetization characteristics of CT	To prove that the turns of CTs secondary windings are not short circuited and to check healthiness of CT cores. The magnetizing currents at KPV (Knee point voltage) shall be less than the specified value. The ratio of secondary and primary voltage shall also be measured.
6.2.3	Ratio test for CT	The ratio errors of the primary to the secondary currents should within specified ratio errors.
6.2.4	IR measurement of CT (Primary & Secondary windings)	Changes in the normal IR value of CT indicate abnormal conditions such as presence of moisture, dirt, dust, crack in insulator of CT and degradation of insulation.
6.2.5	DGA test of CT oil	This test shall be conducted after 30 days of commissioning. The purpose is to identify evolving faults in the CT and DGA values shall be comparable with factory values (if available)
6.3	<b>Checks/ Tests applicable for Circuit Breakers</b>	
6.3.1	Dew point measurement of SF <sub>6</sub> gas	Dew point of SF <sub>6</sub> gas is to measure moisture content in SF <sub>6</sub> gas which shall indicate whether CB evacuation is done properly or not. This test shall be carried out preferably at rated pressure of SF <sub>6</sub> gas.
6.3.2	Measurement of Circuit	To measure closing/ tripping/ CO timings. These timings



Sr. No.	Name of Test / Check point	Purpose of test/ check
	Breaker Operating Timings including PIR Timings	should be within permissible limits and shall be comparable with factory values. Pole discrepancies and Break to Break discrepancies shall be less than specified values.
6.3.3	DCRM Contact Travel Measurement / DC injected currents and trip/ close coil currents.	DCRM is the technique for measuring Contact Resistance during operation (Close/ Trip) of a circuit breaker with a delay Tco of 300ms. A DC current of at least 100 Amp is injected through the circuit breaker. The current and voltage drop are measured and resistance is calculated. The resistance and travel versus time data provides useful information on the condition of the circuit breaker contacts and is used as a diagnostic tool. DCRM test signatures shall be approved by Corporate OS.
6.3.4	Operational lockout checking for EHV Circuit Breakers	To ensure various lockout operation of CB by simulating the actual conditions at the specified pressure of oil/ air/ operating medium.
6.3.5	Measurement of static contact resistance	This test is conducted to evaluate healthiness of Main contacts. 100 Amp DC is injected and voltage drop is measured across each CB contact to compute contact resistance.
6.3.6	Checking the Anti-Pumping feature	By giving simultaneous close/ trip commands, CB hunting shall not take place by operation of Mechanical/ Electrical anti pumping feature.
6.3.7	Checking the Anti-Condensation Heaters	To check correct operation of Thermostat provided for anti condensation heaters.
6.3.8	Pole discrepancy relay testing	To test tripping of CB in case of pole discrepancy more than 2.5 seconds or specified value.
6.3.9	Checking the N2 priming pressure	This test is to check healthiness of N2 accumulators provided in Hydraulic drive mechanisms. N2 priming pressure shall be as per the rated pressure.
<b>6.4</b>	<b>Checks/ Tests applicable for CVTs</b>	
6.4.1	CVT polarity, Ratio test	This test is conducted in the same manner as for CT to determine correct CVT polarity, ratio and phasor group.
6.4.2	Insulation resistance measurement of Primary & secondary winding	Changes in the normal IR value of CVT indicate abnormal conditions such as presence of moisture, dirt, dust, crack in insulator of CVT and degradation of insulation.
<b>6.5</b>	<b>Checks/ Tests applicable for Isolators</b>	
6.5.1	MILLIVOLT Drop test	The voltage drop gives a measure of resistance of current carrying part and contacts by injecting minimum 100 A DC current.

Sr. No.	Name of Test / Check point	Purpose of test/ check
6.5.2	50 operation tests	To test operation of contacts etc with jumpers connected and contact resistance to be measured after 50 operations. There shall not be any change from the previous value.
<b>6.6</b>	<b>Checks/ Tests applicable for Surge Arrestors</b>	
6.6.1	Third Harmonic Resistive Current (THRC) for surge arrestors	To monitor healthiness of Surge arrestors by monitoring third harmonic resistive current from the leakage current. This test is to be conducted after charging of Las. The value of THRC shall be less than 30 $\mu$ A.
6.6.2	IR measurement of each stack of LA	Changes in the normal IR value of LA indicate abnormal conditions such as presence of moisture, dirt, dust, crack in insulator of LA and degradation of insulation.
6.6.3	Checking of operation of LA counter	This test is done to check the healthiness of LA counter.
<b>6.7</b>	<b>Checks/ Tests for other areas/ equipments</b>	
6.7.1	Earth resistance measurement	To ensure value of earth resistance is below 1 ohm.
6.7.2	Secondary current injection test	Conducted for testing of protecting devices, circuit breakers, trip coils, motor overloads etc.
6.7.3	Contact Tightness check of Bay contacts by Primary injection method	Since complete bay contact resistance measurement is practically not possible because DC current may not be injected in CT primary, hence contact tightness check by primary injection method has been introduced to check overall contact tightness.
6.7.4	Stability check for Bus Bar	This test is performed to check the proper operation of Bus Bar protection by simulating actual conditions. Any problem in CT connection, wrong cabling, relay setting can be detected by this test.



## 6.1 TAN DELTA & CAPACITANCE MEASUREMENT OF CT, CVT, CB VOLTAGE GRADING CAPACITORS AND LA STACKS

To measure dissipation factor/loss factor (Tan delta) and Capacitance measurement of EHV class CTs, CVTs, CB Voltage Grading Capacitors & LA stacks by applying test voltages up to 10kV.

### A) CURRENT TRANSFORMERS

CTs with test taps

1. Tan delta tap to be disconnected from ground.
2. High voltage lead from tan delta kit to be connected to primary(HV) Terminal and LV lead to be connected to the Tan delta test tap.
3. P1 and P2 to be shorted
4. Porcelain surface to be thoroughly cleaned.
5. Measurements have to be taken in UST mode with fully automatic test kit.
6. Standard procedure(as specified by kit supplier) for measuring capacitance and tan delta in charged switchyard/induced voltage conditions should be followed for measurement of capacitance and tan delta values.
7. It is to be ensured to connect the test tap to ground terminal after carrying out the test.

### B) CB VOLTAGE GRADING CAPACITOR

1. Connect LV cable to the middle of the double interrupter.
2. Connect HV cable to the other end of the Grading capacitor to be tested.
3. The opposite end of the grading capacitor has to be grounded using earth switch.
4. Measurements have to be taken in UST Mode with fully automatic test kit.
5. Disconnect the HV cable and connect the same to the other grading capacitor and ground the previous grading capacitor. Now the second grading capacitor is ready for testing.
6. Standard procedure (as specified by kit supplier) for measuring capacitance and tan delta in charged switchyard/induced voltage conditions should be followed
7. Measurements are to be carried out at 10 kV/ 12 KV.

### C) CAPACITOR VOLTAGE TRANSFORMERS

1. Testing procedure for Top and Middle Stacks:
  - (a) Apply 10 KV between flanges of Top/Middle stacks (whichever is being tested)
  - (b) Carry out measurements in UST mode at 10.0 KV
  - (c) While measuring Middle/ Bottom stacks, Top/ middle stacks to be shorted.
2. Testing procedure for Bottom Stack connected to EMU PT
  - (a) Connect HV of the test kit at the top flange of bottom stack. HF point to be grounded. Earth connection of the neutral of the PT to be opened/ isolated from ground.
  - (b) Top of CVT to be guarded. LV lead of the kit to be connected at the top of the CVT for guarding.

- (c) Carry out measurements in GSTg mode at 10.0 KV
- (d) Repeat the Test with neutral of PT connected to ground.
- (e) In case Tan delta value is negative or erratic, only capacitance values are to be monitored.
- (f) Measurement to be carried out using fully automatic kit.

3. Standard procedure (as specified by kit supplier) for measuring capacitance and tan delta in charged switchyard/ induced voltage conditions should be followed.

#### D) SURGE ARRESTERS

1. Testing procedure for Top, Middle and Bottom Stacks:

- (a) Apply 10 KV between flanges of Top/Middle/ Bottom stacks (whichever is being tested)
- (b) Carry out measurements in UST mode at 10.0 KV with fully automatic test kit.
- (c) While measuring Middle/ Bottom stacks, the stacks above the HV lead to be shorted.

2. Standard procedure (as specified by kit supplier) for measuring capacitance and tan delta in charged switchyard/ induced voltage conditions should be followed.

3. While doing measurement of bottom stack the earth connection to be removed.

## 6.2 CHECKS/ TESTS APPLICABLE FOR CTs

### 6.2.1 POLARITY TEST FOR CT

A centre zero voltmeter is connected across CT secondary. A 1.5 Volt battery is touched to primary of CT. The deflection of pointer should be similar in case of each CT core.

At any instant current entering the primary from P1 the current should leave secondary from the terminal marked S1. A setup shown in the Figure 9 can show whether the polarity markings are correct or not.

When the key is pressed, current enters the primary through terminal P1, the voltmeter connected as shown, should read positive. A general arrangement of polarity test setup is indicated in Fig. 10.

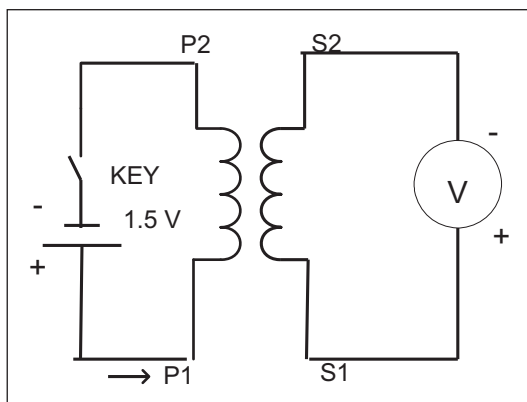


Figure - 9

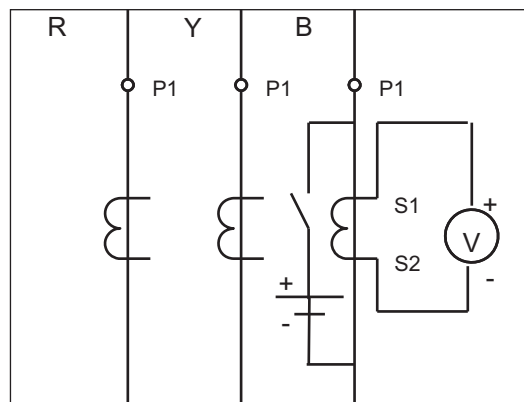


Figure - 10

## 6.2.2 MAGNETIZATION CHARACTERISTICS OF CTs

### PRECAUTIONS

- There should be no joints in testing leads/cables.
- It should be ensured that whole testing equipment along with testing procedures are available at testing site. Testing must be carried out in presence of testing personnel only.

**Test Equipment:** Voltage source of 5 kV, Voltmeter of range 0 to 5 kV, Ammeter of range 0 to 500 Amps, testing leads/cables etc.

**Test Procedure:** Make connections as per diagram shown below (Fig- 11). After making proper connections, applied voltage is increased from zero to rated Knee Point Voltage in steps of 25%, 50%, 75% and 100%. Measure the current drawn by the CT secondary core at respective applied voltages and record the test results

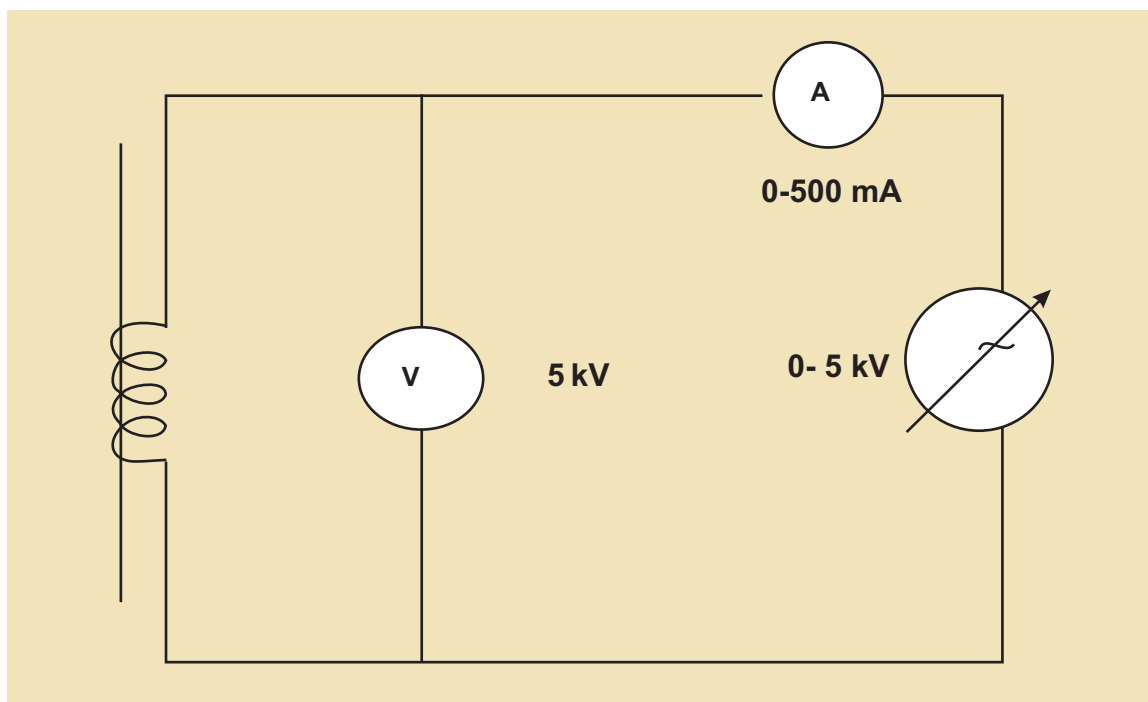
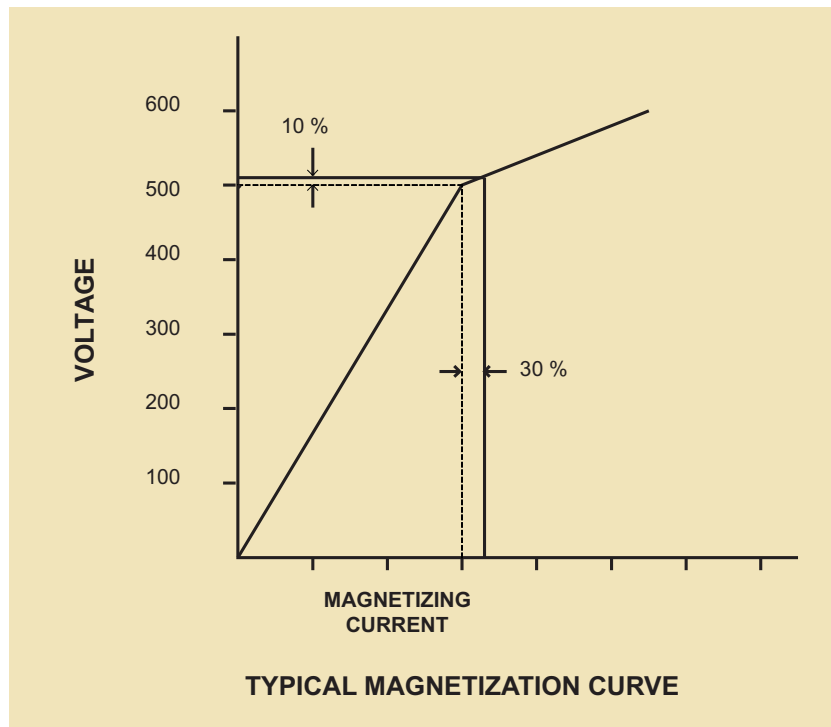


Figure - 11

Knee Point Voltage is normally defined as the voltage at which 10% increase in the applied voltage causes 30 to 50% increase in secondary current. The magnetization current at rated Knee Point Voltage should not be more than the specified/designed value. A curve can be drawn between applied voltage and magnetizing current. Typically, the curve drawn should be like the one given below in Fig.-12.

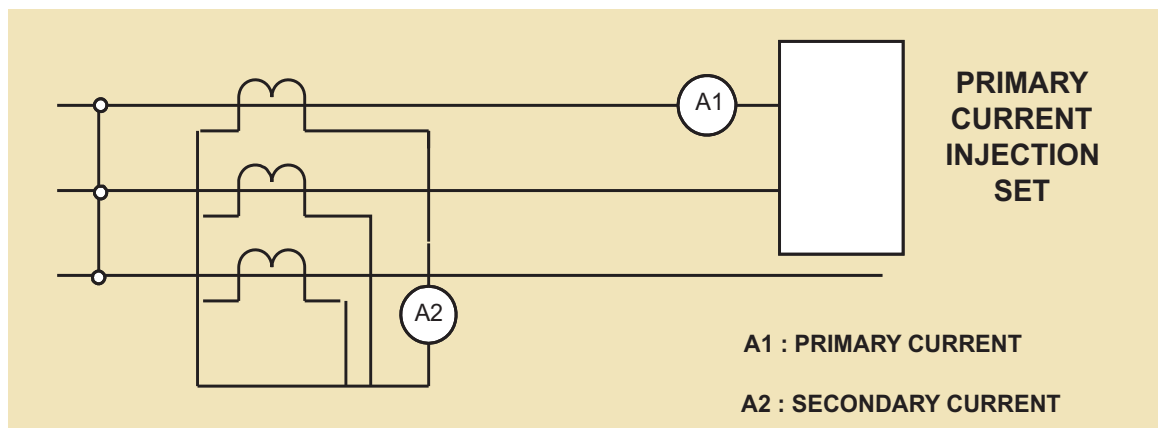


**Figure - 12**

From the curve it can be implied that up to rated KPV (Knee Point Voltage), the VI curve should be almost a straight line. However, if this line is not linear, this indicates that the magnetizing characteristics are not desirable. If the slope of the curve starts increasing, it indicates that magnetizing induction becomes low and total primary current is utilized in exciting the core alone. Consequently, out put of CT secondary disappears.

### 6.2.3 RATIO TEST FOR CURRENT TRANSFORMER

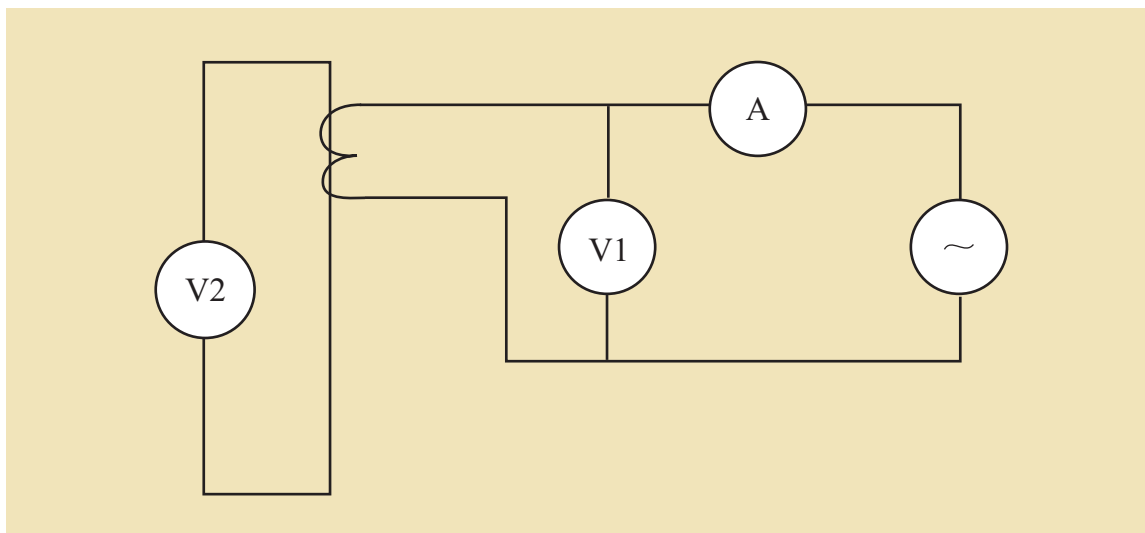
The ratio check has to be carried out as indicated in Fig-13 below.



**Figure - 13**

It is customary to conduct this in conjunction with the primary injection test. Current is passed through the primary circuit with the secondary winding circuit to its normal circuit load. The ratio of the primary to the secondary currents should approximate closely to that stamped under CT identification plate.

Alternatively, ratio test is to be conducted as per the following method (Fig-14).



**Figure - 14**

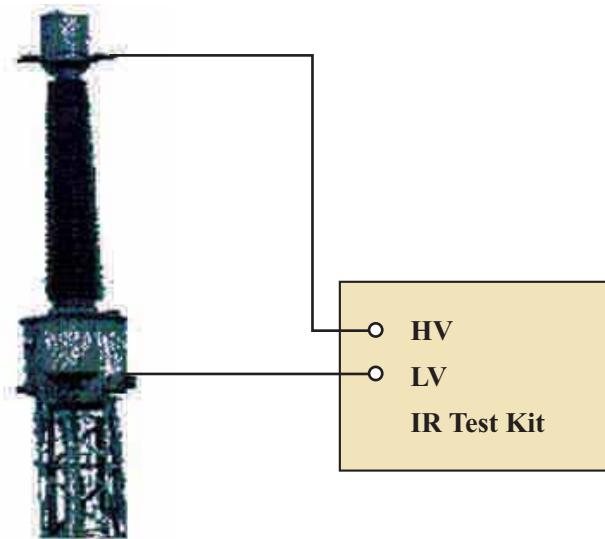
Apply voltage from secondary of the CT and measure voltage in primary winding. Increase voltage in secondary up to rated KPV/ ISF and by recording Primary Voltage, compute ratio of  $V1/V2$ . The ratio should match with the specified value.

#### **6.2.4 INSULATION RESISTANCE MEASUREMENT OF CURRENT TRANSFORMER**

##### **PRECAUTIONS**

- a) There should be no joints in testing cables.
- b) Test leads should not touch any live part.
- c) Megger body should be earthed (if separate terminal is provided).
- d) Surface/terminals should be cleaned.
- e) IR measurement should be carried out preferably in dry and sunny weather.
- f) Never connect the test set to energized equipment.
- g) The ground terminal must be connected first and removed at last.
- h) High voltage plugs should be free from moisture during installation and operation.
- i) If oil traces are found on the surface of CT, the same should be cleaned by Methyl Alcohol only. Petrol or diesel should never be used.
- j) It should be ensured that whole testing equipment along with testing procedures are available at testing site. Testing must be carried out in presence of testing engineer only.
- k) After testing with high voltage, test terminals must be grounded before being touched by any personnel.
- l) Test leads should be properly screened/ shielded.

Connect the Megger as per figure-15 given below. Connect the HV terminal to the Primary terminal of CT by using crocodile clip for firm grip



**Figure-15 Typical Arrangement for IR measurement**

Carry out the measurement as per standard procedure given by the kit supplier.

A test voltage as specified is applied as per the above connections and successive readings are taken. Values of IR should be recorded after 15 seconds, 60 seconds and 600 seconds. Ambient temperature and weather conditions are to be recorded.

**6.2.5 DGA Test of CT Oil:** Oil samples to be collected in 300ml bottles and to be sent to CIOTL Hyderabad for testing. Test results should be comparable to factory values. In case of any deviation, test results to be forwarded to CC-OS for approval.

## **6.3 CHECKS/TESTS APPLICABLE FOR CIRCUIT BREAKERS**

### **6.3.1 DEW POINT MEASUREMENT OF SF<sub>6</sub> GAS FOR CIRCUIT BREAKER**

Dew Point is the temperature at which moisture content in SF<sub>6</sub> gas starts condensing.

**Dew Point at rated pressure of CB:** Dew Point when measured keeping regulating valve in service at the outlet of dew point kit to allow required flow rate of gas, is called at rated pressure of CB. Inlet valve is opened completely.

**Dew Point at atmospheric pressure :** Dew Point when measured by regulating the gas flow at the inlet of dew point kit and keeping outlet regulating valve ( if provided) in fully open condition so that flow rate of gas is maintained as required, is called at atmospheric pressure.

### **TESTING PROCEDURE**

- a) Make the connections to the kit from CB pole ensuring that regulating valve is fully closed at the time of connections of the Dew Point kit.
- b) By regulating the flow rate of SF<sub>6</sub> gas (0.2 liter/min to 0.5 liter/min - ref. IEC 60480), the value of dew point is observed till it becomes stable.

- c) If the regulating valve is provided at outlet of the dew point kit then values as given in Doc. no. for rated pressures are to be monitored.

Dew Point of SF<sub>6</sub> gas varies with pressure at which measurement is being carried out. This is due to the fact that Saturation Vapour Pressure decreases with increase in Pressure of the SF<sub>6</sub> gas. Hence, dew point of SF<sub>6</sub> gas at higher pressure is lower than dew point at atmospheric pressure. Therefore, it is to be ensured that if measurement has been done at a pressure other than the atmospheric pressure, same is to be converted to the atmospheric pressure as given in the table below used at the time of commissioning for various CB manufacturers: Method for converting dew point at different gas pressures, is given/described in IEC-60480.

Sl. No.	Make of CB	Dew point at rated pressure	Dew point at Atmospheric Pressure ( Limit )
1	BHEL	(-) 15° C	- 36° C
2	M & G	-	- 39° C
3	CGL	(-) 15° C	- 35° C
4	ABB	(-) 15° C	- 35° C
5	NGEF	(-) 15° C	- 36° C

### 6.3.2 MEASUREMENT OF CIRCUIT BREAKER OPERATING TIMINGS INCLUDING PRE INSERTION RESISTOR TIMINGS

#### PRECAUTIONS

- There should not be any joint in testing cables.
- Test leads should not touch any live part.
- Never connect the test set to energised equipment.
- The ground cable must be connected first and removed at last.
- High voltage plugs should be free from moisture during installation and operation.
- Circuit Breaker Analyser body should be earthed (if separate earth is provided).
- It should be ensured that whole testing equipment along with testing procedures are available at testing site. Testing must be carried out in presence of testing personnel only.
- Surface/terminals should be cleaned where the connections for testing are to be made.
- Clean earth point with sand paper/wire brush where earth terminal is to be provided.
- Ensure that all the poles trip simultaneously through single close/trip command.

#### TESTING PROCEDURE

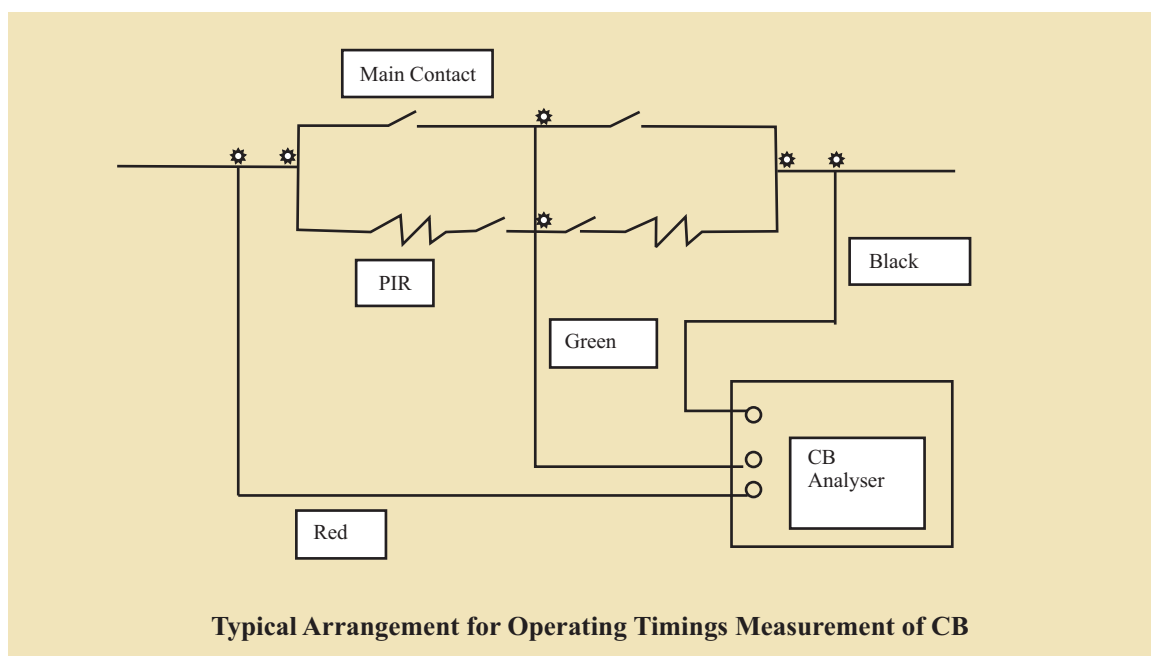
- Make connections as shown in the figure-16 below. It is to be ensured that R, Y, B phase marking cables are connected with the proper place in the CB analyser and colour codes are to be maintained for all the three poles of CB.
- Make connections for recording operating timings of Auxiliary contacts.
- Extend power supply to Circuit Breaker Analyzer.
- Give closing command to closing coil of CB and note down the PIR and main contact closing time. Take the print out from the Analyzer.

- e) Give tripping command to trip coil-I of CB & note down the main contact tripping time.
- f) Give tripping command to trip coil-II of CB & note down the main contact closing time.
- g) Note down the timings for 'CO', and 'OCO' by giving respective commands. CO command to be given without time delay but 300ms time delay to be given between O and CO operation in testing for OCO.
- h) To find out opening time of PIR contacts, PIR assembly has to be electrically isolated from Main contacts and then PIR contacts are to be connected to separate digital channels of the Analyzer.

## EVALUATION OF TEST RESULTS

### A) CLOSING TIMINGS

Closing timings and Discrepancy in operating times of PIR and main contacts should not exceed the permissible limits as specified in the DOC NO: D-5-02-XX-01-03. In any case, main contacts should not close prior to closing of PIR contacts and PIR contacts should not open prior to closing of main contacts. In case, contact bouncing is observed in operating timings for PIR and main contacts, same should be rectified by tightening the cable connections.



**Figure - 16**

### B) TRIPPING TIMINGS

Trip time and pole discrepancy in operating timings should not exceed beyond permissible value given in Doc. No. D-5-02-XX-01-03. In case of ABB, NGEF and CGL make CBs, while tripping, PIR contacts should not open after opening of main contacts.



### C) 'CO' TIMINGS

CO timings should be within permissible limits as specified by different manufacturers. If operating timings of CB poles are not within limits, same may be corrected by:

1. Equalizing the SF<sub>6</sub> gas pressure in all the poles
2. Adjusting plunger movement of trip/ close coils
3. Adjustment in operating mechanism
4. Changing of trip/ close coils (if required)

It is also important to measure timings of auxiliary contacts from the point of view of variations w.r.t. the main contacts.

### 6.3.3 DYNAMIC CONTACT RESISTANCE MEASUREMENT (DCRM) AND CONTACT TRAVEL MEASUREMENT OF EHV CIRCUIT BREAKERS

**Test Equipment:** 100 Amp. DCRM kit with CB operational analyzer with 10k Hz sampling frequency.

#### Isolation Required

- a) CB should be in open position.
- b) Isolator of both sides of CB should be in open position.
- c) Earth switch of one side of CB should be in open position.

#### Precautions

- a) There should be no joints in testing leads/cables.
- b) It should be ensured that whole testing equipment along with testing procedures are available at testing site. Testing must be carried out in presence of testing personnel only.
- c) Current leads should be connected such that voltage leads are not outside area of current flow.

#### Testing Procedure

1. Follow the standard procedure as given in instruction manual of DCRM kit.
2. The tightness of connections at CB flanges is most important to ensure error free measurement. CB during CO operation generates lot of vibrations and failure of connections during this period can dramatically change the dynamic signature of CB resistance.
3. DCRM signatures should be recorded for CO operation. Open command should be extended after 300 ms from the close command.
4. Clean portions of incoming and outgoing flanges of CB with polish paper to remove paint, oxidation etc, at points where Current clamps are mounted.
5. Select this point of connection, as close as possible to the end of porcelain insulator to ensure that minimum resistance is offered by flanges, bolts, terminal connectors etc.
6. It should be ensured that Travel Transducers are properly fitted.
7. Sampling frequency during measurement should be 10 KHz.
8. Resistance, travel, injected current and Trip/ Close coil currents are to be recorded.

The variations in the measured resistance versus time will be seen as a finger print for the breaker contacts and can be used as a bench mark for comparing with future measurements on the same breaker. This provides information on the condition of the breaker contacts, driving mechanism, operating levers etc.

### **Dynamic Contact Resistance Measurement for CB healthiness**

By application of Dynamic Contact Resistance Measurement, condition of arcing contact, main contact, operating levers, driving mechanism can be predicted. If DCRM signature shows wide variations and also there is change in arcing contact insertion time, it indicates erosion of the arcing contacts to main contacts and subsequent failure.

### **Contact Travel Measurement**

Transducers are attached to the operating rod or interrupting chamber in order to record the contact travel. When CB closes, contact travel is recorded. Contact bounces or any other abnormality is also clearly indicated by the Contact Travel Measurement.

If contact travel, contact speed and contact acceleration signature are compared with the original signatures, then it may indicate problems related with the operating mechanism, operating levers, main/ arcing contacts, alignments etc.

DCRM along with Contact Travel measurement is useful in monitoring length of Arcing contacts. Erosion of Arcing contacts may lead to commutation failures and current may get transferred to Main contacts. Due to heat of arc, main contacts may get damaged.

## **6.3.4 OPERATIONAL LOCKOUT CHECKING FOR EHV CIRCUIT BREAKERS**

### **6.3.4.1 TESTING PROCEDURE:**

#### **A. SF<sub>6</sub> GAS PRESSURE LOCKOUT**

##### **a) LOW PRESSURE ALARM**

Close Isolation Valve between CB Pole(s) and density monitor. Start releasing SF<sub>6</sub> gas from density monitor till the low pressure gas alarm contacts are actuated which is detected by Multimeter. Note down the pressure and temperature at which the contacts get actuated.

##### **b) OPERATIONAL LOCKOUT:**

Continue releasing SF<sub>6</sub> gas from isolated zone till the operational lockout Alarm Contacts are actuated which are detected by Multimeter. Note down the pressure and temperature at which the contacts get actuated. This is called operational lockout pressure.

#### **B. PNEUMATIC OPERATING SYSTEM LOCKOUT**

##### **a) COMPRESSOR START/STOP SWITCH**

Close the isolating valve of CB. Release air into atmosphere from the compressor. Note down the value of pressure at which Compressor starts building up air pressure and pressure at which Compressor stops.



b) CBAUTO RECLOSE LOCKOUT

Close isolation valve between pneumatic system and pressure switches. Release air from the isolated zone to atmosphere. Note down pressure at which A/R L/O contacts of pressure switch get actuated which are detected by Multimeter. The leads of the Multimeter should be connected to the contactor where the ARL/O of CB are made.

c) CB CLOSING LOCKOUT

Release air from the isolated zone to atmosphere. Note down pressure at which CB Closing L/O contacts of pressure switch get actuated which are detected by Multimeter.

d) CB OPERATIONAL LOCKOUT

Release air from the isolated zone to atmosphere. Note down pressure at which CB Operational L/O contacts of pressure switch get actuated which are detected by Multimeter.

e) MECHANICAL CLOSING INTERLOCK (FOR ABB & BHEL CBs ONLY)

CB should be in closed position. Release air from pneumatic system of CB to atmosphere and observe whether CB poles start opening, if so, note down the pressure at which tie rod starts coming down. In such case the closing interlock is to be opened for inspection and if required, replace the closing interlock.

C. HYDRAULIC OPERATING SYSTEM LOCKOUT

a) Pump START/STOP

By opening pressure release valve, note down the pressure at which Pump starts building up oil pressure and pressure at which pump stops.

b) CBAUTO RECLOSE LOCKOUT

Close Isolation valve between hydraulic system and pressure switches. Release oil from the isolated zone to oil tank. Note down pressure at which A/R L/O contacts of pressure switch get actuated which are detected by Multimeter.

c) CB CLOSING LOCKOUT

Release oil from the isolated zone to oil tank. Note down pressure at which CB Closing L/O contacts of pressure switch get actuated which are detected by Multimeter.

d) CB OPERATIONAL LOCKOUT

Release oil from the isolated zone to container. Note down pressure at which CB Operational L/O contacts of pressure switch get actuated which are detected by Multimeter.

D. OPERATING PRESSURE DROP TEST:

For Pneumatic/ Hydraulic operating system, operating pressure drop test to be performed during OCO operation of CB, keeping AC supply of Hydraulic pump/ Compressor in off condition. Hydraulic/ Pneumatic pressure drop should be within limits (as recommended by Manufacturer)

### 6.3.4.2 EVALUATION OF TEST RESULTS

#### A. SF6 GAS PRESSURE LOCKOUT

All the SF6 gas pressure switches settings should be checked and corrected with ambient temperature. Settings of SF6 gas pressure switches should be within  $\pm 0.1$  bar/ Kg/cm<sup>2</sup> of the set value ( after taking into account the temperature correction factor).

#### B. AIR PRESSURE LOCKOUT

All the air pressure switches settings should be checked and corrected and should be within  $\pm 0.3$  bar/ Kg/cm<sup>2</sup> of the set value.

#### C. OIL PRESSURE LOCKOUT

All the oil pressure switches settings should be checked and corrected and should be within  $\pm 0.3$  bar/ Kg/cm<sup>2</sup> of the set value.

### 6.3.5 MEASUREMENT OF STATIC CONTACT RESISTANCE

The Static contact resistance of main circuit of each pole of a circuit breaker is of the order of a few tens of micro ohms. 100 A DC is injected and milli volt drop is measured across each CB contact to compute contact resistance. The values should be within specified limits.

### 6.3.6 CHECKING THE ANTI-PUMPING FEATURE

When the breaker is in open position and closing and opening commands are given simultaneously the breaker first closes and then opens, but does not reclose even though the closing command is maintained.

### 6.3.7 CHECKING THE ANTI-CONDENSATION HEATERS

Check the supervisory circuit of the anti-condensation heaters for correct functioning. With the heaters switched ON, measure their current output.

### 6.3.8 POLE DISCREPANCY RELAY TESTING

Pole Discrepancy is defined as the difference in closing & opening timings of different poles of CB.

#### A. WHEN CB IN OPEN POSITION

Closing Command is extended to close one pole, say R-Pole, of CB. After closing R-Pole of CB, this Pole should automatically open after 2.5 seconds (as per pole discrepancy timer settings). Repeat the test for remaining two poles of CB.

## B. WHEN CB IN CLOSED POSITION

Tripping Command is extended to trip one pole, say R-Pole, of CB. Remaining Y and B- Poles of CB should automatically open after 2.5 seconds. Repeat the same test for remaining two poles of CB.

## C. EVALUATION OF TEST RESULTS

Permissible value of pole discrepancy between two poles of CB is 3.33 msec. from system point of view and it should not be confused with the setting of pole discrepancy timer which is generally 1.0 or 2.5 sec. depending on Auto-reclose scheme.

### 6.3.9 CHECKING THE NITROGEN PRIMING PRESSURE

Close the pressure release valve. Shortly after the oil pump starts, the priming pressure (200 bar at 20 °C) in the accumulator can be read. The relationship between the pressure and temperature is indicated in Fig. 17.

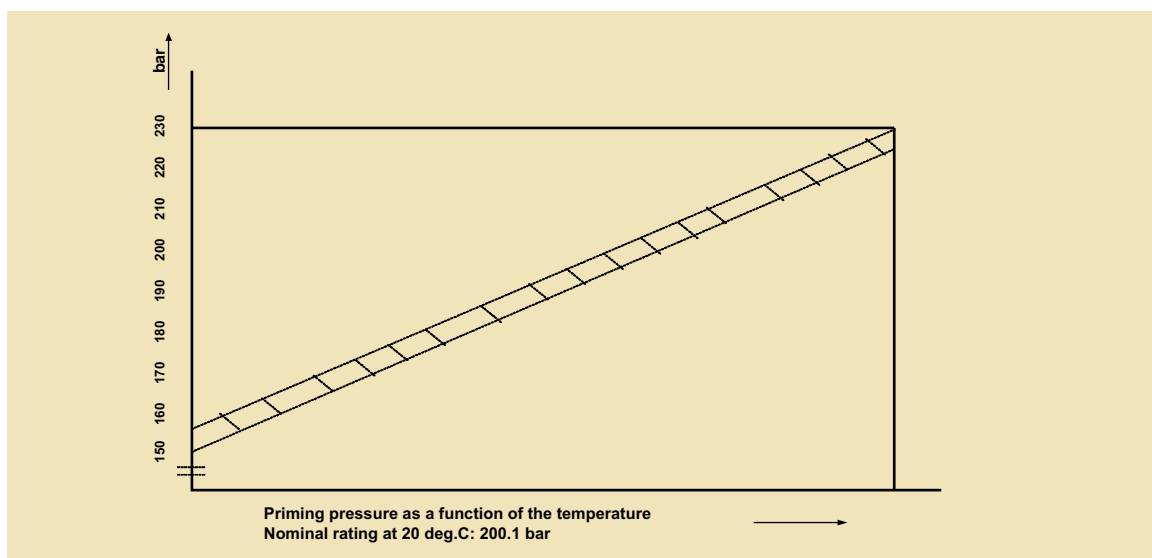


Figure - 17

## 6.4 CHECKS/TESTS APPLICABLE FOR CVTs

### 6.4.1 CVT POLARITY, RATIO TEST

CVT polarity is checked in the same manner as for CT, taking care to ensure that the battery is connected to the primary winding. In case of star/star winding configuration care has to be taken to ensure that the primary and secondary neutral points are not connected together. It is necessary to verify that the phase rotation sequence of the 3 phase CVT is correct. The secondary voltage between phases and neutral are measured and then phase rotation meter is connected across the three phase terminal.

### 6.4.2 INSULATION RESISTANCE MEASUREMENT OF PRIMARY & SECONDARY WINDING

## 6.5 CHECKS/TESTS APPLICABLE FOR ISOLATORS

### 6.5.1 MILLIVOLT DROP TESTS

The milli volt drop across the isolator is measured using DC current. The voltage drop gives a measure of resistance of current carrying part and contacts.

The DC current should be equal to or more than 100 A. The resistance of isolator should be measured at ambient air temperature. The temperature of specimen/environmental temperature should be recorded. The value of measured resistance should be converted to the value of temperature at which factory test results are taken. Temperature corrected value of resistance should be comparable to the factory value.

### 6.5.2 50 OPERATION TESTS

## 6.6 CHECKS/TESTS APPLICABLE FOR SURGE ARRESTERS

### 6.6.1 MEASUREMENT OF THIRD HARMONIC RESISTIVE CURRENT FOR SURGE ARRESTERS

#### Testing Procedure

- Make the connections as per the diagram given below (Fig.18)
- The kit should be properly earthed.
- Clamp On type CT should be placed above the surge monitor to pick up the total leakage current.
- Carryout the measurements as per standard procedure supplied by the test kit manufacturer.
- Note down the system voltage and ambient temperature along with the test current value.
- Avoid measurement during monsoon.

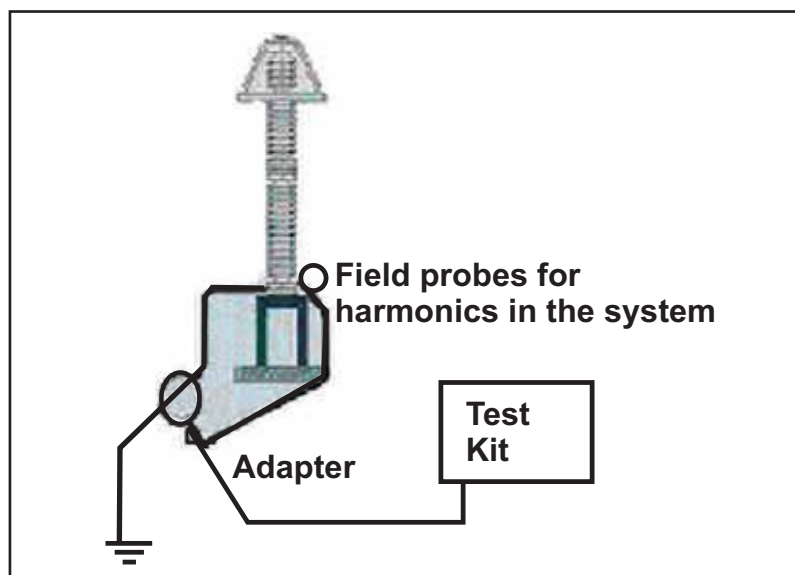
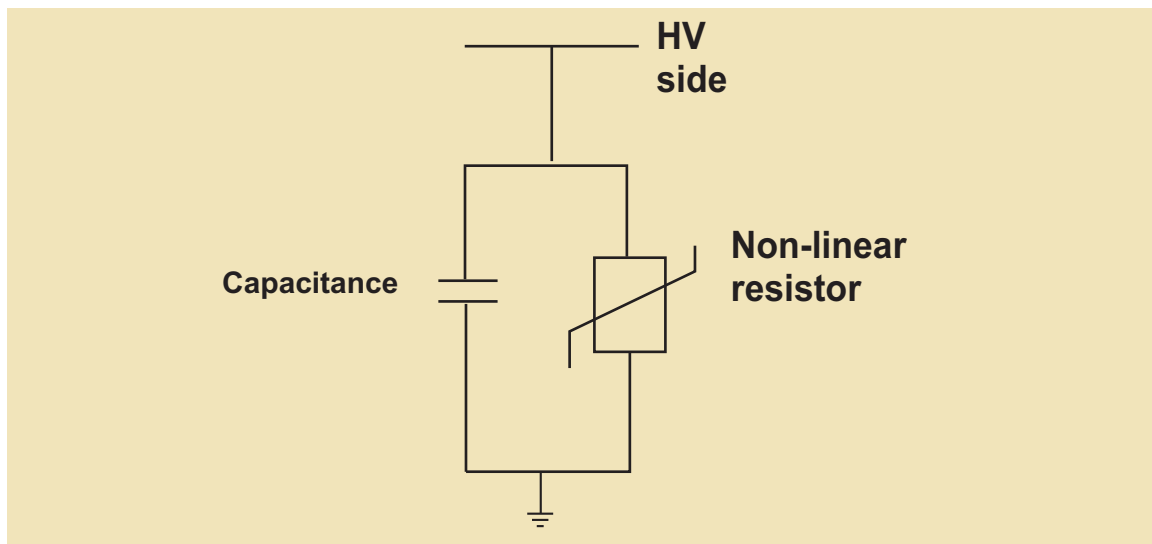


Figure- 18 Typical arrangement for THRCM Test

## EVALUATION OF TEST RESULTS

- A. ZnO Surge Arrester continuously conducts a small leakage current (Fig.19). The resistive component of this leakage current may increase with time due to different stresses causing ageing and finally cause arrester failure.
- B. If Harmonics are present in the system voltage, it affects the value of measured third harmonic current. Compensating device provided to be used to nullify the effect. The value of Third Harmonic Resistive current shall be less than  $30 \mu\text{A}$



**Figure-19 Arrester equivalent circuit**

## 6.7 CHECKS/ TESTS FOR OTHER AREAS/ EQUIPMENTS

### 6.7.1 EARTH RESISTANCE MEASUREMENT

Normally Earth tester is used for measuring

- (a) Soil resistivity
  - (b) Earth resistance
- a. Prior to the testing of soil resistivity and earth resistance the operation manual of the testing instrument available at site may be referred for procedures to be adopted for measurement of soil resistivity and earth resistance.  
A typical earth tester has 4 terminals. C1, P1, C2, P2 and 4 similar electrodes are driven in the ground at equal distances and connected to the instruments in the order of C1, P1 and P2, C2. Then the handle is rotated or button is pressed and the reading of the resistance is read on the scale of the instrument. If R is the resistance measured then

$$\text{Specific Resistivity} = 2\pi a R$$

Where 'a' is the distance between the electrode

And R is the resistance in ohms measured on the earth tester.

- b. In order to measure earth resistance of the electrode of the substation, it could be connected to C1 and the value of R could be read in the scale with the rotation of the handle of the Insulation tester. This will give the earth resistance. The value as far as possible should be around 1 ohm. To improve the value, water should be spread at the earth pit.

### 6.7.2 SECONDARY CURRENT INJECTION TEST SETS

The primary test is essential when commissioning and new installation as a test the whole protection system and will detect current transformers connected with incorrect polarity or relays that have been set in the wrong sequence in differential system. Secondary current injection sets are very useful for conducting these tests. The standard secondary current injection test equipment consists of a 1/5 A current injection set, separate wave form filter unit and a digital counter. The equipment is designed in a portable kit for on site testing of protecting devices, circuit breakers, trip coils, motor overloads, and similar apparatus. The filter unit should be used when testing saturating core type relays to ensure that the test current has a substantially sinusoidal waveform. The typical test setup is shown in fig. 20. Details of the testing will be elaborated in the relay testing.

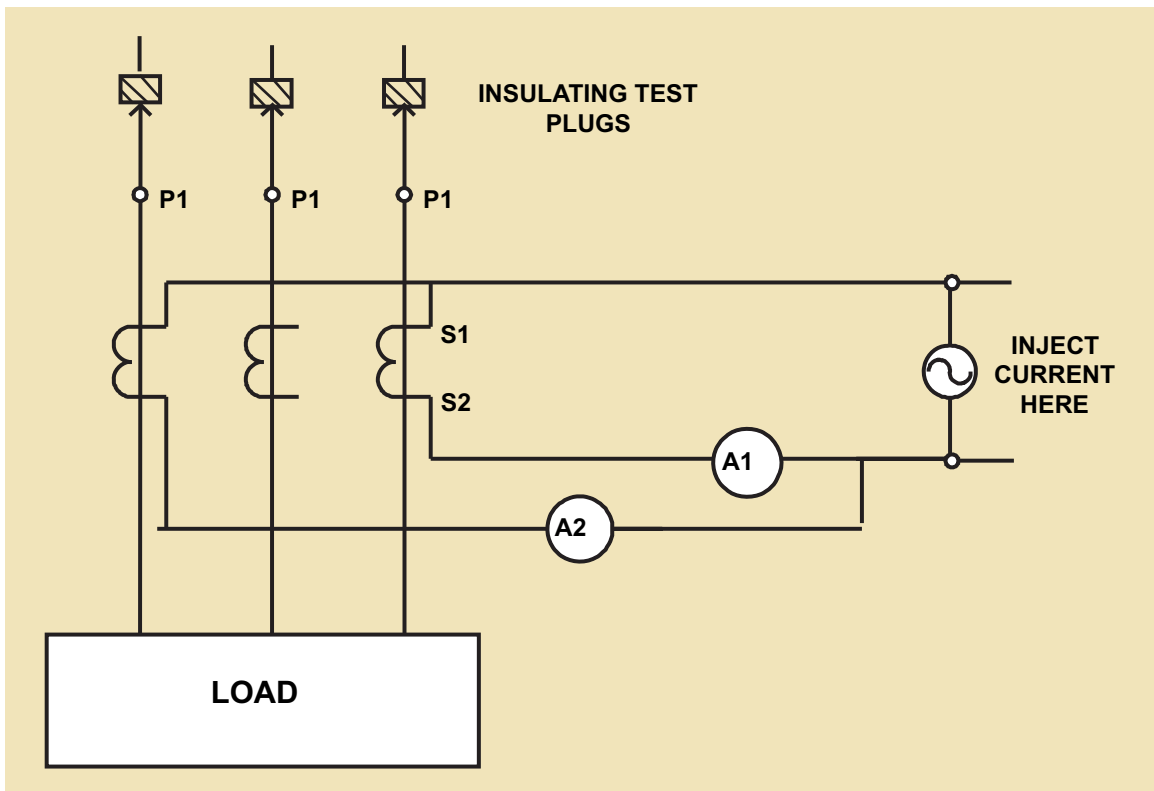
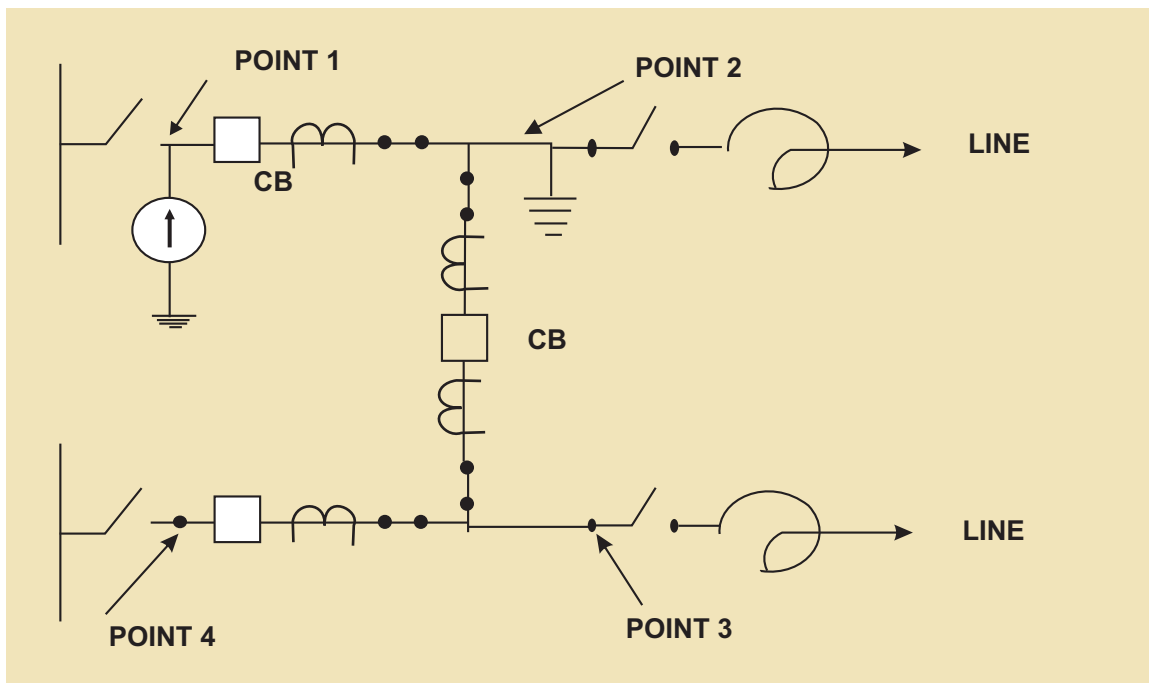


Figure - 20

### 6.7.3 CONTACT TIGHTNESS TEST OF BAY CONTACTS:

- a. Isolate the Bay from Bus–Side and line side as shown in Fig.-21.
- b. Ensure that all the secondary cores are connected or short if not in use.
- c. Inject the Current at Point 1 (200A) from primary injection kit (w r t earth) and return current via earth point at 2 as shown in Fig.-21.
- d. Check that we are able to inject current at point 1 and measure the current at point 2.
- e. Injection of current is the indication of contact tightness.
- f. Repeat the procedure for point 1 & 3
- g. Repeat the procedure for point 1 & 4

**Note:** Above tests can be aborted if individual contact resistances are within satisfactory limit and physical phase checking is satisfactory.



**Figure-21 : Primary injection test to check contact tightness of Bay/ feeders**

**TECHNICAL SPECIFICATION**  
**SECTION: SWITCHGEAR-CB**  
**REVISION-11**

## CIRCUIT BREAKER

### **17.0 PRE-COMMISSIONING TESTS**

- 17.1 An indicative list of tests is given below. All routine tests except power frequency voltage dry withstand test on main circuit breaker shall be repeated on the completely assembled breaker at site. For Pre-commissioning tests, procedures and formats for circuit breakers, POWERGRID document no. CF/CB/03/R-4 dated 01/04/2013 of document no. D-2-01-03-01-04 dated 01-04-2013 will be the reference document. This document will be available at respective sites and shall be referred by the contractor. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./instructions of the equipment Supplier or Employer without any extra cost to the Employer. The Contractor

shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to the Employer for approval.

- (a) Insulation resistance of each pole.
- (b) Check adjustments, if any suggested by manufacturer.
- (c) Breaker closing and opening time.
- (d) Slow and Power closing operation and opening.
- (e) Trip free and anti pumping operation.
- (f) Minimum pick-up voltage of coils.
- (g) Dynamic Contact resistance measurement.
- (h) Functional checking of control circuits interlocks, tripping through protective relays and auto reclose operation.
- (i) Insulation resistance of control circuits, motor etc.
- (j) Resistance of closing and tripping coils.
- (k) SF6 gas leakage check.
- (l) Dew Point Measurement
- (m) Operation check of pressure switches and gas density monitor during gas filling.
- (n) Checking of mechanical 'CLOSE' interlock, wherever applicable.
- (o) Testing of grading capacitor.
- (p) Resistance measurement of main circuit.
- (q) Checking of operating mechanisms
- (r) Check for annunciations in control room.
- (s) Point of wave switching test (wherever applicable)

17.2 The contractor shall ensure that erection, testing and commissioning of circuit breaker shall be carried out under the supervision of the circuit breaker manufacturer's representative. The commissioning report shall be signed by the manufacturer's representative.

## **12.0 PRE-COMMISSIONING TESTS**

- 12.1 Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the equipment manufacturer or Employer without any extra cost to the Employer. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates at his own cost.

An indicative list of tests on isolator and earth switch is given below. For pre-commissioning procedures and formats for Isolators and Grounding switch, Doc No. **CF/ISO/08/R-5** under POWERGRID standard pre-commissioning document **Doc. No. D-2-01-03-01-05** will be the reference document. This document will

be available at respective sites and shall be referred by the contractor.

- (a) Insulation resistance of each pole
- (b) Manual and electrical operation and interlocks
- (c) Insulation resistance of control circuits and motors
- (d) Ground connections
- (e) Contact resistance measurement
- (f) Proper alignment so as to minimize vibration during operation
- (g) Resistance of operating and interlocks coils
- (i) Functional check of the control schematic and electrical & mechanical interlocks
- (j) 50 operations test on isolator and earth switch

- 12.2 The Contractor shall ensure that erection, testing and commissioning of Isolators above 72.5 kV class shall be carried out under the supervision of the Isolator manufacturer's representative and the cost of the same shall be included in the erection price of the respective equipment.

**MODEL TECHNICAL SPECIFICATION**  
**SECTION-SWITCHGEAR-INST**  
**(INSTRUMENT TRANSFORMERS)**  
**(REV. NO. 11)**

## **9.0 PRE-COMMISSIONING TESTS**

- 9.1 An indicative list of tests is given below. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the equipment Supplier or Employer without any extra cost to the Employer. **The Contractor shall arrange all instruments**

**required for conducting these tests alongwith calibration certificates at his own cost.**

## 9.2 **Current Transformers**

- (a) Insulation Resistance Test for primary and secondary
- (b) Polarity test
- (c) Ratio identification test - checking of all ratios on all cores by primary injection of current
- (d) Dielectric test of oil (wherever applicable)
- (e) Magnetizing characteristics test
- (f) Tan delta and capacitance measurement
- (g) Secondary winding resistance measurement
- (h) Contact resistance measurement (wherever possible/accessible)
- (i) Test for SF<sub>6</sub> (for SF<sub>6</sub> filled CTs) – Dew point measurement, SF<sub>6</sub> alarm/lockout check
- (j) DGA test of oil

**Dissolved Gas Analysis (DGA) shall be carried out twice within the first year of service, first within the first month of commissioning/charging and second between six months to one year from the date of commissioning/charging.**

CTs/IVTs must have adequate provision for taking oil samples from the bottom of the CT/IVT without exposure to atmosphere. Manufacturer shall recommend the frequency at which oil samples should be taken and norms for various gases in oil after being in operation for different durations. ~~Bidder~~Manufacturer should also indicate the total quantity of oil which can be withdrawn from CT for gas analysis before refilling or further treatment of CT becomes necessary.

**Bidder shall supply 2 nos. oil sampling device for every 20 nos. oil filled CT supplied with a minimum of 2 nos. oil sampling device for each substation.**

## 9.3 **Inductive Voltage Transformers/Capacitive Voltage Transformers**

- (a) Insulation Resistance test for primary (if applicable) and secondary winding
- (b) Polarity test
- (c) Ratio test
- (d) Dielectric test of oil (wherever applicable)

- (e) Tan delta and capacitance measurement of individual capacitor stacks
- (f) Secondary winding resistance measurement

For pre-commissioning procedures and formats for Current Transformers, Doc.No.: CF/CT/04/R-4 dtd-01.04.2013 and for Voltage Transformers, CF/CVT/05/R-4 dtd-01.04.2011 under POWERGRID document no. D-2-01-03-01-04 will be the reference document. **This document will be available at respective sites and shall be referred by the contractor.**



## **8. PRE-COMMISSIONING TESTS**

8.1. An indicative list of tests is given below:

- a. Operation check of LA counters.
- b. Insulation resistance measurement
- c. Capacitance and Tan delta measurement of individual stacks.

- d. Third harmonic resistive current measurement (to be conducted after energisation.)
- 8.2. Contractor shall perform any additional test based on specialties of the items as per the field Q.P./Instructions of the equipment manufacturer or Employer without any extra cost to the Employer. The Contractor shall arrange all instruments required for conducting these tests along with calibration certificates at his own cost.
- 8.3. For pre-commissioning procedures and formats for Surge Arresters, Doc.No.: CF/SA/08/R-4 dtd-01/04/2013 under POWERGRID Document no. D-2-01-03-01-04 will be reference document. This document will be available at respective sites and shall be referred by the contractor.

# TECHNICAL SPECIFICATION

## SECTION-GENERAL TECHNICAL REQUIREMENTS



पावर ग्रिड कॉर्पोरेशन ऑफ इन्डिया लिमिटेड

(भारत सरकार का उद्यम)

**Power Grid Corporation of India Limited**

(A Government of India Enterprises)

Document No.: C/ENGG/SPEC/GTR (Rev.15)

December 2020

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## **SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

### **1.0 FOREWORD**

The provisions under this section are intended to supplement requirements for the materials, equipment's and services covered under other sections of tender documents and are not exclusive.

### **2.0 GENERAL REQUIREMENT**

- 2.1 a) All equipment/materials/items, as per Annexure-K, as applicable under present scope of works, shall be procured and supplied from domestic manufacturers only

Any imported equipment/material/item/parts/component (comprising of embedded systems) to be supplied under the contract shall be tested in the certified laboratories to check for any kind of embedded malware/trojans/cyber threats and for adherence to Indian Standards as per the directions issued by Ministry of Power/Govt. of India from time to time. In case of such import from specified "prior reference" countries, the requirement of prior permission from the Govt. of India including protocol for testing in certified and designated laboratories by Ministry of Power/Govt. of India shall also be complied with by the contractor.

The bidder/contractor shall list out the products and components producing Toxic e-waste under the contract and shall furnish to the Employer the procedure of safe disposal at the time of closing of the contract

- 2.1 b) The contractor shall furnish catalogues, engineering data, technical information, design documents, drawings etc., fully in conformity with the technical specification during detailed engineering.

- 2.2 It is recognised that the Contractor may have standardised on the use of certain components, materials, processes or procedures different from those specified herein. Alternate proposals offering similar equipment based on the manufacturer's standard practice will also be considered provided such proposals meet the specified designs, standard and performance requirements and are acceptable to Employer.

- 2.3 Wherever a material or article is specified or defined by the name of a particular brand, Manufacturer or Vendor, the specific name mentioned shall be understood as establishing type, function and quality and not as limiting competition.

- 2.4 Equipment furnished shall be complete in every respect with all mountings, fittings, fixtures and standard accessories normally provided with such equipment and/or needed for erection, completion and safe operation of the equipment as required by applicable codes though they may not have been specifically detailed in the Technical Specifications unless included in the list of exclusions. Materials and components which are minor in nature and incidental to the requirement but not specifically stated in the specification and bid price schedule, which are necessary for commissioning and satisfactory operation of the switchyard/ substation unless specifically excluded shall be deemed to be included in the scope of the specification and shall be supplied without any extra cost. All similar standard components/parts of similar standard equipment provided, shall be inter-changeable with one another.

- 2.5 The Contractor shall also be responsible for the overall co-ordination with internal /external agencies; Supplier of Employer's supplied equipments, project management, training of Employer's manpower, loading, unloading, handling, insurance, moving to final destination for successful erection, testing and commissioning of the substation /switchyard.

## **SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

2.6 The Contractor shall be responsible for safety of human and equipment during the working. It will be the responsibility of the Contractor to co-ordinate and obtain Electrical Inspector's clearance before commissioning. Any additional items, modification due to observation of such statutory authorities shall be provided by the Contractor at no extra cost to the Employer.

### **3.0 STANDARDS**

3.1 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.

3.2 The equipment offered by the contractor shall at least conform to the requirements specified under relevant IS standard. In case of discrepancy between IS and other international standard, provisions of IS shall prevail. The Contractor shall also note that the list of standards presented in this specification at Annex-C is not complete. Whenever necessary, the list of standards shall be considered in conjunction with specific IS. If the IS standard is not available for an equipment/material, then other applicable International standard (IEC/Equivalent), as per the specification, shall be accepted.

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

3.4 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 Other internationally accepted standards which ensure equivalent or better performance than that specified in the standards specified under Annexure-C/ individual sections for various equipments shall also, be accepted, however the salient points of difference shall be clearly brought out during detailed engineering along with English language version of such standard. The equipment conforming to standards other than specified under Annexure-C/individual sections for various equipments shall be subject to Employer's approval.

### **4.0 SERVICES TO BE PERFORMED BY THE EQUIPMENT BEING FURNISHED**

4.1 Switching surge over voltage and power frequency over voltage is specified in the system parameters below. In case of the 400kV system, the initial value of the temporary overvoltages could be 2.0 p.u. for 1-2 cycles. The equipment furnished under this specification shall perform all its functions and operate satisfactorily without showing undue strain, restrike etc under such over voltage conditions.

4.2 All equipments shall also perform satisfactorily under various other electrical, electromechanical and meteorological conditions of the site of installation.

4.3 All equipment shall be able to withstand all external and internal mechanical, thermal and electromechanical forces due to various factors like wind load, temperature variation, ice & snow, (wherever applicable) short circuit etc for the equipment.

4.4 The Contractor shall design terminal connectors of the equipment taking into account various forces as mentioned at Sl.No.4.3 that are required to withstand.

4.5 The equipment shall also comply to the following:

- a) To facilitate erection of equipment, all items to be assembled at site shall be "match marked".

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

- b) All piping, if any between equipment control cabinet/operating mechanism to marshalling box of the equipment, shall bear proper identification to facilitate the connection at site.

4.6

**System Parameter**

**765kV, 400kV & 220kV System**

SL No	Description of parameters	765kV System	400kV System	220kV System
1.	System operating voltage	765kV	400kV	220kV
2.	Maximum operating voltage of the system (rms)	800kV	420kV	245kV
3.	Rated frequency	50HZ	50Hz	50Hz
4.	No. of phase	3	3	3
5.	Rated Insulation levels			
i)	Full wave impulse withstand voltage (1.2/50 microsec.)	2100kVp	1550kVp	1050 kVp
ii)	Switching impulse withstand voltage (250/2500 micro sec.) dry and wet	1550kVp	1050kVp	-
iii)	One minute power frequency dry withstand voltage (rms)	830kV	630kV	-
iv)	One minute power frequency dry and wet withstand voltage (rms)	-	-	460kV
6.	Corona extinction voltage	508 kV	320kV	-
7.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz	2500 $\mu$ V at 508 kV rms	1000 $\mu$ V at 266kV rms	1000 $\mu$ V at 156kV rms
8.	Minimum creepage distance - for Equipment other than Insulator string	20000 mm (24800 mm for coastal area)	10500 mm (13020 mm for coastal area)	6125 mm (7595 mm for coastal area)
	Minimum creepage distance - for Insulator String	As specified in Section-Switchyard Erection		
9.	Min. clearances			
i.	Phase to phase	7600mm (for conductor-conductor configuration) 9400mm (for rod-conductor configuration)	4000mm (for conductor-conductor configuration) 4200mm (for rod -conductor configuration)	2100 mm

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

<b>SL No</b>	<b>Description of parameters</b>	<b>765kV System</b>	<b>400kV System</b>	<b>220kV System</b>
ii.	Phase to earth	4900mm (for conductor-structure) 6400mm (for rod- structure)	3500 mm	2100 mm
iii)	Sectional clearances	10300 mm	6500 mm	5000 mm
10.	Rated short circuit current for 1 sec. duration	40kA/50kA (as applicable)	40kA/50kA/63 kA (as applicable)	40kA/50kA(as applicable)
11.	System neutral earthing	Effectively earthed	Effectively earthed	Effectively earthed

**132kV, 66kV, 52kV, 33kV & 11kV System**

<b>SL No</b>	<b>Description of parameters</b>	<b>132 kV System</b>	<b>66kV System</b>	<b>52 kV System</b>	<b>33 kV System</b>	<b>11kV System</b>
1.	System operating voltage	132kV	66kV	52kV	33kV	11kV
2.	Maximum operating voltage of the system(rms)	145kV	72.5kV	52kV	36kV	12kV
3.	Rated frequency	50Hz	50Hz	50Hz	50Hz	50Hz
4.	No. of phase	3	3	3	3	3
5.	<b>Rated Insulation Levels</b>					
i)	Full wave impulse withstand voltage (1.2/50 microsec.)	650 kVp	325 kVp	250 kVp	170 kVp	75 kVp
ii)	One minute power frequency dry and wet withstand voltage (rms)	275kV	140kV	95kV	70kV	28kV
6.	Max. radio interference voltage for frequency between 0.5 MHz and 2 MHz	500 $\mu$ V at 92kV rms	-	-	-	-
7.	Minimum creepage distance	3625 mm (4495mm for coastal area)	1813 mm (2248m m for coastal area)	1300m m (1612 mm for coastal area)	900 mm (1116m m for coastal area)	300 mm (372mm for coastal area)

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

<b>SL No</b>	<b>Description of parameters</b>	<b>132 kV System</b>	<b>66kV System</b>	<b>52 kV System</b>	<b>33 kV System</b>	<b>11kV System</b>
8.	Min. Clearance					
i.	Phase to phase	1300 mm	750 mm	530mm	320 mm	280 mm
ii.	Phase to earth	1300 mm	630 mm	480mm	320 mm	140 mm
iii.	Sectional clearances	4000 mm	3100 mm	3100m m	2800 mm	2800 mm
9.	Rated short circuit current	40kA/ 31.5 kA (as applicable) for 1 sec	31.5 kA for 3 sec/25kA for 3 Sec*	25kA for 1 Sec	25 kA for 3 sec	25 kA for 3 sec
10.	System neutral earthing	Effectively earthed	Effectively earthed	Effectively earthed	Effectively earthed	Effectively earthed

Notes:

1. The above parameters are applicable for installations up to an altitude of 1000m above mean sea level. For altitude exceeding 1000m, necessary altitude correction factor shall be applicable as per relevant IEC/IS.
2. The insulation and RIV levels of the equipments shall be as per values given in the Technical Specification of respective equipment.
3. Corona and radio interference voltage test and seismic withstand test procedures for equipments shall be in line with the procedure given at **Annexure-A** and **Annexure-B** respectively.
4. “\*” For tertiary loading Equipment’s fault level shall be 25kA for 3 Sec. For other switchyard equipment shall be as specified in Section project.
5. Costal Area is to be considered only if defined in Section project.

**5.0 ENGINEERING DATA AND DRAWINGS**

5.1 The list of drawings/documents which are to be submitted to the Employer is enclosed in **Annexure-E**. In case any additional drawings/documents are required, the same shall also be submitted during execution of the contract.

5.2 The contractor shall submit all engineering Documents (Drawings/Design documents/data/detailed bill of quantity/ type test reports) through online Document Review and Engineering Approval Management System ( Herein after DREAMS) for the approval of the employer

**5.3 Drawings**

5.3.1 All drawings submitted by the Contractor shall be in sufficient detail to indicate the type, size, arrangement, material description, Bill of Materials, weight of each component, break-up for packing and shipment, dimensions, internal & the external connections, fixing arrangement required and any other information specifically requested in the specifications.

## **SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

- 5.3.2 Drawings submitted by the Contractor shall be clearly marked with the name of the Employer, the unit designation, the specifications title, the specification number and the name of the Project. POWERGRID has standardized a large number of drawings/documents of various make including type test reports which can be used for all projects having similar requirements and in such cases no project specific approval (except for list of applicable drawings alongwith type test reports) is required. However, distribution copies of standard drawings/documents shall be submitted as per provision of the contract. All titles, noting, markings and writings on the drawing shall be in English. All the dimensions should be in SI units.
- 5.3.3 The review of these data by the Employer will cover only general conformance of the data to the specifications and documents, interfaces with the equipment provided under the specifications, external connections and of the dimensions which might affect substation layout. This review by the Employer may not indicate a thorough review of all dimensions, quantities and details of the equipment, materials, any devices or items indicated or the accuracy of the information submitted. This review and/or approval by the Employer shall not be considered by the Contractor, as limiting any of his responsibilities and liabilities for mistakes and deviations from the requirements, specified under these specifications and documents.
- 5.5 All manufacturing and fabrication work in connection with the equipment prior to the approval of the drawings shall be at the Contractor's risk. The Contractor may make any changes in the design which are necessary to make the equipment conform to the provisions and intent of the Contract and such changes will again be subject to approval by the Employer. Approval of Contractor's drawing or work by the Employer shall not relieve the contractor of any of his responsibilities and liabilities under the Contract.
- 5.6 All engineering data submitted by the Contractor after final process including review and approval by the Employer shall form part of the Contract Document and the entire works performed under these specifications shall be performed in strict conformity, unless otherwise expressly requested by the Employer in Writing.

### **5.7 Approval Procedure**

The following schedule shall be followed generally for approval and for providing final documentation.

- |      |  |   |
|------|--|---|
| i)   | Approval/comments/<br>by Employer on initial<br>submission   | As per L2 schedule                                    |
| ii)  | Resubmission<br>(whenever<br>required)   | Within 3 (three) weeks<br>from date of comments       |
| iii) | Approval or comments   | Within 3 (three) weeks of<br>receipt of resubmission. |
| iv)  | Furnishing of distribution<br>copies (2 hard copies to each<br>substation and one scanned<br>copy (pdf format) | 2 weeks from the date<br>of approval                  |
| v)   | Furnishing of distribution<br>copies of test reports   |   |
|      | (a) Type test reports<br>(one scanned softcopy in  | 2 weeks from the date<br>of final approval            |

## **SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

pdf format to each substation  
plus one for corporate centre  
& one hardcopy per substation)

- |  |                               |
|--|-------------------------------|
| (b) Routine Test Reports<br>(one copy for each<br>substation)  | -do-                          |
| vi) Furnishing of instruction/<br>operation manuals (2 copies<br>per substation and one softcopy<br>(pdf format) for corporate centre<br>& per substation) | On completion of Engineering  |
| (vii) As built drawings (two sets of<br>hardcopy per substation & one<br>softcopy (pdf format) for<br>corporate centre & per substation)                   | On completion of entire works |

### **NOTE :**

- (1) The contractor may please note that all resubmissions must incorporate all comments given in the earlier submission by the Employer or adequate justification for not incorporating the same must be submitted failing which the submission of documents is likely to be returned.
- (2) All drawings should be submitted in "DREAMS" Portal, further substation design drawings like SLD, GA, all layouts etc. shall also be submitted in AutoCAD Version as a supporting document in DREAMS. SLD, GA & layout drawings shall be submitted for the entire substation in case of substation extension also.  
  
For civil drawings associated documents shall be submitted in STAAD/excel format as supporting document in DREAMS.
- (3) The instruction Manuals shall contain full details of drawings of all equipment being supplied under this contract, their exploded diagrams with complete instructions for storage, handling, erection, commissioning, testing, operation, trouble shooting, servicing and overhauling procedures.
- (4) If after the commissioning and initial operation of the substation, the instruction manuals require any modifications/additions/changes, the same shall be incorporated and the updated final instruction manuals shall be submitted by the Contractor to the Employer.
- (5) The Contractor shall furnish to the Employer catalogues of spare parts.
- (6) All As-built drawings/documents shall be certified by site indicating the changes before final submission.

5.8 The list of major drawings/documents to be approved to qualify for second advance as per Section SCC, shall be as per **Annexure-D**.

## **6.0 MATERIAL/ WORKMANSHIP**

### **6.1 General Requirement**

6.1.1 Where the specification does not contain references to workmanship, equipment, materials and components of the covered equipment, it is essential that the same must be new, of highest grade of the best quality of their kind, conforming to best engineering practice and suitable for the purpose for which they are intended.

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- 6.1.2 In case where the equipment, materials or components are indicated in the specification as “similar” to any special standard, the Employer shall decide upon the question of similarity. When required by the specification or when required by the Employer the Contractor shall submit, for approval, all the information concerning the materials or components to be used in manufacture. Machinery, equipment, materials and components supplied, installed or used without such approval shall run the risk of subsequent rejection, it is to be understood that the cost as well as the time delay associated with the rejection shall be borne by the Contractor.
- 6.1.3 The design of the Works shall be such that installation, future expansions, replacements and general maintenance may be undertaken with a minimum of time and expenses. Each component shall be designed to be consistent with its duty and suitable factors of safety, subject to mutual agreements. All joints and fastenings shall be devised, constructed and documented so that the component parts shall be accurately positioned and restrained to fulfill their required function. In general, screw threads shall be standard metric threads. The use of other thread forms will only be permitted when prior approval has been obtained from the Employer.
- 6.1.4 Whenever possible, all similar part of the Works shall be made to gauge and shall also be made interchangeable with similar parts. All spare parts shall also be interchangeable and shall be made of the same materials and workmanship as the corresponding parts of the Equipment supplied under the Specification. Where feasible, common component units shall be employed in different pieces of equipment in order to minimize spare parts stocking requirements. All equipment of the same type and rating shall be physically and electrically interchangeable.
- 6.1.5 All materials and equipment shall be installed in strict accordance with the manufacturer’s recommendation(s). Only first-class work in accordance with the best modern practices will be accepted. Installation shall be considered as being the erection of equipment at its permanent location. This, unless otherwise specified, shall include unpacking, cleaning and lifting into position, grouting, levelling, aligning, coupling of or bolting down to previously installed equipment bases/foundations, performing the alignment check and final adjustment prior to initial operation, testing and commissioning in accordance with the manufacturer’s tolerances, instructions and the Specification. All factory assembled rotating machinery shall be checked for alignment and adjustments made as necessary to re-establish the manufacturer’s limits suitable guards shall be provided for the protection of personnel on all exposed rotating and / or moving machine parts and shall be designed for easy installation and removal for maintenance purposes. The spare equipment(s) shall be installed at designated locations and tested for healthiness.
- 6.1.6 The Contractor shall apply oil and grease of the proper specification to suit the machinery, as is necessary for the installation of the equipment. Lubricants used for installation purposes shall be drained out and the system flushed through where necessary for applying the lubricant required for operation. The Contractor shall apply all operational lubricants to the equipment installed by him.
- 6.1.7 All oil, grease and other consumables used in the Works/Equipment shall be purchased in India unless the Contractor has any special requirement for the specific application of a type of oil or grease not available in India. If such is the case, he shall declare source of oil/grease /other consumables in the GTP/Drawings, where such oil or grease is available. He shall help Employer in establishing equivalent Indian make and Indian Contractor. The same shall be applicable to other consumables too.

### **6.2 Provisions For Exposure to Hot and Humid climate**

## **SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

Outdoor equipment supplied under the specification shall be suitable for service and storage under tropical conditions of high temperature, high humidity, heavy rainfall and environment favourable to the growth of fungi and mildew. The indoor equipments located in non-air conditioned areas shall also be of same type.

### **6.2.1 Space Heaters**

6.2.1.1 The heaters shall be suitable for continuous operation at 240V as supply voltage. On-off switch and fuse shall be provided.

6.2.1.2 One or more adequately rated thermostatically connected heaters shall be supplied to prevent condensation in any compartment. The heaters shall be installed in the compartment and electrical connections shall be made sufficiently away from below the heaters to minimize deterioration of supply wire insulation. The heaters shall be suitable to maintain the compartment temperature to prevent condensation.

### **6.2.2 FUNGI STATIC VARNISH**

Besides the space heaters, special moisture and fungus resistant varnish shall be applied on 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 interfere with the operation or performance of the equipment. Such surfaces or parts shall be protected against the application of the varnish.

### **6.2.3 Ventilation opening**

Wherever ventilation is provided, the compartments shall have ventilation openings with fine wire mesh of brass to prevent the entry of insects and to reduce to a minimum the entry of dirt and dust.

### **6.2.4 Degree of Protection**

The enclosures of the Control Cabinets, Junction boxes and Marshalling Boxes, panels etc. to be installed shall comply with following degree of protection as detailed here under:

- a) Installed out door: IP- 55
- b) Installed indoor in air conditioned area: IP-31
- c) Installed in covered area: IP-52
- d) Installed indoor in non-air conditioned area where possibility of entry of water is limited: IP-41.
- e) For LT Switchgear (AC & DC distribution Boards): IP-52

The degree of protection shall be in accordance with IS/IEC60947; IS/IEC/60529 . Type test report for of relevant Degree of Protection test, shall be submitted for approval.

## **6.3 RATING PLATES, NAME PLATES AND LABELS**

6.3.1 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, Customer 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 Employer. The rating plate of each equipment shall be according to IS/ IEC requirement.

6.3.2 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

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inscription first followed by English. Alternatively two separate plates one with Hindi and the other with English inscriptions may be provided.

### **6.4 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.

### **7.0 DESIGN IMPROVEMENTS / COORDINATION**

7.1 The bidder shall offer the equipment meeting the requirement of the technical specification. However, the Employer or the Contractor may propose changes in the specification of the equipment or quality thereof and if the contractor & Employer agree upon any such changes, the specification shall be modified accordingly.

7.2 If any such agreed upon change is such that it affects the price and schedule of completion, the parties shall agree in writing as to the extent of any change in the price and/or schedule of completion before the Contractor proceeds with the change. Following such agreement, the provision thereof, shall be deemed to have been amended accordingly.

7.3 The Contractor shall be responsible for the selection and design of appropriate equipments to provide the best co-ordinated performance of the entire system. The basic design requirements are detailed out in this Specification. The design of various components, sub-assemblies and assemblies shall be so done that it facilitates easy field assembly and maintenance.

7.4 The Contractor has to coordinate designs and terminations with the agencies (if any) who are Consultants/Contractor for the Employer. The names of agencies shall be intimated to the successful bidders.

7.5 The Contractor will be called upon to attend design co-ordination meetings with the Engineer, other Contractor's and the Consultants of the Employer (if any) during the period of Contract. The Contractor shall attend such meetings at his own cost at POWERGRID Corporate Centre, Gurgaon (Haryana) or at mutually agreed venue as and when required and fully cooperate with such persons and agencies involved during those discussions.

### **8.0 QUALITY ASSURANCE PROGRAMME**

8.1 To ensure that the equipment and services under the scope of this Contract, whether manufactured or performed within the Contractor's Works or at his Sub-Contractor's premises or at the Employer's site or at any other place of Work as applicable, are in accordance with the specifications, the Contractor shall ensure suitable quality assurance programme to control such activities at all points necessary. A quality assurance programme of the Contractor shall be in line with ISO requirements & shall generally cover the following:

- a) The organisation structure for the management and implementation of the proposed quality assurance programme.
- b) System for Document and Data Control.
- c) Qualification and Experience data of Bidder's key personnel.

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- d) The procedure for purchases of materials, parts, components and selection of sub-Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.
- e) System for shop manufacturing and site erection controls including process controls, fabrication and assembly control.
- f) System for Control of non-conforming products including deviation dispositioning, if any and system for corrective and preventive actions based on the feedback received from the Customers and also internally documented system for Customer complaints.
- g) Inspection and test procedure both for manufacture and field activities.
- h) System for Control of calibration of testing and measuring equipment and the indication of calibration status on the instruments.
- i) System for indication and appraisal of inspection status.
- j) System of Internal Quality Audits, Management review and initiation of corrective and Preventive actions based on the above.
- k) System for authorising release of manufactured product to the Employer.
- l) System for maintenance of records.
- m) System for handling, storage and delivery.
- n) A quality plan detailing out the specific quality control measures and procedure adopted for controlling the quality characteristics relevant to each item of equipment furnished and /or service rendered.
- o) System for various field activities i.e. unloading, receipt at site, proper storage, erection, testing and commissioning of various equipment and maintenance of records. In this regard, the Employer has already prepared Standard Field Quality Plan for transmission line/substation equipments as applicable, Civil/erection Works which is required to be followed for associated works.

The Employer or his duly authorised representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor/his vendor's quality management and control activities.

### **8.2 Quality Assurance Documents**

The Contractor shall ensure availability of the following Quality Assurance Documents:

- i) All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication, and reports including radiography interpretation reports.
- ii) Welder and welding operator qualification certificates.
- iii) Welder's identification list, welding operator's qualification procedure and welding identification symbols.
- iv) Raw Material test reports on components as specified by the specification and in the quality plan.
- v) The Manufacturing Quality Plan(MQP) indicating Customer Inspection Points (CIPs) at various stages of manufacturing and methods used to verify that the inspection and testing points in the quality plan were performed satisfactorily.

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- vi) Factory test results for testing required as per applicable quality plan/technical specifications/GTP/Drawings etc.
- vii) Stress relief time temperature charts/oil impregnation time temperature charts, wherever applicable.

### **8.3 INSPECTION, TESTING & INSPECTION CERTIFICATE**

8.3.1 Contractor shall procure bought out items from sub-vendors as per the list in "Compendium of Vendors" available on POWERGRID web-site [www.powergridindia.com](http://www.powergridindia.com) after ensuring compliance to the requirements/conditions mentioned therein. Contractor shall explore first the possibilities of procuring the bought out items from POWERGRID approved existing vendors. In case of their unavailability / non-response, Contractor may approach POWERGRID for additional sub-vendor approval. In that case, the assessment report of proposed sub vendor by Contractor along with the enclosures as per **Annexure-F** shall be submitted within 60 days of the award. The proposal shall be reviewed and approval will be accorded based on the verification of the document submitted and/or after the physical assessment of the works as the case may be. The physical assessment conducted by POWERGRID, if required, shall be on chargeable basis. Charges shall be as per the POWERGRID norms prevailing at that time, which shall be intimated by POWERGRID separately. If proposal for sub-vendor is submitted after 60 days, the Contractor's proposal normally will not be considered for current LOA. However, POWERGRID may process the case for developing more vendors for referred items, if found relevant. In all cases, It is the responsibility of the Contractor that Project activities do not suffer on account of delay in approval/non approval of a new sub-vendor.

The responsibility and the basis of inspection for various items & equipment is placed at **Annexure-G** along with the requirement of MQP (Manufacturing Quality Plan), ITP(Inspection & Test Plan), FAT(Factory Acceptance Test) which should be valid & POWERGRID approved and Level of inspection envisaged against each item.

Contractor shall ensure that order for items where MQP/ITP/FAT is required will be placed only on vendors having valid MQP/ITP/FAT and where the supplier's MQP/ITP/FAT is either not valid or has not been approved by POWERGRID, MQP shall be generally submitted as per POWERGRID format before placing order.

Items not covered under MQP/ITP/FAT shall be offered for inspection as per POWERGRID LOA/technical Specifications/POWERGRID approved data sheets/ POWERGRID approved drawings and relevant Indian/International standards.

**Inspection Levels:** For implementation of projects in a time bound manner and to avoid any delay in deputation of POWERGRID or its authorized representative, involvement of POWERGRID for inspection of various items / equipment will be based on the level below:

**Level –I:** Contractor to raise all inspection calls and review the report of tests carried out by the manufacturer, on his own, as per applicable standards/ POWERGRID specification, and submit to concerned POWERGRID inspection office/Inspection Engineer. CIP/MICC will be issued by POWERGRID based on review of test reports/certificates of manufacturers.

**Level – II:** Contractor to raise all inspection calls and carry out the inspection on behalf of POWERGRID on the proposed date of inspection as per applicable standards/specification. However, in case POWERGRID wishes to associate itself during inspection, the same would be intimated to

## **SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

Contractor and CIP/MICC will be issued by POWERGRID. Else, Contractor would submit their test reports/certificates to POWERGRID. CIP/MICC will be issued by POWERGRID based on review of test reports/certificates.

**Level - III:** Contractor to raise inspection calls for both, stage (as applicable) & final inspection and carry out the stage inspections (if applicable) on behalf of POWERGRID on the proposed date of inspection as per applicable standards/specification. However, in case POWERGRID wishes to associate itself during stage inspection, the same would be intimated to Contractor and CIP will be issued by POWERGRID. Else, Contractor would submit the test reports / certificates of stage inspection after their own review and CIP will be issued by POWERGRID based on review of test reports / certificates. Final inspection will be carried out by POWERGRID and CIP/MICC will be issued by POWERGRID.

**Level - IV:** Contractor to raise inspection calls for both, stage (as applicable) & final inspections. POWERGRID will carry out the inspection for both stage & final inspection as per applicable standards/specification and CIP/MICC will be issued by POWERGRID.

- 8.3.2 Contractor shall ensure that to implement the above inspection levels, particularly for the quality control and inspection at sub-vendor's works, they would depute sufficient qualified & experienced manpower in their Quality Control and Inspection department. Further, to assure quality of construction, Contractor shall have a separate workforce having appropriate qualification & experience and deploy suitable tools and plant for maintaining quality requirement during construction in line with applicable Field Quality Plan (FQP).
- 8.3.3 The Employer, his duly authorised representative and/or outside inspection agency acting on behalf of the Employer shall have at all reasonable times access to the Contractor's premises or Works and shall have the power at all reasonable times to ensure that proper Quality Management practices / norms are adhered to, inspect and examine the materials & workmanship of the Works, to carry out Quality/Surveillance Audit during manufacture or erection and if part of the Works is being manufactured or assembled at other premises or works. The Contractor shall obtain for the Employer and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. The item/equipment, if found unsatisfactory with respect to workmanship or material is liable to be rejected. The observations for improvements during product/ process inspection by POWERGRID shall be recorded in Quality Improvement Register (available & maintained at works) for review & timely compliance of observations.
- 8.3.4 Contractor shall submit inspection calls over internet through POWERGRID website. The required vendor code and password to enable raising inspection call will be furnished to the main Contractor within 30 days of award of contract on submission of documents by Contractor. After raising the inspection calls, Contractor shall then proceed as per the message of that particular call which is available on the message board.
- 8.3.5 The Employer reserves the right to witness any or all type, acceptance and routine tests specified for which the Contractor shall give the Employer/Inspector Twenty one (21) days written notice of any material being ready for testing for each stage of testing as identified in the approved quality plan as customer inspection point(CIP) for indigenous inspections. All inspection calls for overseas material shall be given at least forty five (45) days in advance. Such tests shall be to the Contractor's account

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except for the expenses of the Inspection Engineer. The Employer/inspector, unless witnessing of the tests is waived by Employer, will attend such tests within Twenty one (21) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed with the test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector three copies of tests, duly certified. Contractor shall ensure, before giving notice for type test, that all drawings and quality plans have been got approved. The equipment shall be dispatched to site only after approval of Routine and Acceptance test results and Issuance of Dispatch Clearance in writing by the Employer. CIP/Material Inspection clearance certificate (MICC) shall be issued by the Employer after inspection of the equipment or review of test reports as applicable. Employer may waive off the presence of Employer's inspecting engineer. In that case test will be carried out as per approved QP and test certificate will be furnished by the supplier for approval. CIP/MICC will be issued only after review and approval of the test reports.

- 8.3.6 Contractor shall generally offer material for inspection as per supply bar chart approved by POWERGRID and not before 30 days from schedule indicated in the bar chart. In case Contractor offers material(s) for inspection prior to 30 days from the scheduled date with necessary approval of POWERGRID, POWERGRID shall inspect the material and issue CIP only. However, in such an exceptional case, MICC shall be issued only as per provision of original / revised approved supply schedule.
- 8.3.7 Contractor shall minimize the number of inspection calls by offering optimum quantities in each inspection call at the respective manufacturer's works.
- 8.3.8 Contractor shall inspect the material themselves and only after they are fully convinced about the Quality, they shall offer the material for POWERGRID inspection and shall also ensure that relevant portion of LOA/NOA, approved drawing and data sheets along with applicable Quality Plans are available at the works of Contractor or their Sub-vendor before the material is offered for inspection.
- 8.3.9 Contractor shall ensure that material which has been cleared for dispatch after inspection will be dispatched within 30 days in case of domestic supplies and within 60 days in case of Off-shore supplies from the date of issuance of CIP. Material which is not dispatched within stipulated time as above will be reoffered for POWERGRID inspection or specific approval of POWERGRID QA&I shall be obtained for delayed dispatch.
- 8.3.10 The Employer or IE shall give notice in writing to the Contractor, of any objection either to conformance to any drawings or to any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to the Employer/Inspection Engineer giving reasons therein, that no modifications are necessary to comply with the Contract.
- 8.3.11 All Test Reports and documents to be submitted in English during final inspection of equipment by POWERGRID or as and when required for submission.
- 8.3.12 When the factory tests have been completed at the Contractor's or Sub-Contractor's works, the Employer/Inspection Engineer(IE) shall issue a certificate to this effect within fifteen (15) days after completion of tests & submission of documents by Contractor/manufacturer but if the tests are not witnessed by the Employer/IE, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Employer/IE. Contractor shall, on completion of all tests, submit test reports within Ten (10) days to POWERGRID IE. Failure of the Employer/IE to issue such a certificate shall not prevent the Contractor from proceeding with the Works.

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The completion of these tests or the issue of the certificate shall not bind the Employer to accept the equipment should, it, on further tests after erection, be found not to comply with the Contract.

- 8.3.13 In all cases, where the Contract provides for tests whether at the premises or works of the Contractor or of any Sub- Contractor, the Contractor, except where otherwise specified, shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Employer/Inspector or his authorised representative to carry out effectively such tests of the equipment in accordance with the Contract and shall give facilities to the Employer/Inspection Engineer or to his authorised representative to accomplish testing.
- 8.3.14 The inspection and acceptance by Employer and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of the Contractor in respect of the agreed quality assurance programme forming a part of the Contract, or if such equipment is found to be defective at a later stage.
- 8.3.15 The Employer will have the right of having at his own expenses any other test(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests, to satisfy that the material comply with the specification.
- 8.3.16 The Employer reserves the right for getting any additional field tests conducted on the completely assembled equipment at site to satisfy that material complies with specifications.
- 8.3.17 Rework/ Re-engineering, if any, on any item/equipment shall be carried out only after mutual discussions and in accordance with mutually agreed procedure. Contractor shall submit Joint Inspection Report of equipments under Re-Work/Re-Engineering alongwith procedure for the same to POWERGRID for approval, before taking up the Re-Work/Re-Engineering, failing which POWERGRID reserves the right to reject the equipment.
- 8.3.18 Contractor may establish a field test Laboratory to execute Civil Construction testing requirements at site with the condition that all testing equipment shall be calibrated from POWERGRID approved accredited Testing laboratories, with calibration certificates kept available at site and all testing personnel employed in the Field Testing Laboratories to be qualified and experienced Engineers or testing to be carried out at POWERGRID approved Third Party Laboratories.
- 8.3.19 Contractor shall ensure that all possible steps are taken to avoid damages to the equipment during transport, storage and erection.
- 8.3.20 Contractor shall implement additional stringent quality checks and preparation during installation of GIS at site (if applicable) as per POWERGRID approved guidelines/Technical specifications.
- 8.3.21 Contractor shall ensure commissioning of all CSDs along with Circuit Breakers wherever applicable.
- 8.3.22 For EHV transformers/reactors:**
- Insulation oil shall be as per POWERGRID Technical specifications and same grade shall be used for impregnation of the active part & testing at the works of Transformer/Reactor Manufacturer and as well as for filling the Transformer/Reactors at site. Contractor to ensure that windings for Transformer/Reactors are made in air-conditioned environment. Core-coil assembly shall be performed in positive pressurized dust controlled environment. Dust measurements shall be monitored

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regularly at Transformer / Reactor Manufacturer works. Contractor shall ensure that respective civil foundations & Fire walls for Transformer/Reactors units to be commissioned, shall be made ready at concerned sites before receipt of Transformer/Reactors units. All the requisite material for Neutral & Delta Bus formation required for charging of complete bank of 765KV class 1-ph Transformer/Reactor units shall be made available at the concerned sites before receipt of the Transformer/Reactor units at site.

8.3.23 The Employer reserves the right to increase or decrease their involvement in inspections at Contractor's Works or at his Sub-Contractor's premises or at the Employer's site or at any other place of Work based on performance of Contractor/sub-Contractor.

### **9.0 TYPE TESTING & CLEARANCE CERTIFICATE**

9.1 All equipment being supplied shall conform to type tests as per technical specification and shall be subject to routine tests in accordance with requirements stipulated under respective sections.

9.2 The reports for all type tests as per technical specification shall be furnished by the Contractor along with equipment / material drawings. However, type test reports of similar equipments/ material already accepted in POWERGRID shall be applicable for all projects with similar requirement. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by POWERGRID/representative authorized by POWERGRID/representative of Utility /representative of accredited test lab/ representative of The National Accreditation Board for Certification Bodies( NABCB) certified agency shall also be acceptable.

Unless otherwise specified elsewhere, the type test reports submitted shall be of the tests conducted within the years specified below from the date of NOA. In case the test reports are of the test conducted earlier than the years specified below from the date of NOA, the contractor shall repeat these test(s) at no extra cost to the Employer.

S.No	Name of Equipment	Validity of type test( in years )
1	Power Transformer	5
2	LT Transformer	5
3	Shunt Reactor	5
4	OLTC	10
5	Bushing of Power Transformers/Reactors	7
6	Fittings and accessories for Power transformers & Reactors	10
7	Circuit Breaker	10
8	Isolator	10
9	Lighting Arrester	10
10	Wave Trap	10
11	Instrument transformer	7
12	GIS & Hybrid GIS	10
13	LT Switchgear	10
14	Cable and associated accessories	10
15	Relays	7
16	Capacitors	10

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17	Battery & Battery Charger	7
18	Conductor & Earth wire	10
19	Insulators ( Porcelain/Glass)	10
20	Composite Insulators	5
21	PLCC	5

Note

For all other equipment's validity of type test shall be 10 years from date of NOA

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

The Contractor shall intimate the Employer the detailed program about the type tests atleast two (2) weeks in advance in case of domestic supplies & six (6) weeks in advance in case of foreign supplies.

- 9.3 The Employer intends to repeat those type tests which are indicated in the price schedule and the same shall be payable as per provision of contract. The price of conducting type tests shall be included in Bid price and break up of these shall be given in the relevant schedule of Bid Proposal Sheets. These Type test charges would be considered in bid evaluation. In case Bidder does not indicate charges for any of the type tests or does not mention the name of any test in the price schedules, it will be presumed that the particular test has been offered free of charge. Further, in case any Bidder indicates that he shall not carry out a particular test, his offer shall be considered incomplete and shall be liable to be rejected. The Employer reserves the right to waive the repeating of type tests partly or fully and in case of waiver, test charges for the same shall not be payable.
- 9.4 The Employer reserves the right to witness any or all the type tests. The Employer shall bear all expenses for deputation of Employer's representative(s) for witnessing the type tests except in the case of re-deputation if any, necessitated due to no fault of the Employer.
- 9.5 The list of makes of various items, for which Type test reports are not required to be submitted are specified at Annexure-J.

### **10.0 TESTS**

#### **10.1 Pre-commissioning Tests**

On completion of erection of the equipment and before charging, each item of the equipment shall be thoroughly cleaned and then inspected jointly by the Employer and the Contractor for correctness and completeness of installation and acceptability for charging, leading to initial pre-commissioning tests at Site. The list of pre-commissioning tests to be performed are given in respective chapters and shall be included in the Contractor's quality assurance programme.

#### **10.2 Commissioning Tests**

- 10.2.1 The available instrumentation and control equipment will to be used during such tests and the Employer will calibrate, all such measuring equipment and devices as far as practicable.
- 10.2.2 Any special equipment, tools and tackles required for the successful completion of the Commissioning Tests shall be arranged by the Contractor at his own cost.

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10.2.3 The specific tests requirement on equipment have been brought out in the respective chapters of the technical specification.

### **10.3.4 PRECOMMISSIONING, COMMISSIONING, TRIAL-RUN & COMPLETION**

As soon as the Facilities covered by these specifications are physically completed in all respects, the Pre commissioning, Commissioning, Trial-run and Completion of the Facilities, as mentioned below, shall be attained in accordance with the procedure given in the Conditions of Contract, Vol.-I of the Bidding Documents.

- (i) Pre commissioning : As per relevant Sections
- (ii) Commissioning : Charging of the Facilities at rated voltage.

Further, wherever appearing in these specifications, the words-‘commissioning checks’, ‘installation checks’, ‘site tests’, ‘performance guarantee tests for fire protection system’, are to be considered as ‘pre commissioning checks’.

- (iii) Trial-run : Operation of the Facilities or any part thereof by the Contractor immediately after the Commissioning for a continuous period of 72 (Seventy two) hours continuously. In case of interruption due to problem/failure in the respective equipment, the contractor shall rectify the problem and after rectification, continuous 72 (Seventy two) hours period start after such rectification.

- (iv) Completion : Upon successful completion of Trial-run.

‘Guarantee Test(s)’ and/or ‘Functional Guarantees’ are applicable only for Substation Automation System as specified in Section-‘Substation Automation System.’

10.3. The Contractor shall be responsible for obtaining statutory clearances from the concerned authorities for commissioning the equipment and the switchyard. However necessary fee shall be reimbursed by POWERGRID on production of requisite documents.

### **11.0 PACKAGING & PROTECTION**

11.1 All the equipments shall be suitably protected, coated, covered or boxed and crated to prevent damage or deterioration during transit, handling and storage at Site till the time of erection. On request of the Employer, the Contractor shall also submit packing details/associated drawing for any equipment/material under his scope of supply, to facilitate the Employer to repack any equipment/material at a later date, in case the need arises. While packing all the materials, the limitation from the point of view of availability of Railway wagon sizes in India should be taken into account. The Contractor shall be responsible for any loss or damage during transportation, handling and storage due to improper packing. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor. Employer takes no responsibility of the availability of the wagons.

11.2 All coated surfaces shall be protected against abrasion, impact, discolouration 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 and pipings and conduit equipment connections shall be properly sealed with suitable devices to protect them from damage.

## SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

### **12.0 FINISHING OF METAL SURFACES**

12.1 All metal surfaces shall be subjected to treatment for anti-corrosion protection. All ferrous surfaces for external use unless otherwise stated elsewhere in the specification or specifically agreed, shall be hot-dip galvanized after fabrication. All steel conductors including those used for earthing/grounding (above ground level) shall also be galvanized according to IS: 2629.

### **12.2 HOT DIP GALVANISING**

12.2.1 The minimum weight of the zinc coating shall be 610 gm/sq.m and minimum average thickness of coating shall be 86 microns for all items having thickness 6mm and above **and 900 gm/sq.m for coastal area (if defined in Section Project)** For items lower than 6mm thickness requirement of coating thickness shall be as per relevant ASTM. For surface which shall be embedded in concrete, the zinc coating shall be 610 gm/sq.m minimum **and 900 gm/sq.m for coastal area (if specified in Section-Project)**.

12.2.2 The galvanized surfaces shall consist of a continuous and uniform thick coating of zinc, firmly adhering to the surface of steel. The finished surface shall be clean and smooth and shall be free from defects like discoloured patches, bare spots, unevenness of coating, spelter which is loosely attached to the steel globules, spiky deposits, blistered surface, flaking or peeling off, etc. The presence of any of these defects noticed on visual or microscopic inspection shall render the material liable to rejection.

12.2.3 After galvanizing, no drilling or welding shall be performed on the galvanized parts of the equipment excepting that nuts may be threaded after galvanizing. Sodium dichromate or alternate approved treatment shall be provided to avoid formation of white rust after hot dip galvanization.

12.2.4 The galvanized steel shall be subjected to four numbers of one minute dips in copper sulphate solution as per IS-2633.

12.2.5 Sharp edges with radii less than 2.5 mm shall be able to withstand four immersions of the Standard Preece test. All other coatings shall withstand six immersions. The following galvanizing tests should essentially be performed as per relevant Indian Standards.

- Coating thickness
- Uniformity of zinc
- Adhesion test
- Mass of zinc coating

12.2.6 Galvanised material must be transported properly to ensure that galvanised surfaces are not damaged during transit. Application of touch-up zinc rich paint at site shall be allowed with approval of Engineer Incharge.

### **12.3 PAINTING**

12.3.1 All sheet steel work shall be degreased, pickled, phosphated in accordance with the IS-6005 "Code of practice for phosphating iron and sheet". All surfaces, which will not be easily accessible after shop assembly, shall beforehand be treated and protected for the life of the equipment. The surfaces, which are to be finished painted after installation or require corrosion protection until installation, shall be shop painted with at least two coats of primer. Oil, grease, dirt and swaf shall be thoroughly removed by emulsion cleaning. Rust and scale shall be removed by pickling with dilute acid followed by washing with running water, rinsing with slightly alkaline hot water and drying.

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- 12.3.2 Hot Phosphating shall be done for phosphating process under pretreatment of sheets After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be “flash dried” while the second coat shall be stoved.
- 12.3.3 After application of the primer, two coats of finishing synthetic enamel paint shall be applied, each coat followed by stoving. The second finishing coat shall be applied after inspection of first coat of painting.
- 12.3.4 The exterior and interior colour of the paint in case of new substations shall preferably be RAL 7032 for all equipment, marshalling boxes, junction boxes, control cabinets, panels etc. unless specifically mentioned under respective sections of the equipments. Glossy white colour inside the equipments /boards /panels/junction boxes is also acceptable. The exterior colour for panels shall be matching with the existing panels in case of extension of a substation. Each coat of primer and finishing paint shall be of slightly different shade to enable inspection of the painting. A small quantity of finishing paint shall be supplied for minor touching up required at site after installation of the equipments.
- 12.3.5 In case the contractor proposes to follow his own standard surface finish and protection procedures or any other established painting procedures, like electrostatic painting etc., the procedure shall be submitted during detailed engineering for Employer’s review & approval.
- 12.3.6 The colour scheme as given below shall be followed for Fire Protection and Air Conditioning systems

<b>S.No.</b>	<b>PIPE LINE</b>	<b>Base colour</b>	<b>Band colour</b>
<b><u>Fire Protection System</u></b>			
1	Hydrant and Emulsifier system pipeline/NIFPS	FIRE RED	-
2	Emulsifier system detection line – water	FIRE RED	Sea Green
3	Emulsifier system detection line –Air	FIRE RED	Sky Blue
4	Pylon support pipes	FIRE RED	
<b><u>Air Conditioning Plant</u></b>			
5	Refrigerant gas pipeline – at compressor suction	Canary Yellow	-
6	Refrigerant gas pipeline – at compressor discharge	Canary Yellow	Red
7	Refrigerant liquid pipeline	Dark Admiralty Green	-
8	Chilled water pipeline	Sea Green	-
9	Condenser water pipeline	Sea Green	Dark Blue

The direction of flow shall be marked by → (arrow) in black colour.



Base Colour Direction of flow Band Colour

- 12.3.7 For aluminium casted surfaces, the surface shall be with smooth finish. Further, in case of aluminium enclosures, the surface shall be coated with powder (coating thickness of 60 microns) after surface preparation for painting. For stainless steel surfaces, no painting is envisaged.

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12.3.8 Band colour is required for Emulsifier system detection line only if both water and air detection lines are present at the same substation. Further, band colour shall be applied at an interval of 2 meters approx. along the length and minimum width of band shall be 25mm.

### **13.0 HANDLING, STORING AND INSTALLATION**

13.1 In accordance with the specific installation instructions as shown on manufacturer's drawings or as directed by the Employer or his representative, the Contractor shall unload, store, erect, install, wire, test and place into commercial use all the equipment included in the contract. Equipment shall be installed in a neat, workmanlike manner so that it is level, plumb, square and properly aligned and oriented. Commercial use of switchyard equipment means completion of all site tests specified and energisation at rated voltage.

13.2 Contractor may engage manufacturer's Engineers to supervise the unloading, transportation to site, storing, testing and commissioning of the various equipment being procured by them separately. Contractor shall unload, transport, store, erect, test and commission the equipment as per instructions of the manufacturer's supervisory Engineer(s) and shall extend full cooperation to them.

13.3 The contractor must ensure that the open storage platform (as per Drawing No. C-ENGG-CVL-STD-PLATFORM-01, Rev.0) is constructed for storage of outdoor type equipment/material prior to commencement of delivery at site. Outdoor equipment shall be stored on open storage platform, properly covered with waterproof and dustproof covers to protect them from water seepage and moisture ingress.

However, all indoor equipments including control & protection panels, Communication equipments and operating mechanism boxes etc. of outdoor equipments shall be stored indoors.

Storage of equipment on top of another one is not permitted if the wooden packing is used and there is possibility of equipment/packing damage. Material opened for joint inspection shall be repacked properly as per manufacturer's recommendations.

During storage of material regular periodic monitoring of important parameters like oil level / leakage, SF6 / Nitrogen pressure etc. shall be ensured by the contractor.

13.4 In case of any doubt/misunderstanding as to the correct interpretation of manufacturer's drawings or instructions, necessary clarifications shall be obtained from the Employer. Contractor shall be held responsible for any damage to the equipment consequent to not following manufacturer's drawings/instructions correctly.

13.5 Where assemblies are supplied in more than one section, Contractor shall make all necessary mechanical and electrical connections between sections including the connection between buses. Contractor shall also do necessary adjustments/alignments for proper operation of circuit breakers, isolators and their operating mechanisms. All components shall be protected against damage during unloading, transportation, storage, installation, testing and commissioning. Any equipment damaged due to negligence or carelessness or otherwise shall be replaced by the Contractor at his own expense.

13.6 Contractor shall be responsible for examining all the shipment and notify the Employer immediately of any damage, shortage, discrepancy etc. for the purpose of Employer's information only. The Contractor shall submit to the Employer every week a report detailing all the receipts during the weeks. However, the Contractor shall be solely responsible for any shortages or damages in transit, handling and/or in storage and

## **SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

- erection of the equipment at Site. Any demurrage, wharfage and other such charges claimed by the transporters, railways etc. shall be to the account of the Contractor.
- 13.7 The Contractor shall be fully responsible for the equipment/material until the same is handed over to the Employer in an operating condition after commissioning. Contractor shall be responsible for the maintenance of the equipment/material while in storage as well as after erection until taken over by Employer, as well as protection of the same against theft, element of nature, corrosion, damages etc.
- 13.8 Where material / equipment is unloaded by Employer before the Contractor arrives at site or even when he is at site, Employer by right can hand over the same to Contractor and there upon it will be the responsibility of Contractor to store the material in an orderly and proper manner.
- 13.9 The Contractor shall be responsible for making suitable indoor storage facilities, to store all equipment which requires indoor storage.
- 13.10 The words 'erection' and 'installation' used in the specification are synonymous.
- 13.11 Exposed live parts shall be placed high enough above ground to meet the requirements of electrical and other statutory safety codes.
- 13.12 The design and workmanship shall be in accordance with the best engineering practices to ensure satisfactory performance throughout the service life. If at any stage during the execution of the Contract, it is observed that the erected equipment(s) do not meet the above minimum clearances the Contractor shall immediately proceed to correct the discrepancy at his risks and cost.
- 13.13 Equipment Bases**
- A cast iron or welded steel base plate shall be provided for all rotating equipment which is to be installed on a concrete base unless otherwise agreed to by the Employer. Each base plate shall support the unit and its drive assembly, shall be of a neat design with pads for anchoring the units, shall have a raised lip all around, and shall have threaded drain connections.
- 13.14 Erection, testing and commissioning of Transformers, Reactors, Circuit breakers, Isolators, Substation automation system, Control & protection panels, PLCC, PMU, Telecommunication Equipments, NIFPS System etc. shall be done by the contractor under the supervision of respective equipment manufacturers. Charges for the above supervision shall be included by the bidder in the erection charges for the respective equipment in the BPS.
- 14.0 TOOLS**
- 14.1 TOOLS & PLANTS (T&P)**
- The Contractor shall arrange all T&P (such as necessary supports, cranes, ladders, platforms etc.) for erection, testing & commissioning of the system at his own cost. Further, all consumables, wastage and damages shall be to the account of contractor.
- All such T&P shall be taken back by the contractor after commissioning of the system.
- 14.2 SPECIAL TOOLS AND TACKLES**
- The contractor shall supply all special tools and tackles required for Operation and maintenance of equipment. The special tools and tackles shall only cover items which are specifically required for the equipment offered and are proprietary in nature. The list of special tools and tackles, if any, shall be finalized during detail engineering and the same shall be supplied without any additional cost implication to the Employer.

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### **14.3 FACILITIES TO BE PROVIDED BY THE EMPLOYER**

14.3.1 Employer shall make available the auxiliary supplies at a single point in the substation on chargeable basis. The prevailing energy rates of the state shall be applicable. All further distribution from the same for construction supply shall be made by the contractor. However, in case of failure of power due to any unavoidable circumstances, the contractor shall make his own necessary arrangements like diesel generator sets etc. at his own cost so that progress of work is not affected and Employer shall in no case be responsible for any delay in works because of non-availability of power.

14.3.2 Employer shall make available construction water supply at a single point in the substation. All further distribution for the same shall be made by the Contractor. In case of non-availability or inadequate availability of water for construction work, the contractor shall make his own arrangement at his own cost and the Employer shall in no case be responsible for any delay in works because of non-availability or inadequate availability of water.

### **15.0 AUXILIARY SUPPLY**

15.1 The auxiliary power for station supply, including the equipment drive, cooling system of any equipment, air-conditioning, lighting etc shall be designed for the specified Parameters as under. The DC supply for the instrumentation and PLCC system shall also conform the parameters as indicated in the following table:

<b>Normal Voltage</b>	<b>Variation in Voltage</b>	<b>Frequency in HZ</b>	<b>Phase/Wire</b>	<b>Neutral connection</b>
415V	± 10%	50 ± 5%	3/4 Wire	Solidly Earthed.
240V	± 10%	50 ± 5%	1/2 Wire	Solidly Earthed.
220V	190V to 240V	DC	Isolated 2 wire System	-
110V	95V to 120V	DC	Isolated 2 wire System	-
48V	--	DC	2 wire system (+) earthed	-

Combined variation of voltage and frequency shall be limited to ± 10%.

15.2 Pickup value of binary input modules of Intelligent Electronic Devices, Digital protection couplers, Analog protection couplers shall not be less than 50% of the specified rated station auxiliary DC supply voltage level.

### **16.0 SUPPORT STRUCTURE**

16.1 The equipment support structures shall be suitable for equipment connections at the first level i.e 14.0 meter, 8.0 meter, 5.9 meter and 4.6 meter from plinth level for 765kV, 400kV, 220kV and 132kV substations respectively. All equipment support structures shall be supplied alongwith brackets, angles, stools etc. for attaching the operating mechanism, control cabinets & marshalling box (wherever applicable) etc.

## SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

16.2 The minimum vertical distance from the bottom of the lowest porcelain/polymer part of the bushing, porcelain/polymer enclosures or supporting insulators to the bottom of the equipment base, where it rests on the foundation pad shall be 2.55 metres.

### **17.0 CLAMPS AND CONNECTORS INCLUDING TERMINAL CONNECTORS**

17.1 All power clamps and connectors shall conform to IS:5561 or other equivalent international standard and shall be made of materials listed below :

<b>Sl. No.</b>	<b>Description</b>	<b>Materials</b>
a)	For connecting ACSR conductors/AAC conductors/ Aluminium tube	Aluminum alloy casting, conforming to designation <b>4600</b> of IS:617 and all test shall conform to IS:617
b)	For connecting equipment terminals mad of copper with ACSR conductors/AAC conductors/ Aluminium tube	Bimetallic connectors made from aluminum alloy casting, conforming to designation <b>4600</b> of IS:617 with 2mm thick bimetallic liner/strip and all test shall conform to IS:617
c)	For connecting G.I	Galvanised mild steel shield wire
d)	Bolts, nuts & plain washers	Electro-galvanised for sizes below M12, for others hot dip galvanised.
e)	Spring washers	Electro-galvanised mild steel suitable for atleast service condition-3 as per IS:1573

17.2 Necessary clamps and connectors shall be supplied for all equipment and connections. If corona rings are required to meet these requirements they shall be considered as part of that equipment and included in the scope of work.

17.3 Where copper to aluminum connections are required, bi-metallic clamps shall be used, which shall be properly designed to ensure that any deterioration of the connection is kept to a minimum and restricted to parts which are not current carrying or subjected to stress.

17.4 Low voltage connectors, grounding connectors and accessories for grounding all equipment as specified in each particular case, are also included in the scope of Work.

17.5 No current carrying part of any clamp shall be less than 10 mm thick. All ferrous parts shall be hot dip galvanised. Copper alloy liner/strip of minimum 2 mm thickness shall be cast integral with aluminum body or 2 mm thick bi-metallic liner/strips shall be provided for Bi-metallic clamps.

17.6 All casting shall be free from blow holes, surface blisters, cracks and cavities. All sharp edges and corners shall be blurred and rounded off.

17.7 Flexible connectors, braids or laminated straps made for the terminal clamps for bus posts shall be suitable for both expansion or through (fixed/sliding) type connection of IPS AL tube as required. In both the cases the clamp height (top of the mounting pad to centre line of the tube) should be same.

17.8 Current carrying parts (500A and above) of the clamp/connector shall be provided with minimum four numbers of bolts preferably for 132kV and above.

17.9 All current carrying parts shall be designed and manufactured to have minimum contact resistance.

17.10 Power Clamps and connectors shall be designed to control corona as per requirement.

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### **17.11 Tests**

Clamps and connectors should be type tested on minimum three samples as per IS:5561 and shall also be subjected to routine tests as per IS:5561. Following type test reports shall be submitted for approval. Type test once conducted shall hold good. The requirement of test conducted within last ten years, shall not be applicable.

- i) Temperature rise test (maximum temperature rise allowed is 35°C over 50°C ambient)
- ii) Short time current test
- iii) Corona (dry) and RIV (dry) test [for 132kV and above voltage level clamps]
- iv) Resistance test and Pullout strength test
- v) Cantilever Strength test on bus support clamps & connectors

### **18.0 CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES MARSHALLING BOXES FOR OUTDOOR EQUIPMENT**

18.1 All types of boxes, cabinets etc. shall generally conform to & be tested in accordance with IS/IEC 61439-0, as applicable, and the clauses given below:

18.2 Control cabinets, junction boxes, Marshalling boxes & terminal boxes, Out door ACDB cum DCDB panels shall be made of stainless steel of atleast 1.5 mm thick or aluminum enclosure of atleast 1.6 mm thick and shall be dust, water and vermin proof. Stainless steel used shall be of grade SS304 (SS316 for coastal area) or better. 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. In case of aluminum enclosed box the thickness of aluminum shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.

Control cabinets, junction boxes, marshalling boxes & terminal boxes, out-door ACDB cum DCDB panels shall have adequate space/clearance as per guidelines/technical specifications to access/replace any component. Necessary component labelling to be also done on non-conducting sheet.

For CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES MARSHALLING BOXES FOR OUTDOOR EQUIPMENT Junction Box, wire should be as per IS or equivalent IEC with FRLS grade

Machine laid PU Foam gasket may be permitted for use in Control Cabinets etc.

18.3 A canopy and sealing arrangements for operating rods shall be provided in marshalling boxes / Control cabinets to prevent ingress of rain water.

18.4 Cabinet/boxes with width more than 700 mm 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.

18.5 All doors, removable covers and plates shall be gasketed all around with suitably profiled EPDM/Neoprene/PU gaskets. The gasket shall be tested in accordance with approved quality plan, IS:11149 and IS:3400. Ventilating Louvers, if provided, shall have screen and filters. The screen shall be fine wire mesh made of brass.

Further, the gasketing arrangement shall be such that gaskets are pasted in slots (in door fabrication/gasket itself) in order to prevent ingress of dust and moisture

## **SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

- inside the panels so that no internal rusting occurs in panels during the operation of the equipment.
- 18.6 All boxes/cabinets shall be designed for the entry of cables 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 above 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 plate. Gland plate shall have provision for some future glands to be provided later, if required. The Nickel plated glands shall be dust proof, screw on & double compression type and made of brass. The gland shall have provision for securing armour of the cable separately and shall be provided with earthing tag. The glands shall conform to BS:6121.
- 18.7 A 240V, single phase, 50 Hz, 15 amp AC plug and socket shall be provided in the cabinet with ON-OFF switch for connection of hand lamps. Plug and socket shall be of industrial grade.
- 18.8 LED based illumination of minimum 9 watts shall be provided. The switching of the fittings shall be controlled by the door switch.
- For junction boxes of smaller sizes such as lighting junction box, manual operated earth switch mechanism box etc., plug socket, heater and illumination is not required to be provided.
- 18.9 All control switches shall be of MCB/rotary switch type and Toggle/piano switches shall not be accepted.
- 18.10 Earthing of the cabinet shall be ensured by providing two separate earthing pads. The earth wire shall be terminated on to the earthing pad and secured by the use of self etching washer. Earthing of hinged door shall be done by using a separate earth wire.
- 18.11 The bay marshalling kiosks shall be provided with danger plate and a diagram showing the numbering/connection/feruling by pasting the same on the inside of the door.
- 18.12 The following routine tests alongwith the routine tests as per IS:5039 shall also be conducted:
- i) Check for wiring
  - ii) Visual and dimension check
- 18.13 The enclosure of bay marshalling kiosk, junction box, terminal box and control cabinets shall conform to IP-55 as per IS/IEC60947 including application of 1kV rms for 1 (one) minute, after IP-55 test.
- 19.0 DISPOSAL OF PACKING MATERIAL & WASTE FROM CONSTRUCTION SITE**
- After completion of the work, Contractor shall dispose-off all the packing & waste materials including empty conductor drums, cable drums, wooden containers, oil drums, gas cylinders and other waste/scrapped materials from construction site at his own cost and shall make the substation area properly cleaned.
- 20.0 TERMINAL BLOCKS AND WIRING**
- 20.1 Control and instrument leads from the switchboards or from other equipment will be brought to terminal boxes or control cabinets in conduits. All interphase and external connections to equipment or to control cubicles will be made through terminal blocks.
- 20.2 Terminal blocks shall be 650V grade and have continuous rating to carry the maximum expected current on the terminals and non-breakable type. These shall be of moulded

## **SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

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 the terminal blocks shall be non-disconnecting stud type except for the secondary junction boxes of Current Transformer and Voltage Transformer.

- 20.3 Terminal blocks 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.
- 20.4 The terminal shall be such 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.
- 20.5 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.
- 20.6 The terminal blocks shall be of extensible design, multilayer terminal arrangement is not allowed in any junction box (Common MB, Individual MB, JB etc.). There should be sufficient space at both sides of terminals so that ferrule number of wires / TB numbers are clearly visible during wire removal or insertion.
- 20.7 The terminal blocks shall have locking arrangement to prevent its escape from the mounting rails.
- 20.8 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.
- 20.9 Unless otherwise specified terminal blocks shall be suitable for connecting the following conductors on each side.
- |    |                                    |   |
|----|------------------------------------|---|
| a) | All circuits except CT/PT circuits | Minimum of two of 2.5 sq mm copper flexible.    |
| b) | All CT/PT circuits                 | Minimum of 4 nos. of 2.5 sq mm copper flexible. |
- 20.10 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.
- 20.11 Atleast 20 % spare terminals shall be provided on each panel/cubicle/box and these spare terminals shall be uniformly distributed on all terminals rows.
- 20.12 There shall be a minimum clearance of 250 mm between the First/bottom row of terminal block and the associated cable gland plate for outdoor ground mounted marshalling box and the clearance between two rows of terminal blocks shall be a minimum of 150 mm.
- 20.13 The Contractor shall furnish all wire, conduits and terminals for the necessary interphase electrical connections (where applicable) as well as between phases and common terminal boxes or control cabinets.

### **21.0 LAMPS & SOCKETS**

#### **21.1 Lamps & Sockets**

All lamps shall use a socket base as per IS-1258, except in the case of signal lamps.

All sockets (convenience outlets) shall be suitable to accept both 5 Amp & 15 Amp pin round Standard Indian plugs. They shall be switched sockets with shutters.

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### **21.2 Hand Lamp:**

A 240 Volts, single Phase, 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF Switch for connection of hand lamps.

### **21.3 Switches and Fuses:**

21.3.1 Each panel shall be provided with necessary arrangements for receiving, distributing, isolating and fusing of DC and AC supplies for various control, signaling, lighting and space heater circuits. The incoming and sub-circuits shall be separately provided with miniature circuit breaker / switch fuse units. Selection of the main and Sub-circuit fuse ratings shall be such as to ensure selective clearance of sub-circuit faults. Potential circuits for relaying and metering shall be protected by HRC fuses.

21.3.2 All fuses shall be of HRC cartridge type conforming to relevant IS mounted on plug-in type fuse bases. Miniature circuit breakers with thermal protection and alarm contacts will also be accepted. All accessible live connection to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage.

### **22.0 BUSHINGS, HOLLOW COLUMN INSULATORS, SUPPORT INSULATORS:**

22.1 Bushings shall be manufactured and tested in accordance with IS:2099 & IEC-60137 while hollow column insulators shall be manufactured and tested in accordance with IEC-62155/IS:5621. The support insulators shall be manufactured and tested as per IS:2544/IEC-60168 and IEC-60273. The insulators shall also conform to IEC-60815 as applicable.

The bidder may also offer composite hollow insulators, conforming to IEC-61462.

22.2 Support insulators, bushings and hollow column insulators shall be manufactured from high quality porcelain. Porcelain used shall be homogeneous, free from laminations, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified tough and impervious to moisture.

22.3 Glazing of the porcelain shall be uniform brown in colour, free from blisters, burrs and similar other defects.

22.4 Support insulators/bushings/hollow column insulators shall be designed to have ample insulation, mechanical strength and rigidity for the conditions under which they will be used.

22.5 When operating at normal rated voltage there shall be no electric discharge between the conductors and bushing which would cause corrosion or injury to conductors, insulators or supports by the formation of substances produced by chemical action. No radio interference shall be caused by the insulators/bushings when operating at the normal rated voltage.

22.6 Bushing porcelain shall be robust and capable of withstanding the internal pressures likely to occur in service. The design and location of clamps and the shape and the strength of the porcelain flange securing the bushing to the tank shall be such that there is no risk of fracture. All portions of the assembled porcelain enclosures and supports other than gaskets, which may in any way be exposed to the atmosphere shall be composed of completely non hygroscopic material such as metal or glazed porcelain.

22.7 All iron parts shall be hot dip galvanised and all joints shall be air tight. Surface of joints shall be trued up porcelain parts by grinding and metal parts by machining. Insulator/bushing design shall be such as to ensure a uniform compressive pressure on the joints.

## **SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

22.8 Void

### **22.9 RTV Coating on porcelain insulators (for coastal area)**

RTV coating shall be done at site on all porcelain insulators (i.e. bushings, hollow and solid insulators, disc insulators etc.) for substation(s) in coastal area if defined in section Project. The cost of RTV coating shall be deemed to be included in the respective equipment/items' erection cost. The technical details of RTV coating is attached in **Annexure-H**.

22.10 In case, different designs of lattice and pipe structures other than Employer supplied structures are required to be adopted in view of higher creep age (31mm/kV) of the switchgear/equipment's, insulator strings, bushings & bus post insulators etc., Design, supply & erection of such structures shall be in the scope of contractor against respective standard structure. However dimensional details (except height) shall not be less than that specified in standard structure drawing of respective equipment's.

### **23.0 MOTORS**

Motors shall be "Squirrel Cage" three phase induction motors of sufficient size capable of satisfactory operation for the application and duty as required for the driven equipment and shall be subjected to routine tests as per applicable standards. The motors shall be of approved make.

#### **23.1 Enclosures**

- a) Motors to be installed outdoor without enclosure shall have hose proof enclosure equivalent to IP-55 as per IS: 4691. For motors to be installed indoor i.e. inside a box, the motor enclosure, shall be dust proof equivalent to IP-44 as per IS: 4691.
- b) Two independent earthing points shall be provided on opposite sides of the motor for bolted connection of earthing conductor.
- c) Motors shall have drain plugs so located that they will drain water resulting from condensation or other causes from all pockets in the motor casing.
- d) Motors weighing more than 25 Kg. shall be provided with eyebolts, lugs or other means to facilitate lifting.

#### **23.2 Operational Features**

- a) Continuous motor rating (name plate rating) shall be at least ten (10) percent above the maximum load demand of the driven equipment at design duty point and the motor shall not be over loaded at any operating point of driven equipment that will rise in service.
- b) Motor shall be capable at giving rated output without reduction in the expected life span when operated continuously in the system having the particulars as given in Clause 15.0 of this Section.

#### **23.3 Starting Requirements:**

- a) All induction motors shall be suitable for full voltage direct-on-line starting. These shall be capable of starting and accelerating to the rated speed alongwith the driven equipment without exceeding the acceptable winding temperature even when the supply voltage drops down to 80% of the rated voltage.

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- b) Motors shall be capable of withstanding the electrodynamic stresses and heating imposed if it is started at a voltage of 110% of the rated value.
- c) The locked rotor current shall not exceed six (6) times the rated full load current for all motors, subject to tolerance as given in IS:325.
- d) Motors when started with the driven equipment imposing full starting torque under the supply voltage conditions specified under Clause 15.0 shall be capable of withstanding atleast two successive starts from cold condition at room temperature and one start from hot condition without injurious heating of winding. The motors shall also be suitable for three equally spread starts per hour under the above referred supply condition.
- e) The locked rotor withstand time under hot condition at 110% of rated voltage shall be more than starting time with the driven equipment of minimum permissible voltage by at least two seconds or 15% of the accelerating time whichever is greater. In case it is not possible to meet the above requirement, the Bidder shall offer centrifugal type speed switch mounted on the motor shaft which shall remain closed for speed lower than 20% and open for speeds above 20% of the rated speed. The speed switch shall be capable of withstanding 120% of the rated speed in either direction of rotation.

### **23.4 Running Requirements:**

- a) The maximum permissible temperature rise over the ambient temperature of 50 degree C shall be within the limits specified in IS:325 (for 3-phase induction motors) after adjustment due to increased ambient temperature specified.
- b) The double amplitude of motor vibration shall be within the limits specified in IS: 4729. Vibration shall also be within the limits specified by the relevant standard for the driven equipment when measured at the motor bearings.
- c) All the induction motors shall be capable of running at 80% of rated voltage for a period of 5 minutes with rated load commencing from hot condition.

### **23.5 TESTING AND COMMISSIONING**

An indicative list of tests is given below. Contractor shall perform any additional test based on specialities of the items as per the field Q.P./Instructions of the equipment Contractor or Employer without any extra cost to the Employer. The Contractor shall arrange all instruments required for conducting these tests alongwith calibration certificates and shall furnish the list of instruments to the Employer for approval.

- (a) Insulation resistance.
- (b) Phase sequence and proper direction of rotation.
- (c) Any motor operating incorrectly shall be checked to determine the cause and the conditions corrected.

### **24. TECHNICAL REQUIREMENT OF EQUIPMENTS**

Following equipment shall be offered from the **Indian Manufacturing facilities** of manufacturer(s) who meets the technical requirements as stipulated here, provided the same equipment are not covered under the Bidder's Qualifying requirement of the Bidding Documents.

#### **Legend:**

\* : voltage class of respective equipment as applicable.

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# : **satisfactory operation** means certificate issued by the Employer/Utility certifying the operation without any adverse remark.

@ : **Circuit Breaker Bay** means a bay used for controlling a line or a transformer or a reactor or a bus section or a bus coupler and comprising of at least one circuit breaker, one disconnecter and three nos. of single phase CTs / Bushing CTs

NOA: means Notification Of Award

### **24.1 Technical requirements for 765/400/220/132/110kV\* Air Insulated Switchgear (AIS) Equipment\* (i.e Circuit Breaker, Isolator, Current Transformer, Capacitive Voltage transformer, Inductive Voltage transformer, Surge Arrester and Wave Trap)**

- (i) The manufacturer(s) whose 765/400/220/132/110kV\* equipment(s) are offered, must have, manufactured, type tested (as per IEC/IS or equivalent standard) and supplied 715/345/220/132/110kV\* or higher voltage class equipment(s), which are in satisfactory operation# for atleast two (2) years as on the date of NOA.
- (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India for the offered equipment and not meeting the requirement stipulated in (i) above, can also be considered provided that
  - a) 715/345/220/132/110kV\* or higher Voltage class equipment(s) must have been manufactured in the above Indian works & type tested (as per IEC/IS standard) and supplied as on the date of NOA.
  - b) In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two(2) years over & above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of the offered equipment to be supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 3% of the ex-works cost of the equipments(s)\* for the additional warranty period in addition to the contract performance guarantee to be submitted by the contractor

### **24.2 Technical Requirement for 765kV class Transformer**

- (i) The Manufacturer whose 765kV Transformer(s) are offered must have designed, manufactured, tested & supplied 715 kV or higher voltage class one (1) number 1-phase Transformer of at least 500 MVA capacity or at least three (3) numbers 1-phase Transformers each having a capacity of at least 166 MVA, and the same transformer (s) should have been in satisfactory operation# for atleast two (2) years as on the date of NOA.
- (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that
  - a) 715 kV or higher voltage class either One (1) no. 1-phase Transformer of at least 166 MVA capacity or One (1) no. 1-phase Reactor of at least 80 MVAR capacity must have been manufactured in the above Indian works based on

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technological support of collaborator, type tested (as per IEC/IS standard) and same should have been supplied as on the date of NOA.

- b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply 765kV transformer in India, shall be submitted.
- c) the collaborator shall furnish performance guarantee for an amount of **3%** of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor

### **24.3 Technical Requirement for 765kV class Reactor**

- (i) The Manufacturer whose 765kV Reactor(s) are offered must have designed, manufactured, tested & supplied 715 kV or higher voltage class one (1) number 1-phase Reactor of at least 110 MVAR capacity or at least three (3) numbers 1-phase Reactors each having a capacity of at least 36.7 MVAR and the same Reactor(s) should have been in satisfactory operation# for atleast two (2) years as on the date of NOA.

OR

The Manufacturer must have designed, manufactured, tested & supplied 715 kV or higher voltage class one (1) number 1-phase Transformer of at least 500 MVA capacity or at least three (3) numbers 1-phase Transformers each having a capacity of at least 166 MVA and the bidder should have designed, manufactured, tested & supplied 345 kV or higher voltage class one (1) number 3-phase Reactor of at least 50 MVAR capacity or at least three (3) numbers 1-phase Reactors each having a capacity of at least 16.7 MVAR and the same Transformer(s) & Reactor(s) should have been in satisfactory operation# for atleast two (2) years as on the date of NOA.

- (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that
  - a) 715 kV or higher voltage class either One (1) no. 1-phase Reactor of at least 80 MVAR capacity or One (1) no. 1-phase Transformer of at least 166 MVA capacity must have been manufactured in the above Indian works based on technological support of collaborator, type tested (as per IEC/IS standard) and same should have been supplied as on the date of NOA.
  - b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer/license to design, manufacture, test and supply 765kV Reactor in India, shall be submitted.
  - c) the collaborator shall furnish performance guarantee for an amount of **3%** of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor.

### **24.4 Technical Requirement for 400kV, 220kV, 132kV class Transformer**

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- (i) The manufacturer whose transformer(s) are offered must have designed, manufactured, tested and supplied transformers as per table below:

345kV or above class 3-phase transformers of at least 200 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 66.7 MVA	applicable for supply of 400kV class Transformer
220kV or above class 3-phase transformers of at least 50 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 16.7 MVA	applicable for supply of 220kV class Transformer
commissioned 132kV or above class 3-phase transformers of at least 20 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 6.7 MVA	applicable for supply of 132kV class Transformer

These Transformer(s) must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.

- (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that
- a) 220kV (applicable for supply of 400kV class Transformer)/ 132kV (applicable for supply of 220kV class Transformer)/ 66kV (applicable for supply of 132kV class Transformer) or higher voltage class transformers must have been designed, manufactured in the above Indian works based on technological support of collaborator, type tested (as per IEC/IS standard) and supplied as on the date of NOA.
- b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply 400kV/220kV/132kV\* transformer in India, shall be submitted.
- c) The collaborator shall furnish performance guarantee for an amount of 3% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor.

### **24.5 Technical Requirement for 400kV, 220kV and 132kV class Reactor**

- (i) The Manufacturer whose 400kV/220kV/132kV\* Reactor(s) are offered must have designed, manufactured, tested & supplied Reactor as per table below:

345kV or above class 3-phase shunt	applicable for supply of 400kV class
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## **SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

reactor of at least 50 MVAR capacity or at least three (3) nos. 1-phase Shunt Reactors, each having capacity of at least 16.7 MVAR	Reactors
220kV or above class 3-phase shunt reactor of at least 20 MVAR capacity or at least three (3) nos. 1-phase Shunt Reactors each having capacity of at least 6.67 MVAR	applicable for supply of 220kV class Transformer
132kV or above class 3-phase shunt reactor of at least 15 MVAR capacity or at least three (3) nos. 1-phase Shunt Reactors each having capacity of at least 5 MVAR	applicable for supply of 132kV class Transformer

These Reactor(s) must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.

- (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that
  - a) Such manufacturer has designed, manufactured based on technological support of collaborator, type tested (as per IEC/IS standard) and supplied 400kV class transformer or 220kV or above class shunt reactors (applicable for supply of 400kV class Reactors) / 220kV class transformer or 132kV or above class shunt reactors (applicable for supply of 220kV class Reactors)/ 132kV class transformer or 66kV or above class shunt reactors (applicable for supply of 132kV class Reactors) as on the date of NOA.
  - b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer/license to design, manufacture, test and supply the Reactor in India, shall be submitted.
  - c) the collaborator shall furnish performance guarantee for an amount of 3% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor.

### **24.6 Technical Requirement for 400 kV Grade XLPE Power Cables**

- (i) The manufacturer(s) whose XLPE Power Cables are offered must have designed, manufactured, type tested and supplied in a single contract atleast 5 (five) km of single core, 400kV grade XLPE insulated cable which must be in operation for atleast 2 (two) years as on the date of NOA.
- (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that

## **SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

- a) The manufacturer must have designed, manufactured, type tested and supplied 400kV grade XLPE insulated cable and which must be in satisfactory operation# for atleast one (1) year as on the date of NOA.

OR

- b) The manufacturer must have designed, manufactured, type tested and completed Pre-qualification (PQ) tests as per IEC for 400kV grade XLPE insulated Cable as on the date of NOA.

Note: In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two(2) years over & above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of cable to supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 3% of the ex-works cost of the equipments(s)\* and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor.

### **24.7 Technical Requirement for 220KV,132kV,110kV Grade XLPE Power Cables**

- (i) The manufacturer(s) whose XLPE Power Cables are offered must have designed, manufactured, type tested and supplied in a single contract atleast 5 (five) km of single core, 220kV/132kV/110kV\* or higher grade XLPE insulated cable which must be in operation for atleast 2 (two) years as on the date of NOA.

- (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that

- a) The manufacturer must have designed, manufactured, type tested and supplied 220kV/132kV/110kV\* or higher grade XLPE insulated cable and which must be in satisfactory operation# for atleast one (1) year as on the date of NOA.

OR

- b) The manufacturer must have designed, manufactured, type tested and completed Pre-qualification (PQ) tests as per IEC for 220kV/132kV/110kV\* or higher grade XLPE insulated Cable as on the date of NOA.

Note: In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two(2) years over & above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of cable to supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 3% of the ex-works cost of the equipments(s)\* and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor

### **24.8 Technical Requirement for 66kV Grade XLPE Power Cables**

- (i) The manufacturer(s) whose XLPE Power Cables are offered must have designed, manufactured, type tested and supplied in a single contract atleast 5 (five) km of single core, 66kV or higher grade XLPE insulated cable which must be in satisfactory operation# for atleast two (2) years as on the date of NOA.

- (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that

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- a) The manufacturer must have designed, manufactured, type tested and supplied 66kV or higher grade XLPE insulated cable and which must be in satisfactory operation# for atleast one (1) year as on the date of NOA.

### **24.9 Technical Requirement for 1.1 KV Grade PVC Control Cable**

The manufacturer(s), whose PVC control cables are offered, must have designed, manufactured, tested and supplied in a single contract atleast 100 Kms of 1.1kV grade PVC insulated control cables as on the date of NOA. Further the manufacturer must also have designed, manufactured, tested and supplied atleast 1 km of 27C x 2.5 Sq.mm or higher size as on the date of NOA.

### **24.10 Technical Requirement for 1.1 KV Grade PVC Power Cable**

The manufacturer(s), whose PVC Power Cables are offered, must have designed, manufactured, tested and supplied in a single contract atleast 100 Kms of 1.1kV or higher grade PVC insulated power cables as on the date of NOA. Further the manufacturer must also have designed, manufactured, tested and supplied atleast 1 km of 1C x 150 Sq. mm or higher size as on the date of NOA.

### **24.11 Technical Requirement for 1.1 KV Grade XLPE Power Cables**

The manufacturer(s), whose XLPE Power cables are offered, must have designed, manufactured, tested and supplied in a single contract atleast 25 Kms of 1.1 KV or higher grade XLPE insulated power cables as on the date of NOA. Further the manufacturer must also have designed, manufactured, tested and supplied atleast 1 km of 1C x 630 Sq. mm or higher size as on the date of NOA.

### **24.12 Technical Requirement for LT Switchgear**

- i) The manufacturer whose LT Switchgear(s) are offered, must be a manufacturer of LT Switchboards of the type and rating being offered. He must have designed, manufactured, tested and supplied atleast 50 nos. draw out circuit breaker panels, out of which atleast 5 nos. should have been with relay and protection schemes with current transformer. He must have also manufactured atleast 50 nos. MCC panels comprising of MCCBs (ie Moulded Case Circuit Breakers) modules of the type offered which must be in satisfactory operation# as on the date of NOA.
- ii) The Switchgear items (such as circuit breakers, fuse switch units, contactors etc.), may be of his own make or shall be procured from reputed manufacturers and of proven design, atleast one hundred circuit breakers of the make and type being offered must have been in satisfactory operation# as on the date of NOA.

### **24.13 Technical Requirements for Battery**

The manufacturer whose Batteries are offered, must have designed, manufactured and supplied DC Batteries of the type specified and being offered, having a capacity of atleast 600 AH and these must be satisfactory operation# for atleast two (2) years in power sector or industrial installations as on the date of NOA.

### **24.14 Technical Requirements for Battery Charger**

The manufacturer, whose Battery Chargers are offered, must have designed, manufactured and supplied Battery Chargers generally of the type offered, with static automatic voltage regulators and having a continuous output of atleast ten (10) KW and these must have been in satisfactory operation# as on the date of NOA.

### **24.15 Technical Requirements for LT Transformer**

- i) The manufacturer, whose LT transformer(s) are offered, must have designed, manufactured, type tested including short circuit test as per IEC/IS or equivalent

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standards and supplied transformer(s) of atleast 33kV class of 315kVA or higher. The transformer must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.

- ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that At least 33kV class of 315kVA or higher rating LT transformer(s) must have been designed, manufactured in the above Indian works, type tested (as per IEC/IS standard) including short circuit test and supplied as on the date of NOA.

Note In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two(2) years over & above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of the offered equipment to be supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 3% of the ex-works cost of the equipments(s)\* for the additional warranty period in addition to the contract performance guarantee to be submitted by the contractor

### **24.16 Technical Requirements for Composite Long Rod Polymer Insulator (765kV & 400kV)**

- (i) The manufacturer whose Composite Long rod Insulator are offered, must have designed, manufactured, tested and supplied Composite Long rod Insulator of 120KN or higher electro-mechanical strength for 765kV/400kV\* or higher voltage class and the same must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.
- (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that
- a) The manufacturer must have designed, manufactured, type tested and supplied Composite Long rod Insulator of 120KN or above electro-mechanical strength for 765kV/400kV\* or higher voltage class and the same must have been in satisfactory operation# as on the date of NOA.
- b) Contractor shall furnish performance guarantee for an amount of 10% of the ex-works cost of the equipments(s)\* and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor.

Note: In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two(2) years over & above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of the offered equipment to be supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 3% of the ex-works cost of the equipments(s)\* for the additional warranty period in addition to the contract performance guarantee to be submitted by the contractor

### **24.17 Technical Requirements for Control, Relay & Protection System and Sub-station Automation System**

The manufacturer whose Control, Relay & Protection System (Control & protection Intelligent Electronic Devices (IEDs)), and Sub-station Automation System (as applicable) are offered, must have designed, manufactured, tested, installed and

## **SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

commissioned Control, Relay & Protection system along with Sub-station Automation System which must have been in satisfactory operation# on (i) 400 kV system [applicable for 765kV substation] & (ii) specified voltage level or above [applicable for 400kV & below substation] for atleast two (2) years as on the date of NOA.

AND

The Manufacturer or their joint venture or subsidiary company or parent company must be a manufacturer of control and protection IEDs and must have established repair, testing and integration (atleast for 4 bays) facilities for Control, Relay & Protection System and Sub-station Automation System in India.

### **24.18 Technical Requirements for analog and digital PLCC panels (765kV, 400kV, 220kV & 132kV)**

- (i) The manufacturer whose PLCC panels are offered, must have designed, manufactured, tested, supplied and commissioned PLCC panels for (i) 400kV system or above [applicable for 765 kV & 400 kV substation], (ii) 220 kV System or above [applicable for 220 kV Substation] & (iii) 132 kV system or above [applicable for 132 kV substation] and the same must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.
- (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that
  - a) PLCC panels must have been manufactured in the above Indian works based on technological support of collaborator, type tested (as per IEC/IS standard) and supplied as on the date of NOA.
  - b) collaborator shall furnish performance guarantee for an amount of 3% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor.
  - c) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply PLCC panels in India, shall be submitted.

### **24.19 Technical Requirement of Communication Equipment**

The SDH equipment shall be offered from a manufacturer(s) who is a “**Local Supplier**” as per DPIIT PP notification & has been Manufacturing SDH equipments for the last three (3) years and SDH equipment Manufactured by such manufacturer(s) shall have been satisfactory operation in 110kV or higher voltage Power Substations for at least two (2) years as on the date of NOA

### **24.20 Technical Requirement for 400kV GIS Equipment**

- (i) The manufacturer whose 400kV GIS bays are offered must have designed, manufactured, type tested\*\* (as per IEC or equivalent standard), supplied and supervised erection & commissioning of at least two (2) nos. Gas Insulated Switchgear (GIS) circuit breaker bays@ of 345kV or above voltage class in one (1) Substation or Switchyard during the last seven (7) years and these bays must be in satisfactory operation# for at least two (2) years as on the date of NOA.

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- (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that
- a) Atleast one no. 345kV or above voltage class GIS Circuit Breaker bay@ must have been manufactured in the above Indian works based on the technological support of the Collaborator(s) and either supplied or type tested the above CB bay (as per IEC or equivalent standard) as on the date of NOA.
  - b) The collaborator(s) meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply 400kV or above voltage level GIS equipment in India, shall be submitted.
  - c) The Collaborator(s) shall furnish performance guarantee for an amount of 3% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to Contract Performance Guarantee to be submitted by the bidder.

Note :-

(\*\*) Type test reports of the collaborator/ parent company/ subsidiary company/ group company shall also be acceptable

### **25.0 Technical Requirement of Sub-contractors:**

The sub-contractor must have either of the following experience of having successfully completed similar works during last 7 years as on the last day of month previous to the one in which the sub-contractor is proposed to be engaged:

- a) Three similar works costing not less than the amount equal to 40% of the cost of the work to be sub-contracted.

**OR**

- b) Two similar works costing not less than the amount equal to 50% of the cost of the work to be sub-contracted.

**OR**

- c) One similar work costing not less than the amount equal to 80% of the cost of the work to be sub-contracted.

1. Minimum Average Annual Turnover **\*\***(MAAT) for best three years i.e. 36 months out of last five financial years of the sub-contractor should be.....:

**\*\***Annual Gross Revenue from operations/ Gross operating income as incorporated in the profit & loss account excluding Other Income.

**Note:**

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- a) Similar work shall mean the work which are of similar in nature to the work to be sub-contracted e.g. for the scope of civil work to be sub-contracted, the experience should be of civil work.
- b) The aforesaid qualifying requirement shall however, not be applicable for engaging labour as per extant policy.
- c) The cost of the work to be sub-contracted shall be considered as available in the Contract Agreement. However, if the value is not available in the Contract Agreement, the same shall be the estimated value for such work.
- d) The above criteria is in addition to extant policy on selection of sub-contractor as per WPPP, Vol-II.
- e) The MAAT requirement shall be worked out basis the following formula:

$$\text{Minimum Average Annual Turnover (MAAT)} = \frac{\text{Cost of the work to be sub-contracted} \times 1.5}{\text{Completion period in years}^{**}}$$

\*\*The completion period shall be considered as 1 year even if the same is less than 1 year.

### 26.0 **Technical Requirement of Sub-contractors of GIS Packages**

In case of GIS is supplied from Indian GIS manufacturer, the erection, testing & commissioning of GIS shall be executed either by the bidder himself or by the Subcontractor meeting the following technical requirement:

The bidder/Subcontractor must have erected, tested and commissioned at least two (2) nos. GIS/AIS Circuit breaker equipped bays@ of voltage class\*\* as specified below or higher in one (1) substation or switchyard during the last seven (7) years and these bays must be in satisfactory operation# as on the date of NOA.

S.no	Voltage class of GIS Package	Minimum Voltage class Circuit Breaker Equipped of Bay(**)
1	765kV & 400kV GIS	345kV
2	220kV	220kV
3	132kV	110kV
4	66kV	66kV

Further, the sub-contractor shall also meet the requirement specified at Clause No. 25.0 of this section.

#### **Note:**

1. (@) For the purpose of technical requirement, one no. of circuit breaker bay shall be considered as a bay used for controlling a line or a transformer or a reactor or a bus section or a bus coupler and comprising of at least one circuit breaker, one disconnecter and three nos. of single phase CTs / Bushing CTs. GIS means SF6 Gas insulated Switchgear. AIS Means Air Insulated Switchgear.

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2. # satisfactory operation means certificate issued by the Owner/Utility certifying the operation without any adverse remark.

**CORONA AND RADIO INTERFERENCE VOLTAGE (RIV) TEST**

**1. General**

Unless otherwise stipulated, all equipment together with its associated connectors, where applicable, shall be tested for external corona (for 400kV & above) both by observing the voltage level for the extinction of visible corona under falling power frequency voltage and by measurement of radio interference voltage (RIV) for 132kV and above.

**2. Test Levels:**

The test voltage levels for measurement of external RIV and for corona extinction voltage are listed under the relevant clauses of the specification.

**3. Test Methods for RIV:**

3.1 RIV tests shall be made according to measuring circuit as per International Special-Committee on Radio Interference (CISPR) Publication 16-1(1993) Part -1. The measuring circuit shall preferably be tuned to frequency with 10% of 0.5 Mhz but other frequencies in the range of 0.5 MHz to 2 MHz may be used, the measuring frequency being recorded. The results shall be in microvolts.

3.2 Alternatively, RIV tests shall be carried out in accordance with relevant IEC of respective equipment or NEMA standard Publication No. 107-1964.

3.3 In measurement of, RIV, temporary additional external corona shielding may be provided. In measurements of RIV only standard fittings of identical type supplied with the equipment and a simulation of the connections as used in the actual installation will be permitted in the vicinity within 3.5 meters of terminals.

3.4 Ambient noise shall be measured before and after each series of tests to ensure that there is no variation in ambient noise level. If variation is present, the lowest ambient noise level will form basis for the measurements. RIV levels shall be measured at increasing and decreasing voltages of 85%, 100%, and 110% of the specified RIV test voltage for all equipment unless otherwise specified. The specified RIV test voltage for 765kV, 400 kV, 220 KV is listed in the detailed specification together with maximum permissible RIV level in microvolts.

3.5 The metering instruments shall be as per CISPR recommendation or equivalent device so long as it has been used by other testing authorities.

3.6 The RIV measurement may be made with a noise meter. A calibration procedure of the frequency to which noise meter shall be tuned shall establish the ratio of voltage at the high voltage terminal to voltage read by noise meter.

**4. Test Methods for Visible Corona**

The purpose of this test is to determine the corona extinction voltage of apparatus, connectors etc. The test shall be carried out in the same manner as RIV test described above with the exception that RIV measurements are not required during test and a search technique shall be used near the onset and extinction voltage, when the test voltage is raised and lowered to determine their precise values. The test voltage shall be raised to 110% of specified corona extinction voltage and maintained there for five minutes. In case corona inception does not take place at 110%, test shall be stopped,

## **SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

### **ANNEXURE-A**

otherwise test shall be continued and the voltage will then be decreased slowly until all visible corona disappears. The procedure shall be repeated at least 3 times with corona inception and extinction voltage recorded each time. The corona extinction voltage for purposes of determining compliance with the specification shall be the lowest of the three values at which visible corona (negative or positive polarity) disappears.

The test to determine the visible corona extinction voltage need not be carried out simultaneously with test to determine RIV levels.

However, both test shall be carried out with the same test set up and as little time duration between tests as possible. No modification on treatment of the sample between tests will be allowed. Simultaneous RIV and visible corona extinction voltage testing may be permitted at the discretion of Employer's inspector if, in his opinion, it will not prejudice other test

#### **5. Test Records:**

In addition to the information previously mentioned and the requirements specified as per CISPR or NEMA 107-1964 the following data shall be included in test report:

- a) Background noise before and after test.
- b) Detailed procedure of application of test voltage.
- c) Measurements of RIV levels expressed in micro volts at each level.
- d) Results and observations with regard to location and type of interference sources detected at each step.
- e) Test voltage shall be recorded when measured RIV passes through 100 microvolts in each direction.
- f) Onset and extinction of visual corona for each of the four tests required shall be recorded.

**SEISMIC WITHSTAND TEST PROCEDURE**

The seismic withstanding test on the complete equipment (for 400kV and above) shall be carried out along with supporting structure. Seismic Withstand Test carried out using either lattice or pipe structure is acceptable.” **Seismic Calculations certified by NABL Labs shall also be acceptable**

The Bidder shall arrange to transport the structure from his Contractor’s premises/ POWERGRID sites for the purpose of seismic withstand test only.

The seismic level specified shall be applied at the base of the structure. The accelerometers shall be provided at the Terminal Pad of the equipment and any other point as agreed by the Employer. The seismic test shall be carried out in all possible combinations of the equipment. The seismic test procedure shall be furnished for approval of the Employer.

The frequency range for the earthquake spectra shall be as per IEC-62271-300.

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C**LIST OF GENERAL STANDARDS AND CODES**

<b>CODES</b>	<b>TITLE</b>
--	India Electricity Rules
--	Indian Electricity Act
--	Indian Electricity (Supply) Act
--	Indian Factories Act
IS-5	Colors for Ready Mixed Paints and Enamels
IS-335	New Insulating Oils
IS-617	Aluminium and Aluminium Alloy Ingots and Castings for General Engineering Purposes
IS-1448 (P1 to P 145)	Methods of Test for Petroleum and its Products
IS-2071 (P1 to P3)	Methods of High Voltage Testing
IS-12063	Classification of degrees of protection provided by enclosures of electrical equipment
IS-2165 ; P1:1997, P2:1983	Insulation Coordination
IS-3043	Code of Practice for Earthing
IS-6103	Method of Test for Specific Resistance (Resistivity) of Electrical Insulating Liquids
IS-6104	Method of Test for Interfacial Tension of Oil against Water by the Ring Method
IS-6262	Method of test for Power factor & Dielectric Constant of Electrical Insulating Liquids
IS-6792	Method for determination of electric strength of insulating oils
IS-5578	Guide for marking of insulated conductors
IS-11353	Guide for uniform system of marking & identification of conductors & apparatus terminals.
IS-8263	Methods for Radio Interference Test on High voltage Insulators
IS-9224 (Part 1,2&4)	Low Voltage Fuses
IEC-60060 (Part 1 to P4)	High Voltage Test Techniques
IEC 60068	Environmental Test
IEC-60117	Graphical Symbols
IEC-60156	Method for the Determination of the Electrical Strength of Insulation Oils
IEC-60270	Partial Discharge Measurements
IEC-60376	Specification and Acceptance of New Sulphur Hexafluoride
IEC-60437	Radio Interference Test on High Voltage Insulators
IEC-60507	Artificial Pollution Tests on High Voltage Insulators to be used on AC Systems
IEC-62271-1	Common Specification for High Voltage Switchgear & Control gear Standards
IEC-60815	Guide for the Selection of Insulators in respect of Polluted Conditions

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C

<b>CODES</b>	<b>TITLE</b>
IEC-60865 (P1 & P2)	Short Circuit Current - Calculation of effects
ANSI-C.1/NFPA.70	National Electrical Code
ANSI-C37.90A	Guide for Surge Withstand Capability (SWC) Tests
ANSI-C63.21, C63.3	Specification for Electromagnetic Noise and Field Strength Instrumentation 10 KHz to 1 GHZ
C36.4ANSI-C68.1	Techniquet for Dielectric Tests
ANSI-C76.1/EEE21	Standard General Requirements and Test Procedure for Outdoor Apparatus Bushings
ANSI-SI-4	Specification for Sound Level Meters
ANSI-Y32-2/C337.2	Drawing Symbols
ANSI-Z55.11	Gray Finishes for Industrial Apparatus and Equipment No. 61 Light Gray
NEMA-107T	Methods of Measurements of RIV of High Voltage Apparatus
NEMA-ICS-II	General Standards for Industrial Control and Systems Part ICSI-109
CISPR-1	Specification for CISPR Radio Interference Measuring Apparatus for the frequency range 0.15 MHz to 30 MHz
CSA-Z299.1-1978h	Quality Assurance Program Requirements
CSA-Z299.2-1979h	Quality Control Program Requirements
CSA-Z299.3-1979h	Quality Verification Program Requirements
CSA-Z299.4-1979h	Inspection Program Requirements
<b>TRANSFORMERS AND REACTORS</b>	
IS:10028 (Part 2 & 3)	Code of practice for selection, installation & maintenance of Transformers (P1:1993), (P2:1991), (P3:1991)
IS-2026 (P1 to P4)	Power Transformers
IS-3347 (part 1 to Part 8)	Dimensions for Porcelain transformer Bushings for use in lightly polluted atmospheres
IS-3639	Fittings and Accessories for Power Transformers
IS-6600	Guide for Loading of oil immersed Transformers
IEC-60076 (Part 1 to 5)	Power Transformers
IEC-60214	On-Load Tap-Changers
IEC-60289	Reactors
IEC- 60354	Loading Guide for Oil - Immersed power transformers
IEC-60076-10	Determination of Transformer and Reactor Sound Levels
ANSI-C571280	General requirements for Distribution, Power and Regulating Transformers
ANSI-C571290	Test Code for Distribution, Power and Regulation Transformers
ANSI-C5716	Terminology & Test Code for Current Limiting Reactors
ANSI-C5721	Requirements, Terminology and Test Code for Shunt Reactors Rated Over 500 KVA
ANSI-C5792	Guide for Loading Oil-Immersed Power Transformers upto and including 100 MVA with 55 deg C or 65 deg C Winding Rise

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<b>CODES</b>	<b>TITLE</b>
ANSI-CG,1EEE-4	Standard Techniques for High Voltage Testing
IEC 60076	Power transformers
IEC 60076-1	Part 1: General
IEC 60076-2	Part 2: Temperature rise
IEC 60076-3	Part 3: Insulation levels, dielectric tests and external clearances in air
IEC 60076-4	Part 4: Guide to the lightning impulse and switching impulse testing - Power transformers and reactors
IEC 60076-3-1	Part 3-1: Insulation Levels and Dielectric Tests –External Clearances in Air
IEC 60076-5	Part 5: Ability to withstand short circuit
IEC 60076-6	Part 6: Reactors
IEC 60076-7	Part 7: Loading guide for oil-immersed power transformers
IEC 60076-8	Part 8: Application guide
IEC 60076-10	Part 10: Determination of sound levels
IEC 60076-10-1	Part 10-1: Determination of sound levels - Application guide
IEC 60076-11	Part 11: Dry-type transformers
IEC 60076-12	Part 12: Loading guide for dry-type power transformers
IEC 60076-13	Part 13: Self-protected liquid-filled transformers
IEC 60076-14	Part 14: Design and application of liquid-immersed power transformers using high-temperature insulation materials
IEC 60076-15	Part 15: Gas-filled power transformers
IEC 60076-16	Part 16: Transformers for wind turbine applications
IEC 60076-18	Part 18: Measurement of frequency response
IEC 60076-19	Part 19: Rules for the determination of uncertainties in the measurement of losses in power transformers and reactors
IEC 60076-21	Part 21: Standard requirements, terminology, and test code for step-voltage regulators
IEC 60044, BS 3938	Current transformers
IEC 60050	International Electrotechnical Vocabulary
IEC 60050(421)	International Electrotechnical vocabulary- Chapter 421 : Power Transformers and Reactors
IEC 60060	High Voltage test techniques
IEC 60060-1	General definitions and test requirements
IEC 60060-2	Measuring systems
IEC 60071	Insulation co-ordination
IEC 60071-1	Part 1: Definitions, principles and rules
IEC 60071-2	Part 2 : Application guide
IEC 60137	Bushing for alternating voltage above 1000V
IEC 60214	On-Load Tap changers
IEC 255-21-3	Relays vibration

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C

<b>CODES</b>	<b>TITLE</b>
IEC 60270	Partial discharge measurements
IEC 60296	Specification for Unused Mineral Oil for Transformers and Switchgear
IEC 60422	Supervision and Maintenance guide for Mineral Insulating Oil in Electrical Equipment
IEC 60475	Method of Sampling Liquid dielectrics
IEC 60529	Classification of Degrees of Protection provided by Enclosures
IEC 60542	Application Guide for On-Load Tap-Changers
IEC 60567	Guide for the Sampling of Gases and of Oil from Oil-filled Electrical Equipment for the Analysis of Free and Dissolved Gases
IEC 60651	Sound Level Meters
IEC 61083	Digital Recorders and Software for High Voltage Impulse testing
IEC 61083-1	Part 1: Requirements for digital recorders in high voltage impulse tests
IEC 61083-2	Part 2: Evaluation of software used for the determination of the parameters of impulse waveforms
CISPR 16	Specification for radio disturbance and immunity measuring apparatus
CISPR 16-1	Radio disturbance and immunity measuring apparatus
CISPR-18	Radio Interference Characteristics of Power Lines and High Voltage Equipment
ISO 9001	Quality system-Model for Quality Assurance in Design /development
Cigre Publication 202	Guidelines for conducting design reviews for transformers 100 MVA and 123 kV and above. August 2002-Cigre Working Group 12.22
WG 12-15	Guide for Customers Specifications for Transformers 100 MVA and 123 kV and above
WG 12 19	Short Circuit Performance of Transformers.
BS-4360	Specification for weldable structural steel
BS-5135	Specification for arc welding of carbon and carbon manganese steels
BS-5500	Specification for unfired fusion welded pressure vessels
IS-3618	Specification for phosphate treatment of iron & steel for protection against corrosion
IS-6005	Code of practice for phosphating of Iron and Steel
ISO-8501	Preparation of steel surface before application of Paints and related product
IEC-60599	Mineral oil impregnated electrical equipment in service – guide to the interpretation of dissolved and free gases analysis
IS-10593	Method of evaluating the analysis of gases in oil filled electrical equipment in service
IS-2099	Bushings for alternating voltages above 1000 volts

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<b>CODES</b>	<b>TITLE</b>
IS-3347 Part I to 8	Dimension for porcelain transformer bushing
DIN-42530	Bushing up to 1000kV from 250A-5000A for liquid filled Transformer
IS-2026 Part 1 to 5	Power transformer
IS-4691	Degrees of protection provided by enclosure for rotating electrical machinery
IEC-60034-5	Degrees of protection provided by integral design of rotating electrical machines(IP Code) classification
IS:325 / IEC -60034	Performance of cooling fan / oil pump motor
IS-13947 part 1 to 5	Specification for low voltage switchgear and control gear
IS:3400	Methods of test for vulcanised rubber
IS:7016 part 1 to 14	Methods of test for coated and treated fabrics
IS:803	Code of practice for design, fabrication and erection of vertical mild steel cylindrical welded oil storage tanks.
IS:3637	Gas operated Relays
IS:335	New Insulating oils – Specification
IEC-62271-203	Gas insulated metal enclosed switchgear for rated voltage above 52kV
IEC-61639	Direct connection between power transformers and gas-insulated metal enclosed switchgear for rated voltages of 52.5 kV and above.
IS:3400 / BS 903 / IS:7016	Air cell ( Flexible Air Separator)
IEC 60529 / IP : 55	Degree of protection for cooler control cabinet , MOLG, Cooling fan , oil pump, Buchholz Relay
IEC 60529 / IP : 56	Degree of protection for Pressure Relief Device
IEC 60529 / IP : 43	Degree of protection for Remote tap Changer cubicle (RTCC)
<b>CIRCUIT BREAKERS</b>	
IEC-62271-100	High-voltage switchgear and control gear - Part 100: Alternating current circuit-breakers
IEC-62271-101	High-voltage switchgear and control gear - Part 101: Synthetic testing
IEC-62155	Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1000 V
IEC-62271-110	High-voltage switchgear and control gear - Part 110: Inductive load switching
IEC-62271-109	High-voltage switchgear and control gear - Part 110: Inductive load switching
<b>CURRENT TRANSFORMERS, VOLTAGE TRANSFORMERS AND COUPLING CAPACITOR VOLTAGE TRANSFORMERS</b>	
IS-2705- (P1 to P4)	Current Transformers

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<b>CODES</b>	<b>TITLE</b>
IS:3156- (P1 to P4)	Voltage Transformers
IS-4379	Identification of the Contents of Industrial Gas Cylinders
IEC-61869 (Part-1)	Instrument transformers - Part 1: General requirements
IEC-61869 (Part-2)	Instrument transformers - Part 2: Additional requirements for current transformers
IEC-61869 (Part-3)	Instrument transformers - Part 3: Additional requirements for inductive voltage transformers
IEC-61869 (Part-4)	Instrument transformers - Part 4: Additional requirements for combined transformers
IEC-61869 (Part-5)	Instrument transformers - Part 5: Additional requirements for capacitor voltage transformers
IEC-61869 (Part-6)	Instrument transformers - Part 6: Additional general requirements for low-power instrument transformers
IEC-61869 (Part-9)	Instrument transformers - Part 9: Digital interface for instrument transformers
IEC-61869 (Part-102)	Instrument transformers - Part 102: Ferroresonance oscillations in substations with inductive voltage transformers
IEC-61869 (Part-103)	Instrument transformers - The use of instrument transformers for power quality measurement
<b>BUSHING</b>	
IS-2099	Bushings for Alternating Voltages above 1000V
IEC-60137	Insulated Bushings for Alternating Voltages above 1000V
<b>SURGE ARRESTERS</b>	
IS-3070 (PART2)	Lightning arresters for alternating current systems : Metal oxide lightning arrestors without gaps
IEC-60099-4	Metal oxide surge arrestors without gaps
IEC-60099-5	Selection and application recommendation
ANSI-C62.1	IEE Standards for S A for AC Power Circuits
NEMA-LA 1	Surge Arresters
<b>CUBICLES AND PANELS &amp; OTHER RELATED EQUIPMENTS</b>	
IS-722, IS-1248	Electrical relays for power system
IS-3231, 3231 (P-3)	Protection
IS:5039	Distributed pillars for Voltages not Exceeding 1000 Volts
IEC-60068.2.2	Basic environmental testing procedures Part 2: Test B: Dry heat
IEC-60529	Degree of Protection provided by enclosures
IEC-60947-4-1	Low voltage switchgear and control gear
IEC-61095	Electromechanical Contactors for household and similar purposes
IEC-60439 (P1 & 2)	Low Voltage Switchgear and control gear assemblies
ANSI-C37.20	Switchgear Assemblies, including metal enclosed bus
ANSI-C37.50	Test Procedures for Low Voltage Alternating Current Power

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ANNEXURE-C

<b>CODES</b>	<b>TITLE</b>
	Circuit Breakers
ANSI-C39	Electric Measuring instrument
ANSI-C83	Components for Electric Equipment
IS: 8623: (Part I to 3)	Specification for Switchgear & Control Assemblies
NEMA-AB	Moulded Case Circuit and Systems
NEMA-CS	Industrial Controls and Systems
NEMA-PB-1	Panel Boards
NEMA-SG-5	Low voltage Power Circuit breakers
NEMA-SG-3	Power Switchgear Assemblies
NEMA-SG-6	Power switching Equipment
NEMA-5E-3	Motor Control Centers
1248 (P1 to P9)	Direct acting indicating analogue electrical measuring instruments & their accessories
<b>Disconnecting switches</b>	
IEC-62271-102	High-voltage switchgear and control gear - Part 102: Alternating current disconnectors and earthing switches
IEC-60265 (Part 1 & 2)	High Voltage switches
ANSI-C37.32	Schedule of preferred Ratings, Manufacturing Specifications and Application Guide for high voltage Air Switches, Bus supports and switch accessories
ANSI-C37.34	Test Code for high voltage air switches
NEMA-SG6	Power switching equipment
<b>PLCC and line traps</b>	
IS-8792	Line traps for AC power system
IS-8793	Methods of tests for line traps
IS-8997	Coupling devices for PLC systems
IS-8998	Methods of test for coupling devices for PLC systems
IEC-60353	Line traps for A.C. power systems
IEC-60481	Coupling Devices for power line carrier systems
IEC-60495	Single sideboard power line carrier terminals
IEC-60683	Planning of (single Side-Band) power line carrier systems
CIGRE	Teleprotection report by Committee 34 & 35
CIGRE	Guide on power line carrier 1979
CCIR	International Radio Consultative Committee
CCITT	International Telegraph & Telephone Consultative Committee
EIA	Electric Industries Association
<b>Protection and control equipment</b>	
IEC-60051: (P1 to P9)	Recommendations for Direct Acting indicating analogue electrical measuring instruments and their accessories
IEC-60255 (Part 1 to 23)	Electrical relays
IEC-60297 (P1 to P4)	Dimensions of mechanical structures of the 482.6mm (19 inches)

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ANNEXURE-C

<b>CODES</b>	<b>TITLE</b>
	series
IEC-60359	Expression of the performance of electrical & electronic measuring equipment
IEC-60387	Symbols for Alternating-Current Electricity meters
IEC-60447	Man machine interface (MMI) - Actuating principles
IEC-60521	Class 0.5, 1 and 2 alternating current watt hour metres
IEC-60547	Modular plug-in Unit and standard 19-inch rack mounting unit based on NIM Standard (for electronic nuclear instruments)
ANSI-81	Screw threads
ANSI-B18	Bolts and Nuts
ANSI-C37.1	Relays, Station Controls etc
ANSI-C37.2	Manual and automatic station control, supervisory and associated telemetering equipment
ANSI-C37.2	Relays and relay systems associated with electric power apparatus
ANSI-C39.1	Requirements for electrical analog indicating instruments
<b>MOTORS</b>	
IS-325	Three phase induction motors
IS-4691	Degree of protection provided by enclosure for rotating electrical machinery
IEC-60034 (P1 to P19:)	Rotating electrical machines
IEC-Document 2	Three phase induction motors
(Central Office) NEMA-MGI	Motors and Generators
<b>Electronic equipment and components</b>	
MIL-21B, MIL-833 & MIL-2750	Environmental testing
EC-60068 (P1 to P5)	Printed boards
IEC-60326 (P1 to P2)	Material and workmanship standards
IS-1363 (P1 to P3)	Hexagon head bolts, screws and nuts of product grade C
IS-1364 (P1 to P5)	Hexagon head bolts, screws and nuts of products grades A and B
IS-3138	Hexagonal Bolts and Nuts (M42 to M150)
ISO-898	Fasteners: Bolts, screws and studs
ASTM	Specification and tests for materials
<b>Clamps &amp; connectors</b>	
IS-5561	Electric power connectors
NEMA-CC1	Electric Power connectors for sub station
NEMA-CC 3	Connectors for Use between aluminium or aluminum-Copper Overhead Conductors
<b>Bus hardware and insulators</b>	
IS: 2121	Fittings for Aluminum and steel cored Al conductors for overhead

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<b>CODES</b>	<b>TITLE</b>
	power lines
IS-731	Porcelain insulators for overhead power lines with a nominal voltage greater than 1000 V
IS-2486 (P1 to P4)	Insulator fittings for overhead power lines with a nominal voltage greater than 1000 V
IEC-60120	Dimensions of Ball and Socket Couplings of string insulator units
IEC-60137	Insulated bushings for alternating voltages above 1000 V
IEC-60168	Tests on indoor and outdoor post insulators of ceramic material or glass for Systems with Nominal Voltages Greater than 1000 V
IEC-62155	Hollow pressurized and unpressurized ceramic and glass insulators for use in electrical equipment with rated voltages greater than 1 000 V
IEC-60273	Characteristics of indoor and outdoor post insulators for systems with nominal voltages greater than 1000V
IEC-61462	Pressurized and un-pressurized insulator for use in electrical equipment with rated voltage greater than 1000V – Definitions, Test methods, acceptance criteria and design recommendations
IEC-60305	Insulators for overhead lines with nominal voltage above 1000V-ceramic or glass insulator units for ac systems Characteristics of String Insulator Units of the cap and pin type
IEC-60372 (1984)	Locking devices for ball and socket couplings of string insulator units : dimensions and tests
IEC-60383 (P1 and P2)	Insulators for overhead lines with a nominal voltage above 1000 V
IEC-60433	Characteristics of string insulator units of the long rod type
IEC-60471	Dimensions of Clevis and tongue couplings of string insulator units
ANSI-C29	Wet process porcelain insulators
ANSI-C29.1	Test methods for electrical power insulators
ANSI-C92.2	For insulators, wet-process porcelain and toughened glass suspension type
ANSI-C29.8	For wet-process porcelain insulators apparatus, post-type
ANSI-G.8	Iron and steel hardware
CISPR-7B	Recommendations of the CISPR, tolerances of form and of Position, Part 1
ASTM A-153	Zinc Coating (Hot-Dip) on iron and steel hardware
<b>Strain and rigid bus-conductor</b>	
IS-2678	Dimensions & tolerances for Wrought Aluminum and Aluminum Alloys drawn round tube
IS-5082	Wrought Aluminum and Aluminum Alloy Bars. Rods, Tubes and Sections for Electrical purposes
ASTM-B 230-82	Aluminum 1350 H19 Wire for electrical purposes

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<b>CODES</b>	<b>TITLE</b>
ASTM-B 231-81	Concentric - lay - stranded, aluminum 1350 conductors
ASTM-B 221	Aluminum - Alloy extruded bar, rod, wire, shape
ASTM-B 236-83	Aluminum bars for electrical purpose (Bus-bars)
ASTM-B 317-83	Aluminum-Alloy extruded bar, rod, pipe and structural shapes for electrical purposes (Bus Conductors)
<b>Batteries</b>	
IS:1651	Stationary Cells and Batteries, Lead-Acid Type (with Tubular Positive Plates)
IS:1652	Stationary Cells and Batteries, Lead-Acid Type (with Plante Positive Plates)
IS:1146	Rubber and Plastic Containers for Lead-Acid Storage Batteries
IS:6071	Synthetic Separators for Lead-Acid Batteries
IS:266	Specification for Sulphuric Acid
IS:1069	Specification for Water for Storage Batteries
IS:3116	Specification for Sealing Compound for Lead-Acid Batteries
IS:1248	Indicating Instruments
IS:10918	Vented type nickel Cadmium Batteries
IEC:60896-21&22	Lead Acid Batteries Valve Regulated types – Methods of Tests & Requirements
IEC: 60623	Vented type nickel Cadmium Batteries
IEC:60622	Secondary Cells & Batteries – Sealed Ni-Cd rechargeable single cell
IEC:60623	Secondary Cells & Batteries – Vented Ni-Cd rechargeable single cell
IEC:60896-11	Stationary Lead Acid Batteries – Vented Type – General requirements & method of tests
IEEE-485	Recommended practices for sizing of Lead Acid Batteries
IEEE-1115	Sizing of Ni-Cd Batteries
IEEE-1187	Recommended practices for design & installation of VRLA Batteries
IEEE-1188	Recommended practices for design & installation of VRLA Batteries
IEEE-1189	Guide for selection of VRLA Batteries
<b>Battery Charger</b>	
IS:3895	Mono-crystalline Semiconductor Rectifier Cells and Stacks
IS:4540	Mono-crystalline Semiconductor Rectifier Assemblies and Equipment
IS:6619	Safety Code for Semiconductor Rectifier Equipment
IS:2026	Power Transformers

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<b>CODES</b>	<b>TITLE</b>
IS:2959	AC Contactors for Voltages not Exceeding 1000 Volts
IS:1248	Indicating Instruments
IS:2208	HRC Fuses
IS:13947 (Part-3)	Air break switches, air break disconnectors & fuse combination units for voltage not exceeding 1000V AC or 1200V DC
IS:2147	Degree of protection provided by enclosures for low voltage switchgear and control gear
IS:6005	Code of practice for phosphating of Iron and Steel
IS:3231	Electrical relays for power system protection
IS:3842	Electrical relay for AC Systems
IS:5	Colours for ready mix paint
IEEE-484	Recommended Design for installation design and installation of large lead storage batteries for generating stations and substations
IEEE-485	Sizing large lead storage batteries for generating stations and substations
<b>Wires and cables</b>	
ASTMD-2863	Measuring the minimum oxygen concentration to support candle like combustion of plastics (oxygen index)
IS-694	PVC insulated cables for working voltages upto and including 1100 Volts
IS-1255	Code of practice for installation and maintenance of power cables, upto and including 33 kV rating
IS-1554 (P1 and P2)	PVC insulated (heavy duty) electric cables (part 1) for working voltage upto and including 1100 V Part (2) for working voltage from 3.3 kV upto and including 11kV
IS:1753	Aluminium conductor for insulated cables
IS:2982	Copper Conductor in insulated cables
IS-3961 (P1 to P5)	Recommended current ratings for cables
IS-3975	Mild steel wires, formed wires and tapes for armouring of cables
IS-5831	PVC insulating and sheath of electric cables
IS-6380	Elastometric insulating and sheath of electric cables
IS-7098	Cross linked polyethylene insulated PVC sheathed cables for working voltage upto and including 1100 volts
IS-7098	Cross-linked polyethylene insulated PVC sheathed cables for working voltage from 3.3kV upto and including 33 kV
IS-8130	Conductors for insulated electrical cables and flexible cords
IS-1753	Aluminum Conductors for insulated cables
IS-10418	Specification for drums for electric cables
IEC-60096 (part 0 to p4)	Radio Frequency cables
IEC-60183	Guide to the Selection of High Voltage Cables

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C

<b>CODES</b>	<b>TITLE</b>
IEC-60189 (P1 to P7)	Low frequency cables and wires with PVC insulation and PVC sheath
IEC-60227 (P1 to P7)	Polyvinyl Chloride insulated cables of rated voltages up to and including 450/750V
IEC-60228	Conductors of insulated cables
IEC-60230	Impulse tests on cables and their accessories
IEC-60287 (P1 to P3)	Calculation of the continuous current rating of cables (100% load factor)
IEC-60304	Standard colours for insulation for low-frequency cables and wires
IEC-60331	Fire resisting characteristics of Electric cables
IEC-60332 (P1 to P3)	Tests on electric cables under fire conditions
IEC-60502	Extruded solid dielectric insulated power cables for rated voltages from 1 kV upto to 30 kV
IEC-754 (P1 and P2)	Tests on gases evolved during combustion of electric cables
<b>AIR conditioning and ventilation</b>	
IS-659	Safety code for air conditioning
IS-660	Safety code for Mechanical Refrigeration
ARI:520	Standard for Positive Displacement Refrigeration Compressor and Condensing Units
IS:4503	Shell and tube type heat exchanger
ASHRAE-24	Method of testing for rating of liquid coolers
ANSI-B-31.5	Refrigeration Piping
IS:2062	Steel for general structural purposes
IS:655	Specification for Metal Air Dust
IS:277	Specification for Galvanised Steel Sheets
IS-737	Specification for Wrought Aluminium and Aluminium Sheet & Strip
IS-1079	Hot rolled cast steel sheet & strip
IS-3588	Specification for Electrical Axial Flow Fans
IS-2312	Propeller Type AC Ventilation Fans
BS-848	Methods of Performance Test for Fans
BS-6540 Part-I	Air Filters used in Air Conditioning and General Ventilation
BS-3928	Sodium Flame Test for Air Filters (Other than for Air Supply to I.C. Engines and Compressors)
US-PED-2098	Method of cold DOP & hot DOP test
MIL-STD-282	DOP smoke penetration method
ASHRAE-52	Air cleaning device used in general ventilation for removing particle matter
IS:3069	Glossary of Terms, Symbols and Units Relating to Thermal Insulation Materials

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

ANNEXURE-C

<b>CODES</b>	<b>TITLE</b>
IS:4671	Expanded Polystyrene for Thermal Insulation Purposes
IS:8183	Bonded Mineral Wool
IS:3346	Evaluation of Thermal Conductivity properties by means of guarded hot plate method
ASTM-C-591-69	Standard specification for rigid preformed cellular urethane thermal insulation
IS:4894	Centrifugal Fans
BS:848	Method of Performance Test for Centrifugal Fans
IS:325	Induction motors, three-phase
IS:4722	Rotating electrical machines
IS:1231	Three phase foot mounted Induction motors, dimensions of
IS:2233	Designations of types of construction and mounting arrangements of rotating electrical machines
IS:2254	Vertical shaft motors for pumps, dimensions of
IS:7816	Guide for testing insulation resistance of rotating machines
IS:4029	Guide for testing three phase induction motors
IS: 4729	Rotating electrical machines, vibration of, Measurement and evaluation of
IS:4691	Degree of protection provided by enclosures for rotating electrical machinery
IS:7572	Guide for testing single-phase ac motors
IS:2148	Flame proof enclosure for electrical apparatus
BS:4999(Part-51)	Noise levels
<b>Galvanizing</b>	
IS-209	Zinc Ingot
IS-2629	Recommended Practice for Hot-Dip galvanizing on iron and steel
IS-2633	Methods for testing uniformity of coating of zinc coated articles
ASTM-A-123	Specification for zinc (Hot Galvanizing) Coatings, on products Fabricated from rolled, pressed and forged steel shapes, plates, bars and strips
ASTM-A-121-77	Zinc-coated (Galvanized) steel barbed wire
<b>Painting</b>	
IS-6005	Code of practice for phosphating of iron and steel
ANSI-Z551	Gray finishes for industrial apparatus and equipment
SSPEC	Steel structure painting council
<b>Fire protection system</b>	
--	Fire protection manual issued by tariff advisory committee (TAC) of India
<b>HORIZONTAL CENTRIFUGAL PUMPS</b>	
IS:1520	Horizontal centrifugal pumps for clear, cold and fresh water
IS:9137	Code for acceptance test for centrifugal & axial pumps

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

ANNEXURE-C

<b>CODES</b>	<b>TITLE</b>
IS:5120	Technical requirement – Rotodynamic special purpose pumps
API-610	Centrifugal pumps for general services Hydraulic Institutes Standards
BS:599	Methods of testing pumps
PTC-8.2	Power Test Codes - Centrifugal pumps
<b>DIESEL ENGINES</b>	
IS:10000	Methods of tests for internal combustion engines
IS:10002	Specification for performance requirements for constant speed compression ignition engines for general purposes (above 20 kW)
BS:5514	The performance of reciprocating compression ignition (Diesel) engines, utilizing liquid fuel only, for general purposes
ISO:3046	Reciprocating internal combustion engines performance
IS:554	Dimensions for pipe threads where pressure tight joints are required on threads
ASME Power Test Code	Internal combustion engine PTC-17
--	Codes of Diesel Engine Manufacturer's Association, USA
<b>PIPING VALVES &amp; SPECIALITIES</b>	
IS:636	Non percolating flexible fire-fighting delivery hose
IS:638	Sheet rubber jointing and rubber inserting jointing
IS:778	Gun metal gate, globe and check valves for general purpose
IS:780	Sluice valves for water works purposes (50 to 300 mm)
IS:901	Couplings, double male and double female instantaneous pattern for fire fighting
IS:902	Suction hose couplings for fire-fighting purposes
IS:903	Fire hose delivery couplings branch pipe nozzles and nozzle spanner
IS:1538	Cast iron fittings for pressure pipes for water, gas and sewage
IS:1903	Ball valve (horizontal plunger type) including floats for water supply purposes
IS:2062	SP for weldable structural steel
IS:2379	Colour Code for the identification of pipelines
IS:2643	Dimensions of pipe threads for fastening purposes
IS:2685	Code of Practice for selection, installation and maintenance of sluice valves
IS:2906	Sluice valves for water-works purposes (350 to 1200 mm size)
IS:3582	Basket strainers for fire-fighting purposes (cylindrical type)
IS:3589	Electrically welded steel pipes for water, gas and sewage (150 to 2000 mm nominal diameter)
IS:4038	Foot valves for water works purposes
IS:4927	Unlined flax canvas hose for fire fighting

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C

<b>CODES</b>	<b>TITLE</b>
IS:5290	Landing valves (internal hydrant)
IS:5312 (Part-I)	Swing check type reflex (non-return) valves
IS:5306	Code of practice for fire extinguishing installations and equipment on premises
Part-I	Hydrant systems, hose reels and foam inlets
Part-II	Sprinkler systems
BS:5150	Specification for cast iron gate valves
<b>MOTORS &amp; ANNUNCIATION PANELS</b>	
IS:325	Three phase induction motors
IS:900	Code of practice for installation and maintenance of induction motors
IS:996	Single phase small AC and universal electric motors
IS:1231	Dimensions of three phase foot mounted induction motors
IS:2148	Flame proof enclosure of electrical apparatus
IS:2223	Dimensions of flange mounted AC induction motors
IS:2253	Designations for types of construction and mounting arrangements of rotating electrical machines
IS:2254	Dimensions of vertical shaft motors for pumps
IS:3202	Code of practice for climate proofing of electrical equipment
IS:4029	Guide for testing three phase induction motors
IS:4691	Degree of protection provided by enclosure for rotating electrical machinery
IS:4722	Rotating electrical machines
IS:4729	Measurement and evaluation of vibration of rotating electrical machines
IS:5572	Classification of hazardous areas for electrical (Part-I) installations (Areas having gases and vapours)
IS:6362	Designation of methods of cooling for rotating electrical machines
IS:6381	Construction and testing of electrical apparatus with type of protection 'e'
IS:7816	Guide for testing insulation for rotating machine
IS:4064	Air break switches
IEC DOCUMENT 2 (Control Office) 432	Three Phase Induction Motor
VDE 0530 Part I/66	Three Phase Induction Motor
IS:9224 (Part-II)	HRC Fuses
IS:6875	Push Button and Control Switches
IS:694	PVC Insulated cables
IS:1248	Indicating instruments
IS:375	Auxiliary wiring & busbar markings

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

ANNEXURE-C

<b>CODES</b>	<b>TITLE</b>
IS:2147	Degree of protection
IS:5	Colour Relay and timers
IS:2959	Contactors
<b>PG Test Procedures</b>	
NFPA-13	Standard for the installation of sprinkler system
NFPA-15	Standard for water spray fixed system for the fire protection
NFPA-12A	Standard for Halong 1301 Fire Extinguishing System
NFPA-72E	Standard on Automatic Fire Detectors
--	Fire Protection Manual by TAC (Latest Edition)
NFPA-12	Standard on Carbon dioxide extinguisher systems
IS:3034	Fire of industrial building
--	Electrical generating and distributing stations code of practice
IS:2878	CO2 (Carbon dioxide) Type Extinguisher
IS:2171	DC (Dry Chemical Powder) type
IS:940	Pressurised Water Type
<b>D.G. SET</b>	
IS:10002	Specification for performance requirements for constant speed compression ignition (diesel engine) for general purposes
IS:10000	Method of tests for internal combustion engines
IS:4722	Rotating electrical machines-specification
IS:12063	Degree of protection provided by enclosures
IS:12065	Permissible limit of noise levels for rotating electrical machines
--	Indian Explosive Act 1932
<b>Steel structures</b>	
IS-228 (1992)	Method of Chemical Analysis of pig iron, cast iron and plain carbon and low alloy steels.
IS-802 (P1 to 3)	Code of practice for use of structural steel in overhead transmission line towers
IS-806	Code of practice for use of steel tubes in general building construction
IS-808	Dimensions for hot rolled steel beam, column channel and angle sections
IS-814	Covered electrodes for manual arc welding of carbon of carbon manganese steel
IS-816	Code of Practice for use of metal arc welding for general construction in Mild steel
IS-817	Code of practice for training and testing of metal arc welders. Part 1 : Manual Metal arc welding
IS-875 (P1 to P4)	Code of practice for design loads (other than earthquake) for buildings and structures
IS-1161	Steel tubes for structural purposes

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-C

<b>CODES</b>	<b>TITLE</b>
IS-1182	Recommended practice for radiographic examination of fusion welded butt joints in steel plates
IS-1363 (P1 to P3)	Hexagonal head bolts, screws & nuts of products grade C
IS-1364	Hexagon head bolts, screws and nuts of product grades A and B
IS-1367 (P1 to P18)	Technical supply condition for threaded steel fasteners
IS-1599	Methods for bend test
IS-1608	Method for tensile testing of steel products
IS-1893	Criteria for earthquake resistant design of structures
IS-1978	Line Pipe
IS-2062	Steel for general structural purposes
IS-2595	Code of practice for Radiographic testing
IS-3063	Single coil rectangular section spring washers for bolts, nuts and screws
IS-3664	Code of practice for ultrasonic pulse echo testing by contact and immersion methods
IS-7205	Safety code for erection of structural steel work
IS-9595	Recommendations for metal arc welding of carbon and carbon manganese steels
ANSI-B18.2.1	Inch series square and Hexagonal bolts and screws
ANSI-B18.2.2	Square and hexagonal nuts
ANSI-G8.14	Round head bolts
ASTM-A6	Specification for General Requirements for rolled steel plates, shapes, sheet piling and bars of structural use
ASTM-A36	Specifications of structural steel
ASTM-A47	Specification for malleable iron castings
ASTM-A143	Practice for safeguarding against embilement of Hot Galvanized structural steel products and procedure for detaching embrilement
ASTM-A242	Specification for high strength low alloy structural steel
ASTM-A283	Specification for low and intermediate tensile strength carbon steel plates of structural quality
ASTM-A394	Specification for Galvanized steel transmission tower bolts and nuts
ASTM-441	Specification for High strength low alloy structural manganese vanadium steel
ASTM-A572	Specification for High strength low alloy colombium-Vanadium steel of structural quality
AWS D1-0	Code for welding in building construction welding inspection
AWS D1-1	Structural welding code
AISC	American institute of steel construction
NEMA-CG1	Manufactured graphite electrodes

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

ANNEXURE-C

<b>CODES</b>	<b>TITLE</b>
<b>Piping and pressure vessels</b>	
IS-1239 (Part 1 and 2)	Mild steel tubes, tubulars and other wrought steel fittings
IS -3589	Seamless Electrically welded steel pipes for water, gas and sewage
IS-6392	Steel pipe flanges
ASME	Boiler and pressure vessel code
ASTM-A120	Specification for pipe steel, black and hot dipped, zinc-coated (Galvanized) welded and seamless steel pipe for ordinary use
ASTM-A53	Specification for pipe, steel, black, and hot-dipped, zinc coated welded and seamless
ASTM-A106	Seamless carbon steel pipe for high temperature service
ASTM-A284	Low and intermediate tensile strength carbon-silicon steel plates for machine parts and general construction
ASTM-A234	Pipe fittings of wrought carbon steel and alloy steel for moderate and elevated temperatures
ASTM-S181	Specification for forgings, carbon steel for general purpose piping
ASTM-A105	Forgings, carbon steel for piping components
ASTM-A307	Carbon steel externally threaded standard fasteners
ASTM-A193	Alloy steel and stainless steel bolting materials for high temperature service
ASTM-A345	Flat rolled electrical steel for magnetic applications
ASTM-A197	Cupola malleable iron
ANSI-B2.1	Pipe threads (Except dry seal)
ANSI-B16.1	Cast iron pipe flanges and flanged fitting. Class 25, 125, 250 and 800
ANSI-B16.1	Malleable iron threaded fittings, class 150 and 300
ANSI-B16.5	Pipe flanges and flanged fittings, steel nickel alloy and other special alloys
ANSI-B16.9	Factory-made wrought steel butt welding fittings
ANSI-B16.11	Forged steel fittings, socket-welding and threaded
ANSI-B16.14	Ferrous pipe plug, bushings and locknuts with pipe threads
ANSI-B16.25	Butt welding ends
ANSI-B18.1.1	Fire hose couplings screw thread
ANSI-B18.2.1	Inch series square and hexagonal bolts and screws
ANSI-B18.2.2	Square and hexagonal nuts
ANSI-B18.21.1	Lock washers
ANSI-B18.21.2	Plain washers
ANSI-B31.1	Power piping
ANSI-B36.10	Welded and seamless wrought steel pipe
ANSI-B36.9	Stainless steel pipe
<b>Other civil works standards</b>	

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

ANNEXURE-C

<b>CODES</b>	<b>TITLE</b>
IS-269	33 grade ordinary portland cement
IS2721	Galvanized steel chain link fence fabric
IS-278	Galvanized steel barbed wire for fencing
IS-383	Coarse and fine aggregates from natural sources for concrete
IS-432 (P1 and P2)	Mild steel and medium tensile steel bars and hard-dawn steel wire for concrete reinforcement
IS-456	Code of practice for plain and reinforced concrete
IS-516	Method of test for strength of concrete
IS-800	Code of practice for general construction in steel
IS-806	Steel tubes for structural purposes
IS-1172	Basic requirements for water supply, drainage and sanitation
IS-1199	Methods of sampling and analysis of concrete
IS-1566	Hard-dawn steel wire fabric for concrete reinforcement
IS-1742	Code of Practice for Building drainage
IS-1785	Plain hard-drawn steel wire for pre-stressed concrete
IS-1786	High strength deformed Steel Bars and wires for concrete reinforcement
IS-1811	Methods of sampling Foundry sands
IS-1893	Criteria for earthquake resistant design of structures
IS-2062	Steel for general structural purposes
IS-2064	Selection, installation and maintenance of sanitary appliances- code of practices
IS-2065	Code of practice for water supply in buildings
IS-2090	High tension steel bars used in pre-stressed concrete
IS-2140	Standard Galvanized steel wire for fencing
IS-2470 (P1 & P2)	Code of practice for installation of septic tanks
IS-2514	Concrete vibrating tables
IS-2645	Integral cement waterproofing compounds
IS-3025 (Part 1 to Part 48)	Methods of sampling and test (Physical and chemical) for water and waste water
IS-4091	Code of practice for design and construction of foundations for transmission line towers and poles
IS-4111 (Part 1 to P5)	Code of practice for ancillary structures in sewerage system
IS-4990	Plywood for concrete shuttering work
IS-5600	Sewage and drainage pumps
<b>National building code of India 1970</b>	
USBR E12	Earth Manual by United States Department of the interior Bureau of Reclamation
ASTM-A392-81	Zinc/Coated steel chain link fence fabric
ASTM-D1557-80	test for moisture-density relation of soils using 10-lb (4.5 kg)

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)****ANNEXURE-C**

<b>CODES</b>	<b>TITLE</b>
	rame land 18-in. (457 mm) Drop
ASTM-D1586(1967)	Penetration Test and Split-Barrel Sampling of Soils
ASTM-D2049-69	Test Method for Relative Density of Cohesionless Soils
ASTM-D2435	Test method for Unconsolidated, (1982) Undrained Strengths of Cohesive Soils in Triaxial Compression
BS-5075	Specification for accelerating Part I Admixtures, Retarding Admixtures and Water Reducing Admixtures
CPWD	Latest CPWD specifications
<b>ACSR MOOSE CONDUCTOR</b>	
IS:6745 BS:443-1969	Methods for Determination of Mass of zinc coating on zinc coated Iron and Steel Articles
IS:8263	Methods for Radio Interference
IEC:437-1973 NEMA:107-1964 CISPR	Test on High Voltage Insulators
IS:209, BS:3436-1961	Zinc Ingot
IS:398 Part - V IEC:209-1966	Aluminum Conductors for Overhead Transmission Purposes
BS:215(Part-II), IEC:209-1966	Aluminium Conductors galvanized steel reinforced extra high voltage (400 kV and above)
IS:1778, BS:1559-1949	Reels and Drums for Bare Conductors
IS:1521, ISO/R89-1959	Method for Tensile Testing of steel wire
IS:2629	Recommended practice for Hot dip Galvanising on Iron and Steel
IS:2633	Method for Testing Uniformity of coating of zinc Coated Articles
IS:4826/ ASTMA-472-729	Hot dip galvanised coatings on round steel wires
<b>GALVANISED STEEL EARTHWIRE</b>	
IS:1521, ISO/R:89-1959	Method for Tensile Testing of Steel Wire
IS:1778	Reels and Drums for Bare Conductors
IS:2629	Recommended practice for Hot Dip Galvanising on Iron and Steel
IS:2633	Methods for testing Uniformity of Coating of Zinc Coated Articles
IS:4826/ ASTM: A 475-72a BS:443-1969	Hot dip Galvanised Coatings on Round Steel Wires
IS:6745/ BS:443-1969	Method for Determination of mass of Zinc Coating on Zinc coated Iron and Steel Articles.
IS:209/ BS:3463-1961	Zinc ingot
IS:398 (Pt. I to P5:1992)/ BS:215 (Part-II	Aluminum Conductors for overhead transmission purposes

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)****ANNEXURE-C**

<b>CODES</b>	<b>TITLE</b>
<b>Lighting Fixtures and Accessories</b>	
IS:1913	General and safety requirements for electric lighting fittings
IS:3528	Water proof electric lighting fittings
IS:4012	Dust proof electric lighting fittings
IS:4013	Dust tight proof electric lighting fittings
IS:10322	Industrial lighting fittings with metal reflectors
IS:10322	Industrial lighting fittings with plastic reflectors
IS:2206	Well glass lighting fittings for use under ground in mines (non-flameproof type)
IS:10322	Specification for flood light
IS:10322	Specification for decorative lighting outfits
IS:10322	Luminaries for street lighting
IS:2418	Tubular fluorescent lamps
IS:9900	High pressure mercury vapour lamps
IS:1258	Specification for Bayonet lamp fluorescent lamp
IS:3323	Bi-pin lamp holder tubular fluorescent lamps
IS:1534	Ballasts for use in fluorescent lighting fittings. (Part-I)
IS:1569	Capacitors for use in fluorescent lighting fittings
IS:2215	Starters for fluorescent lamps
IS:3324	Holders for starters for tubular fluorescent lamps
IS:418	GLS lamps
IS:3553	Water tight electric fittings
IS:2713	Tubular steel poles
IS:280	MS wire for general engg. Purposes
<b>Conduits, Accessories and Junction Boxes</b>	
IS:9537	Rigid steel conduits for electrical wiring
IS:3480	Flexible steel conduits for electrical wiring
IS:2667	Fittings for rigid steel conduits for electrical wiring
IS:3837	Accessories for rigid steel conduits for electrical wiring
IS:4649	Adaptors for flexible steel conduits
IS:5133	Steel and Cast Iron Boxes
IS:2629	Hot dip galvanising of Iron & Steel
<b>Lighting Panels</b>	
IS:13947	LV Switchgear and Control gear(Part 1 to 5)
IS:8828	Circuit breakers for over current protection for house hold and similar installations
IS:5	Ready mix paints
IS:2551	Danger notice plates
IS:2705	Current transformers

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

ANNEXURE-C

<b>CODES</b>	<b>TITLE</b>
IS:9224	HRC Cartridge fuse links for voltage above 650V(Part-2)
IS:5082	Wrought aluminium and Al. alloys, bars, rods, tubes and sections for electrical purposes
IS:8623	Factory built Assemblies of Switchgear and Control Gear for voltages upto and including 1000V AC and 1200V DC
IS:1248	Direct Acting electrical indicating instruments
<b>Electrical Installation</b>	
IS:1293	3 pin plug
IS:371	Two to three ceiling roses
IS:3854	Switches for domestic and similar purposes
IS:5216	Guide for safety procedures and practices in electrical work
IS:732	Code of practice for electrical wiring installation (system voltage not exceeding 650 Volts.)
IS:3043	Code of practice for earthing
IS:3646	Code of practice of interior illumination part II & III
IS:1944	Code of practice for lighting of public through fares
IS:5571	Guide for selection of electrical equipment for hazardous areas
IS:800	Code of practice for use of structural steel in general building construction
IS:2633	Methods of Testing uniformity of coating on zinc coated articles
IS:6005	Code of practice for phosphating iron and steel
	INDIAN ELECTRICITY ACT
	INDIAN ELECTRICITY RULES
<b>LT SWITCHGEAR</b>	
IS:8623 (Part-I)	Specification for low voltage switchgear and control gear assemblies
IS:13947 (Part-I)	Specification for low voltage switchgear and control gear, Part 1 General Rules
IS:13947 (part-2)	Specification for low voltage switchgear and control gear, Part 2 circuit breakers
IS:13947 (part-3)	Specification for low voltage switchgear and control gear. Part 3 Switches, Disconnectors, Switch-disconnectors and fuse combination units
IS:13947 (part-4)	Specification for low voltage switchgear and control gear. Part 4 Contactors and motors starters
IS:13947 (part-5)	Specification for low voltage switchgear and control gear. Part 5 Control-circuit devices and switching elements
IS:13947 (part-6)	Specification for low voltage switchgear and control gear. Part 6 Multiple function switching devices
IS:13947 (part-7)	Specification for low voltage switchgear and control gear. Part 7 Ancillary equipments
IS:12063	Degree of protection provided by enclosures

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

**ANNEXURE-C**

<b>CODES</b>	<b>TITLE</b>
IS:2705	Current Transformers
IS:3156	Voltage Transformers
IS:3231	Electrical relays for power system protection
IS:1248	Electrical indicating instruments
IS:722	AC Electricity meters
IS:5578	Guide for Marking of insulated conductors of apparatus terminals
IS:13703 (part 1)	Low voltage fuses for voltage not exceeding 1000V AC or 1500V DC Part 1 General Requirements
IS:13703 (part 2)	Low voltage fuses for voltage not exceeding 1000V AC or 1500V DC Part 2 Fuses for use of authorized persons
IS:6005	Code of practice of phosphating iron and steel
IS:5082	Wrought Aluminum and Aluminum alloys for electrical purposes
IS:2633	Hot dip galvanising

Note: If any standard is expired or does not exist anymore than other standard which has substituted it, shall be applicable.

**LIST OF DRAWINGS/DOCUMENTS FOR SECOND ADVANCE**

**A. ELECTRICAL DRAWINGS/DOCUMENTS FOR SWITCHYARD**

- (1) Single Line Diagram
- (2) Electrical Layout – Plan and Sections
- (3) DSLP Calculation and drawing
- (4) Structure Layout (Plan & Section) drawing
- (5) Foundation & Cable Trench Layout
- (6) Earthmat Layout
- (7) Short circuit Force and Critical Span Calculations (for non-standard span)
- (8) Cantilever Strength calculations (for non-standard span)

**B. CIVIL DRAWINGS/DOCUMENTS**

- (1) Soil Investigation Report (if applicable)
- (2) Structure Design, Foundation Design & Drawing, Plinth Beam Design & Drawing and column Design & Drawing up to G.F. Level of control room building
- (3) Structure Design, Foundation Design & Drawing, Plinth Beam Design & Drawing and column Design & Drawing of GIS building(s)

**C. DRAWINGS/DOCUMENTS OF EQUIPMENT**

- (1) Circuit Breaker, Isolator, CT, CVT, IVT, Surge Arrestor, Bus Post Insulator
  - Drawing, GTP and Type test Reports
- (2) Control and Relay Panels
  - GTP and Type test Reports
- (3) Substation Automation System (SAS)
  - GTP and Type test Reports

**D. DRAWINGS/DOCUMENTS OF POWER TRANSFORMER**

- (1) Design Review documents
- (2) GA drawings for transformer, bushings
- (3) Foundation Plan
- (4) GTP
- (5) RTCC -GA and schematic drawings
- (6) Rating and Diagram Plate
- (7) Power Transformer foundation design & drawings (if Applicable)
- (8) For Single Phase Autotransformer (if Applicable)
  - Single Line Diagram
  - Electrical Layout & Section
  - Foundation Layout including Neutral & Delta Formation

**LIST OF DRAWINGS/DOCUMENTS FOR SECOND ADVANCE**

**E. DRAWINGS/DOCUMENTS OF REACTOR**

- (1) Design Review documents
- (2) GA drawings for reactor, NGR, LA, bushings
- (3) Foundation Plan
- (4) GTP
- (5) Rating and Diagram Plate
- (6) Shunt Reactor, NGR & SA foundation design & drawings (if Applicable)
- (7) For Single Phase Reactor (if Applicable)
  - Single Line Diagram
  - Electrical Layout & Section
  - Foundation Layout including Neutral Formation

**F. DRAWINGS/DOCUMENTS OF GIS**

- (1) GTP
- (2) Gas Line Diagram
- (3) GIS Layout Drawing

**G. DRAWINGS/DOCUMENTS OF EHV Cable (132kV of Above)**

- (1) GTP
- (2) Cross Section Drawing

**NOTES:-**

1. The list of drawings/ documents mentioned above is a standard list. Some of the items may not be applicable and need not to be referred for a particular substation package.
2. In case type tests are to be repeated/conducted, then approval of type test reports is not required at this stage.
3. Category-II approved drawings shall also be considered for release of second/engineering advance.

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

ANNEXURE-E

<b>Comprehensive List of Drawing Submission Schedule</b>		
<b>SL.NO.</b>	<b>DRAWINGS/DOCUMENTS TITLE</b>	<b>CATEGORY</b>
<b>1.00</b>	<b>DRAWING FOR SWITCHYARD</b>	
1.01	Over all General Arrangement Drawing	A
1.02	Single Line Diagram	A
1.03	Electrical layout plan & section	A
1.04	Structure loading diagram cum layout arrangement	A
1.05	DSLPP Calculation & layout	A
1.06	Switchyard Foundation & cable Trench Layout	A
1.07	Indoor Cable Trench Layout ( As applicable for Control Room Building, GIS Hall ,Switchyard panel Room, FFPH Building)	A
1.08	Buried Cable Trench layout	A
1.09	Erection Key Diagram (plan & section) & Erection Bill of Quantity	A
1.10	Earthmat layout	A
1.11	Indoor Illumination layout ( As applicable for Control Room Building, FFPH Building, Transit Camp, Switchyard panel Room, GIS Hall )	A
1.12	Out door illumination Layout	A
1.13	SLD of LT AC/DC System	A
1.14	Panel arrangement layout in Control Room Building	A
1.15	Panel arrangement layout in Switchyard panel room/LCR Room of GIS Hall	A
1.16	Fire detection and alarm system for control Room building, GIS Building and Switchyard panel room	A
1.17	Air Conditioning Layout ( As applicable for Control Room Building, LCR room in GIS Hall ,Switchyard panel Room)	
1.18	LT Station Layout	A
1.19	Power and control cable schedule	A
<b>2.00</b>	<b>DESIGN CALCULATION</b>	
2.01	DSLPP calculation	R
2.02	Lighting system design calculation (if applicable)	R
2.03	Earthing system design calculation (if applicable)	R
2.04	Battery sizing calculation (if applicable)	R
2.05	Hydrolic Calculation for Fire protection (if applicable)	R
2.06	AC and ventilation calculation for GIS Building ( if applicable)	R
2.07	EOT crane sizing calculation	R
<b>3.00</b>	<b>GAS INSULATED SWITCHGEAR</b>	
3.01	Design Review along with all supporting documents for new design of GIS	A

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)****ANNEXURE-E**

<b>Comprehensive List of Drawing Submission Schedule</b>		
3.02	Guaranteed Technical Particular (GTP)	A
3.03	Type Test Reports of GIS	A
3.04	Drawings, GTP & Type Test Reports of SF6/Air Bushing	A
3.05	Component Drawing of Each type of GIS Equipment	R
3.06	Single Line Diagram	A
3.07	Layout for GIS Arrangement (Plan and Section View and plate form arrangement)	A
3.08	Foundation for GIS (Including Loading Data)	A
3.09	Earthing Layout including Special Earthing Requirement for GIS	R
3.10	Gas System Diagram	A
3.11	GIS support Structure layout including Details of Support Structure.	A
3.12	GIS Key Diagram	R
3.13	PD Location Layout along with sensitivity attenuation calculation	R
3.14	GA & Schematic drawings of Local Control Cabinets (LCC)	A
3.15	Type Test Reports of Local Control Cabinets (LCC)	A
3.16	Spare Parts List (Based on Contract)	A
3.17	Special Tools List (Based on Contract)	A
3.18	Name Plates	A
3.19	GA, Data Sheet and Catalogues for	
a)	SF6 gas leakage detector	R
b)	SF6 gas filling & evacuation plant	R
c)	SF6 gas Analyser	R
d)	Partial discharge monitoring system	R
e)	catalogue of UHF sensors	R
3.20	GA & Schematic drawings of overhead crane	A
<b>4.00</b>	<b>AUTOTRANSFORMER</b>	
4.01	Design Review	R
4.02	Guaranteed Technical Particulars	A
4.03	Outline General Arrangement Drawing with Bill of material (OGA parts list) & Shipping details	A
4.04	Foundation Plan	A
4.05	GA & schematic drawing of Cooler control cabinet/Marshalling Box and Write up	A
4.06	GA & schematic drawing of Common Marshalling Box and Write up (as applicable)	A
4.07	GA & schematic drawing of Drive Mechanism Box and Write up	A
4.08	Bushing dwg and GTP (HV, IV, LV and Neutral as applicable)	A
4.09	Radiator Details	A
4.10	Magnetising Characteristics of bushings CT	A
4.11	Rating and Diagram plate	A

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)****ANNEXURE-E**

<b>Comprehensive List of Drawing Submission Schedule</b>		
4.12	Valve Schedule plate rating	A
4.13	Twin-Bi directional roller	A
4.14	Type Test Report	A
4.15	Instruction Manual	R
<b>5.00</b>	<b>REACTOR</b>	
5.01	Design Review	R
5.02	Guaranteed Technical Particulars	A
5.03	Outline General Arrangement Drawing with Bill of material (OGA parts list) & Shipping details	A
5.04	Foundation Plan	A
5.05	Bushing dwg and GTP (HV and Neutral)	A
5.06	GA & schematic drawing of Marshalling Box and Write up	A
5.07	Magnetization characteristics of Reactor Core and bushing CTs	A
5.08	Rating and diagram plate	A
5.09	Twin bi-directional roller	A
5.10	Radiator Details	A
5.11	Type test Report	A
5.12	Instruction Manual	R
<b>6.0</b>	<b>NEUTRAL GROUNDING REACTOR (NGR)</b>	
<b>A</b>	<b>Air Core NGR</b>	
6.01	Design Review	R
6.02	Guaranteed Technical Particulars	A
6.03	General Arrangement Drawing with pedestal details and Bill of material (OGA parts list) & Shipping details	A
6.04	Foundation Plan	A
6.05	Rating and diagram plate	A
<b>B</b>	<b>Oil Filled Type NGR</b>	
6.06	Design Review	R
6.07	Guaranteed Technical Particulars	A
6.08	General Arrangement Drawing with Bill of material (OGA parts list) & Shipping details	A
6.09	Foundation Plan including Combined Foundation for NGR & LA	A
6.10	Rating and diagram plate	A
<b>7.00</b>	<b>CIRCUIT BREAKER</b>	
7.01	GA drg of SF6 CB	A
17.02	OGA drawing of control unit	A
7.03	OGA drawing of support insulator, interrupter insulator	R
7.04	Support structure & foundation plan drawing	A

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

ANNEXURE-E

<b>Comprehensive List of Drawing Submission Schedule</b>		
7.05	Electrical schematic diagram	A
7.06	Rating and name plate drawing	A
7.07	Hydraulic/SF6 gas connection diagram	R
7.08	Schematic diagram of operating mechanism	R
7.09	Wiring diagram	R
7.10	Terminal connector and corona rings	R
7.11	Sectional view of interrupter	R
7.12	GTP	A
7.13	Type Test Reports	A
7.14	Instruction Manual	R
<b>8.00</b>	<b>ISOLATOR</b>	
8.01	GA drawing of Isolator without earth switch	A
8.02	Contact blade assembly (main & earth switch)	R
8.03	Terminal pad & hinge contacts	R
8.04	GA of MOM - main switch	R
8.05	Schematic & wiring drg. for main switch	R
8.06	Name plate - details	A
8.07	GA of terminal connectors	A
8.08	GA of post insulator for isolator	R
8.09	GTP	A
8.10	Type Test Report	A
8.11	Instruction Manual	R
<b>9.00</b>	<b>INSTRUMENT TRANSFORMER (CT/CVT/IVT)</b>	
9.01	GTP	A
9.02	General Arrangement	A
9.03	Sectional view	R
9.04	Sec. terminal box GA	R
9.05	GA of Junction box	R
9.06	Data sheet of junction box	A
9.07	Wiring drg of JB incl. interpole	R
9.08	Terminal connectors	A
9.09	Schematic & rating plate	R
9.10	Porcelain insulator	R
9.11	Corona ring	R
9.12	Type Test Reports	A
9.13	Instruction Manual	R
<b>10.00</b>	<b>SURGE ARRESTER</b>	

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)****ANNEXURE-E**

<b>Comprehensive List of Drawing Submission Schedule</b>		
10.01	GA of Surge Arrester	A
10.02	GTP	A
10.03	Porcelain insulator	R
10.04	Cross sectional view	R
10.05	Arrestor and unit name plate	A
10.06	Grading rings	R
10.07	Insulating base / surge counter detail	R
10.08	Outline drg of surge counter	R
10.09	Circuit diagram of surge counter	R
10.10	GA of ZnO element	R
10.11	Line terminal bracket with corona rings	R
10.12	Drawing showing pressure relief arrangement.	R
10.13	Type Test Report	A
10.14	Instruction Manual	R
<b>11.00</b>	<b>BUS POST INSULATOR</b>	
11.01	GA drawing & GTP	A
11.02	Type Test Reports	A
<b>12.00</b>	<b>Marshaling Box, Junction Boxes</b>	
12.01	GA Drawings	A
12.02	Schematic Drawing	A
12.03	Type Test reports	A
<b>13.00</b>	<b>Conductor, Al Tube &amp; GS Earth Switch</b>	
13.01	Type Test Reports (if applicable)	A
<b>14.00</b>	<b>DISC INSULATOR (if applicable)</b>	
14.01	GA drawing	A
14.02	Type Test Reports	A
<b>15.00</b>	<b>LONG ROD POLYMER INSULATOR</b>	
15.01	GA drawing	A
15.02	Type Test Reports	A
<b>16.00</b>	<b>INSULATOR STRINGS WITH HARDWARE ASSEMBLY</b>	
16.01	GA DRG	A
16.02	Component drawings	R
16.03	Type Test Reports	A

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)****ANNEXURE-E**

<b>Comprehensive List of Drawing Submission Schedule</b>		
<b>17.00</b>	<b>CLAMPS &amp; CONNECTORS</b>	
17.01	Drawings	A
17.02	Type Test Reports	A
<b>18.00</b>	<b>HORN GAP FUSE</b>	
18.01	GA OF HG FUSE	A
18.02	Type Test Reports	A
<b>19.00</b>	<b>BATTERY AND BATTERY CHARGER</b>	
19.01	GTP	A
19.02	Drawings	A
19.03	Type Test Reports	A
<b>20.00</b>	<b>ILLUMINATION</b>	
20.01	GTP of all types of fittings/fixtures & control gear	A
20.02	GA drg. of lighting poles/posts	A
20.03	Wiring drgs. of panel/LDBs to fixtures	R
20.04	GA of Junction box	A
20.05	GA street lighting panel/outdoor lighting panel	A
20.06	GA of Receptacles	A
<b>21.00</b>	<b>LT SWITCHGEAR</b>	
21.01	GA drg of ACDB	A
21.02	SLD of ACDB	A
21.03	GA drg of 220V DCDB	A
21.04	SLD of 220V DCDB	A
21.05	GA drg of 50V DCDB	A
21.06	SLD of 50V DCDB	A
21.07	Data sheet	A
21.08	Sch. of each type of module	R
21.09	Type Test Reports	A
21.10	Instruction Manual	R
<b>22.00</b>	<b>HT Power Cable</b>	
22.01	GTP & Catalogue	A
22.02	Type Test Reports	A
<b>23.00</b>	<b>POWER &amp; CONTROL CABLE</b>	
23.01	Type Test Reports for Power Cable	A
23.02	<b>Type Test Reports for Control Cable</b>	<b>A</b>

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

ANNEXURE-E

<b>Comprehensive List of Drawing Submission Schedule</b>		
<b>24.00</b>	<b>CONTROL AND RELAY PANELS &amp; SUBSTATION AUTOMATION SYSTEM (SAS)</b>	
24.01	GTP & detailed technical literature & O&M manuals of all types of relays, SAS Equipments	A/R
24.02	Type Test Reports of all relays & equipments	R
	GA and schematic drgs. for :-	
a)	Relay and protection panels for all type line(s)	A
b)	Relay and protection panels for all type autotransformer(s) including tertiary loading	A
c)	Relay and protection panels for bus/line reactor(s)	A
d)	Relay and protection panels for tie bay(s)	
e)	Relay and protection panels for TBC bay(s)	A
f)	Relay and protection panels for BC bay(s)	A
g)	Busbar protection panel (s)	A
h)	Circuit Breaker relay panel(s)	
24.03	Panel Construction Details	A
24.04	SAS Architecture	A
24.05	Relay Settings	A
<b>25.00</b>	<b>Visual Monitoring System</b>	
25.01	GTP/Catalogue of VMS Equipment and Camera	A
25.02	VMS Architectural Drawing	A
<b>26.00</b>	<b>PLCC EQUIPMENTS</b>	
26.01	GTP & technical literature	A/R
26.02	Type Test Reports of all PLCC equipment	A
26.03	GA & GTPs for wave trap	A
26.04	GA drg of PLCC terminal	R
26.05	Digital/ Analog Protection coupler	R
26.06	SNR calculation (if applicable)	R
26.07	Coupling device	R
26.08	GTP of HF cable	A
26.09	Testing & maintenance equipments	R
26.10	Frequency Planning	A
<b>27.00</b>	<b>DG SET</b>	
27.01	GTP	A
27.02	Drawings/manuals	A
<b>28.00</b>	<b>AIR CONDITIONING &amp; VENTILATION SYSTEM</b>	

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

ANNEXURE-E

<b>Comprehensive List of Drawing Submission Schedule</b>		
28.01	GTP	A
28.02	Drawings	A
28.03	A/C sizing calculation	A
<b>29.00</b>	<b>LT TRANSFORMER</b>	
29.01	GTP	A
29.02	Drawings	A
29.03	Type Test Reports	A
<b>30.00</b>	<b>FIRE PROTECTION SYSTEM</b>	
30.01	Piping layout in the switchyard	A
30.02	HVW spray system drawings (plan, elevation, side view , isometric view and pylon support details)	R
30.03	Pylon support locations	R
30.04	Schematic and GA for LCP for deluge valve operation	A
30.05	Hydraulic calculations for HVW spray network	R
30.06	Drawing for deluge valve housing	A
30.07	GTP & drawings for strainers (Y type & basket strainer)	A
30.08	Drawing of valve pit details	A
30.09	System writeup with various settings	A
30.10	GTP & drgs. for gate valve, check valve, solenoid valve, outdoor hydrant valve	A
30.11	GTP & catalogue for deluge valve, spray nozzles & projectors	A
30.12	GTP & catalogue for quartzoid bulb detector	A
30.13	GTP & drg. for pressure switch, pressure gauge	A
30.14	GTP for G.I. & M.S. pipes & pipe accessories	A
<b>31.00</b>	<b>CONTROL ROOM BUILDING / TRANSIT CAMP /FFPH BUILDING/SWITCHAYRD PANEL ROOM/INDOOR HT SWITCHGEAR ROOM/TOWNSHIP BUILDINGS (AS applicable)</b>	
31.01	Architectural drawing	
a)	Plan, Section & elevation	A
b)	Doors and Window Schedule	A
31.02	Building design calculation( if applicable)	A
31.03	Civil Construction Drawings	A
<b>32.00</b>	<b>DRAWING FOR GIS BUILDING ( if Applicable)</b>	A
31.01	Architectural drawing	A
a)	Plan, section & elevation	A
b)	Doors & windows schedule	A

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

ANNEXURE-E

<b>Comprehensive List of Drawing Submission Schedule</b>		
31.02	GIS Building Superstructure drawings & design calculation	A
31.03	Civil Construction Drawings	A
31.04	GIS Equipment foundation inside GIS building	A
<b>33.0</b>	<b>SWITCHYARD CIVIL CONSTRUCTION DRAWING (AS APPLICABLE)</b>	
33.01	Tower Foundation	A
33.02	Equipment Foundation	A
33.03	Transformer Foundation	A
33.04	Reactor Foundation	A
33.05	Road Construction including culverts, rail cum roads	A
33.06	Switchyard fencing and Gate	A
33.07	Cable trench section	A
33.08	Drain Section	A
33.09	Rain water harvesting	A
33.10	Boundary wall	A
33.11	DG Set foundation	A
33.12	LT transformer foundation	A
33.13	Car parking Shed/Security Room	A
33.14	Out Door GIB foundations	A
33.15	Outdoor Sf6/Air Bushing Foundation	A
33.16	BMK/Lighting pole foundation	A
33.17	Fire wall	A
33.18	Contour layout	A
33.19	Drawing of formation level	A
33.20	Soil investigation Report	A
33.21	Any other foundation in Switchyard	A
<b>34.00</b>	<b>DESIGN, FABRICATION &amp; PROTO CORRECTED DRAWINGS OF ALL TYPES OF TOWERS &amp; BEAMS</b>	R
<b>35.00</b>	<b>DESIGN, FABRICATION DRAWINGS FOR EQUIPMENT SUPPORT STRUCTURES</b>	R
<b>36.00</b>	<b>MISCELLANEOUS CIVIL DRGS</b>	A

LEGEND:- A- for Approval; R:- for Record

Note: i) The above list of Drawing is indicative. The same shall be used for formulation of Master Drawing List (MDL) in DREAMS System.

## **SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

### **Annexure- F**

**Assessment report from Contractor for proposed sub-vendor along with following enclosures (to the extent available):**

1. Registration / License of the works
2. Organization chart with name and qualification of key persons
3. List of Plant and Machinery.
4. List of testing equipment with their calibration status.
5. List of Raw material, bought out items with sourcing details
6. List of out-sourced services with sourcing details.
7. List of supply in last three years.
8. Third party approval, if any (viz. ISO, BIS),
9. Pollution clearance wherever applicable
10. Energy Conservation & Efficiency report  
(Applicable to industries having contract load more than 100 KVA)
11. Formats for RM, in process and acceptance testing
12. Type test approvals conducted in last 5 years, if applicable
13. Performance Certificates from customers
14. Photographs of factory, plant and machinery & testing facilities

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)****Annexure-G****MQP & INSPECTION LEVEL REQUIREMENT**

Sl. No	Item / Equipment	Reference document for inspection	Inspection Level
A.01	LT Transformer /Power Transformer/ Reactor/ Converter Transformer/ Filter Reactor	MQP/ITP	IV
A.02	Bushing	MQP	IV
A.03	Insulating Oil	POWERGRID TS	III
A.04	Oil storage tank for transformers	MQP	III
A.05	Nitrogen injection based explosion prevention system	FAT/ITP	III
A.06	On Line oil drying system for transformers	POWERGRID TS	II**
A.07	On Line DGA and moisture monitoring system	POWERGRID TS	II**
A.08	Flow sensitive conservator isolation valve	POWERGRID TS	II**
A.09	Oil Filtration Machine	MQP	III
B.01	Circuit Breakers	MQP	IV
B.02	Current Transformers	MQP/ITP	IV
B.03	CVT/PT/IVT	MQP	IV
B.04	Isolators	MQP/ITP	IV
B.05	Surge Arrestors	MQP/ITP	III
B.06	Line Trap & Air Core Reactor	MQP/ITP	III
B.07	Point On switching device (CSD) for Circuit Breaker (wherever required)	FAT/ITP	IV
C.01	STATCOM including Valve, valve base electronics, DC capacitor, series reactor and all accessories	ITP	IV
C.02	Mechanically switched Reactor bank (3-ph) including all accessories (MSR Branches)	ITP	IV
C.03	Mechanically switched Capacitor bank (3-ph) including all accessories (MSC Branches)	ITP	IV
C.04	Harmonic Pass filters	ITP	IV
C.05	HT Capacitor	MQP	IV
D.01	Thyristor Valve	FAT/ITP	III
D.02	PLC Capacitors for HVDC	FAT/ITP	III
D.03	Valve Cooling system for	FAT/ITP	III

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

**Annexure-G**

Sl. No	Item / Equipment	Reference document for inspection	Inspection Level
	HVDC		
D.04	AC/DC Filter Resistors	ITP	III
D.05	DC Current and Voltage measuring device for HVDC	FAT/ITP	III
D.06	Maintenance platform for valve hall	POWERGRID TS	II
D.07	Optical signal column for FSC	FAT/ITP	II
E.01	GIS including spares	MQP/ITP	IV
E.02	Dew Point Meter for GIS	POWERGRID TS	I*
E.03	Portable Partial Discharge monitoring system for GIS	POWERGRID TS	I*
E.04	Partial Discharge Monitoring System (Online) for GIS	ITP	III
E.05	PEB Structure and Puf Panels	MQP	III
F.01	Substation Automation system	FAT/MQP	III
F.02	Event Logger	POWERGRID TS	III
F.03	PLCC equipment Viz PLCC Terminal ,Carrier equipment, Protection Coupler , Coupling Device but excluding EPAX / HF Cable	MQP	III
F.04	Control & Relay Panels	MQP	III
G.01	EHV Cables	MQP/ITP	III
G.02	Power Cables & Control Cables	MQP	III
G.03	Cable Joints (11 kV and above)	POWERGRID TS	II
G.04	Cable Lugs & Glands / Clamps/Terminations	POWERGRID TS	I
H.01	LT Switchgear & ACDB/DCDB/MLDB/ELDB	MQP	III
H.02	Battery	POWERGRID TS	II
H.03	Battery Charger	MQP	III
H.04	UPS & Voltage Stabilizer	MQP/FAT	III
H.05	D. G. Set	FAT/ITP	III
H.06	Lighting Panel	POWERGRID TS	II
H.07	Lighting Poles	POWERGRID TS	II
H.08.1	Lighting Fixtures, Lighting Earthwire, Switches / sockets, Conduits, Lamps & fans including exhaust fans	POWERGRID TS	I
H.8.2	Solar based LEDs System including street light/pole solar panel, Inverter controller/LED fixture	FAT	III
H.09	MS/GI /PVC Pipes for cable	POWERGRID TS	I

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)****Annexure-G**

Sl. No	Item / Equipment	Reference document for inspection	Inspection Level
	trenches and lighting		
H.10	Outdoor Receptacle	POWERGRID TS	I
H.11	Split A.C/window A.C./ precision AC/ Kiosk AC/ Cascade AC/ Tower AC	POWERGRID TS	I
H.12	Occupancy sensors for control of lighting	POWERGRID TS	I
H.13	Solar based street lighting pole including Solar Panel, Inverter, Controller, etc.	POWERGRID TS	III
H.14	Junction Box / Lighting Switch Boards / Bay MB / Portable Flood Light Panel	POWERGRID TS	II
H.15	Lighting transformer	POWERGRID TS	II
I.01	SF6 gas processing unit, SF6 gas Leakage detector, SF6 gas Analyzer	POWERGRID TS	I*
I.02	SF6 Gas	POWERGRID TS	I
I.03	Spark Gap	FAT/ITP	III
I.04	Time synchronizing Equipment (GPS Clock)	POWERGRID TS	I
I.05	Galvanized Cable trays	POWERGRID TS	II
I.06	Video Monitoring System	FAT/ITP	I
I.07	Public Address System (All Components)	POWERGRID TS	I
I.08	Building Management System (All components)	POWERGRID TS	I
I.09	Access Control System (All Components)	POWERGRID TS	I
I.10	Video Display system/ Video Projection system	POWERGRID TS	I
I.11	VESDA (smoke detector)	POWERGRID TS	I
I.12	High Mast Pole	MQP	III
J.01	Aluminium ladder	POWERGRID TS	I
J.02	Hume Pipes	POWERGRID TS	I
J.03	Castle Key	POWERGRID TS	I
J.04	Water Treatment plant (All components).	POWERGRID TS	I
J.05	Furniture	POWERGRID TS	I
J.06	DOL Starter	POWERGRID TS	I
J.07	Oil Sample Bottles and Syringe	POWERGRID TS	I
J.08	Test & Measuring Equipment, T&P	POWERGRID TS	I*
K.01	EOT Crane	POWERGRID TS	II

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)****Annexure-G**

Sl. No	Item / Equipment	Reference document for inspection	Inspection Level
K.02	Boom Crane/Golf Cart/Platform Truck/Man Lift/ Fork Lift/ Lifts	POWERGRID TS	II
L.00	Fire Protection System		
L.001	Panels, Hydro pneumatic tank for fire protection system.	POWERGRID TS	III
L.002	Deluge valve, Strainers, MS/GI pipes, Pumps, motors, air compressor, and other valves, Diesel Engines	POWERGRID TS	II
L.003	Others	POWERGRID TS	I
M.00	HVAC SYSTEM		
M.001	Air Cooled Chiller	POWERGRID TS	III
M.002	Pump	POWERGRID TS	II
M.003	Air Handling Unit	POWERGRID TS	II
M.004	Fan Filter Unit With Centrifugal Blower	POWERGRID TS	II
M.005	Axial Flow Fan	POWERGRID TS	II
M.006	Main Climate Control Unit (Dehumidifier)	POWERGRID TS	I
M.007	Dampers	POWERGRID TS	II
M.008	Fire Dampers	POWERGRID TS	II
M.009	Pressure Gauge, Thermometers, Other Instruments / Sensors	POWERGRID TS	I
M.010	Grill, Diffuser, Jet Nozzle, Louvers etc	POWERGRID TS	I
M.011	Ducting	POWERGRID TS	III
M.012	M S Pipe	POWERGRID TS	II
M.013	Pipe Insulation Material	POWERGRID TS	I
M.014	Duct Insulation Material	POWERGRID TS	I
M.015	Underdeck Insulation Material	POWERGRID TS	I
M.016	Gate Valve & Non Return valve	POWERGRID TS	I
M.017	Y Strainer	POWERGRID TS	II
M.018	Ball Valve/ Motorised Butterfly Valve/ Balancing Valve	POWERGRID TS	I
M.019	Closed Expansion Tank	POWERGRID TS	II
M.020	Air Separator	POWERGRID TS	I
M.021	MCC /PLC /Electrical Panels	POWERGRID TS	III
M.022	Propeller Fan/ Conduit	POWERGRID TS	II
M.023	Air Filter/ Mixing Valve with Thermostat	POWERGRID TS	I

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

**Annexure-G**

<b>Sl. No</b>	<b>Item / Equipment</b>	<b>Reference document for inspection</b>	<b>Inspection Level</b>
N.01	SDH Equipment	FAT/ITP	IV
N.02	Termination Equipment Primary/ DI Multiplexer	FAT/ITP	IV
N.03	DACS	FAT/ITP	IV
N.04	Optical Amplifier	FAT/ITP	IV
N.05	FODP including pigtail, Joint Box, FDMS	FAT/ITP	II
N.06	IMPS	FAT/ITP	IV
N.07	Optical bypass switch	FAT/ITP	IV
N.08	Air Purifier	FAT/ITP	I
N.09	Patch cord & connector	FAT/ITP	I
N.10	NMS	FAT/ITP	IV
N.11	OPGW Cable	MQP/ITP/FAT	III
N.12	Hardware Fittings for OPGW cable	MQP/ITP	III
N.13	DCPS	FAT/ITP	III
N.14	Radio Links	FAT/ITP	III
N.15	SMPS based DC Power Supply (DCPS) system	FAT/ITP	III
N.16	WAMS (PMU & Accessories)	FAT/ITP	III
N.17	PUF Shelter	FAT/ITP	III
N.18	Aerial OFC/UGOFC/ADSS/FO Cable	FAT/ITP	III
N.19	DWDM	FAT/ITP	III
N.20	OTN	FAT/ITP	III
N.21	MPLS-TP Equipment	FAT/ITP	III
N.22	L2 Switch	FAT/ITP	III
N.23	IP-MPLS Router	FAT/ITP	III
N.24	HDPE Pipes	POWERGRID TS	II
N.25	Equipment Cabinets	POWERGRID TS	II
N.26	Main Distribution Frame	POWERGRID TS	I
N.27	Telephone system, EPAX, Telephone wires, Telephone sockets	POWERGRID TS	I
N.28	Fibre Optic Cable	MQP	III
N.29	Hardware Fittings for Fibre Optic cable	MQP	III
O.01	Re-rollers of MS/HT Angle Section and galvanized tower parts.	MQP	IV
O.02	Conductor	MQP	IV
O.03	Hardware fittings and Conductor & Earthwire Accessories	MQP	IV
O.04	Earth wire	MQP	IV

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

**Annexure-G**

Sl. No	Item / Equipment	Reference document for inspection	Inspection Level
O.05	Insulator	MQP	IV
O.06	Bolts & Nuts of Gr 8.8 / 8	MQP	IV
O.07	Mono Pole	MQP	IV
O.08	Foundation Bolts & Anchor Bolts	POWERGRID TS	III
O.09	D-shackle/ Hanger / Links and associated Special bolt/nuts	MQP	III
O.10	Span Marker, Obstruction lights and Wind Measuring Equipment	POWERGRID TS	III
O.11	MS ROD rolled by Approved Re-roller of POWERGRID	MQP	III
O.12	MS ROD rolled by Approved steel producers of POWERGRID	POWERGRID TS	I
O.13	Spring Washers & Pack washers	POWERGRID TS	II
O.14	Bolts & Nuts Gr up to 5.6/5	POWERGRID TS	II
O.15	ACD & Barbed wire for ACD/Bird guard	POWERGRID TS	II
O.16	Danger Plate /Phase Plate / Number Plate / Circuit plate	POWERGRID TS	I
O.17	Sub Station Structure (lattice/pipe type)	MQP	III
O.18	Clamps & Connecters (including equipment connectors)	MQP	III
O.19	MS/ GI Flat, rod type, pipe type and other earthing material.	POWERGRID TS	II
O.20	Aluminium Tube & Busbar materials	POWERGRID TS	II
O.21	Pipe Type & Counter Poise Earthing	POWERGRID TS	II
O.22	DTS System	POWERGRID TS	II

For Equipment where requirement of MQP is envisaged, ITP/FAT will be followed If sourced from off shore. For items required in S/S or T/L or TELECOM/LD&C , same inspection level as specified shall be followed for all the cases.

\* MICC for test and measuring equipment (inspection level I or II) shall be issued only after actual verification/ demonstration of satisfactory performance at site.

\*\* Though level-2 items, CIP/MICC can be issued also on review of TCs and visual inspection of these item.

**RTV Silicone high voltage insulation coating (HVIC)**

**1. SCOPE**

The scope of work shall include supply, transportation and application of RTV-1 silicone rubber high voltage insulator coating and cleaning/removal of waste from the equipment.

- a) All the required materials, tools & tackles, testing equipments including man lift etc. are in the scope of successful bidders/contractor.
- b) Surface preparation:  
All equipment surfaces to be coated should be made free from dust, grease, oil etc. & other foreign matter. Also the surface meant for application must be dry.
- c) The RTV coating supplied for application should be properly mixed before application as per the recommendations of manufacturer. The coating should cover complete surface and should be applied in manner that prevents runs, sags, drips, spills etc. The application shall be done by certified applicator of Manufacturer.
- d) Successful bidder/contractor shall submit the detailed field quality plan for approval. It is not the intention of this specification to specify completely herein all details and design requirements. However, the materials offered & work execution shall confirm in all respects to high standards of engineering and workmanship and be capable of performing in continuous commercial operation up to guarantee in a manner acceptable to purchaser.

**2. CLIMATIC CONDITIONS:**

The overall climate is moderate hot, humid, tropical, highly polluted and conducive to rust and fungus growth. The climatic conditions are prone to wide range of outdoor service conditions.

**3. APPLICABLE CODES AND STANDARDS**

The latest revision/amendments of the following Codes and Standards shall be applicable for the equipment/material covered in this Technical Specification. In case of conflict, the vendor/manufacturer may propose equipment/material conforming to one group of Industry Codes and Standards quoted hereunder without jeopardizing the requirements of this Technical Specification.

IEC 60243-1	Electric strength of insulating materials - Test methods - Part 1: Tests at power frequencies
IEC TR 62039	Selection guide for polymeric materials for outdoor use under HV stress
IEC 60250	Recommended methods for the determination of the permittivity and dielectric dissipation factor of electrical materials at power, audio and radio frequencies including meter wavelengths
IEC 60587	Electrical insulating materials used under severe ambient conditions - Test methods for evaluating resistance to tracking and erosion
IEC TS 62073	Guidance on the measurement of hydrophobicity of insulator surfaces
IEC 61621	Dry, solid insulating materials-Resistance test to high - voltage, low - current arc discharges
IEC 62217	Polymeric HV insulators for indoor and outdoor use-General definitions, test methods and acceptance criteria

## SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

### ANNEXURE-H

#### RTV Silicone high voltage insulation coating (HVIC)

IEC 62631-3-2	Dielectric and resistive properties of solid insulating materials - Part 3-2: Determination of resistive properties (DC methods) - Surface resistance and surface resistivity
IEEE Std 957	IEEE Guide for Cleaning Insulators
IEEE Std 1523	IEEE Guide for the Application, Maintenance and Evaluation of Room Temperature Vulcanizing (RTV) Silicone Rubber Coatings for Outdoor Insulation Applications.
ASTM D149-09	Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM D150-11	Standard Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation
ASTM D257-14	Standard Test Methods for DC Resistance or Conductance of Insulating Materials
ASTM D495-14	Standard Test Method for High - Voltage, Low - Current, Dry Arc Resistance of Solid Electrical Insulation
CEA LWIWG-02 (1996)	Line Post Composite Insulator for Overhead Distribution Lines

#### 4. Technical Parameters

4.1 RTV Silicon compound in its liquid form shall have the following properties:

Material Properties	Requirement
Material Type	One part RTV
Appearance	Paint
Filler type	ATH, Quartz or both
Color	Gray
Percent of solids by weight	≥ 70%
Substrate Application Temperature Range °C	-4°C to 121°C
Tack free at 25°C and 50% RH	30 minutes

4.2 RTV Silicon coating after cured form shall have the following properties:

Parameters	Requirement
Application Area	Glass, Porcelain, station insulators, as well as bushing, instrument transformers and related devices
Full cure time	≥ 24 hours
Coating thickness	500 microns + 10% tolerance, dry film thickness
Dielectric Strength	≥ 20 kV/mm
Volume Resistivity	≥ 1.0*10 <sup>12</sup> ohm.m
Tracking and Erosion test	1000 Hours
Min. Salinity Level withstood during "Artificial Pollution Test using Salt Fog Method"	≥160 kg/m <sup>3</sup>
Hydrophobic Recovery Test	HC2 or HC1
Method of Application	Airless Spray
Dry Arc resistance	Tract ≥ 140 seconds Burn Out ≥ 420 seconds

## **SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

### **ANNEXURE-H**

#### **RTV Silicone high voltage insulation coating (HVIC)**

<b>Parameters</b>	<b>Requirement</b>
Tracking and Erosion (IEC 60587, Method 1: Application of constant tracking voltage)	Class 1A 4.5kV or better
Primer Required	No primer material shall be allowed
Resistant to	Marine salt fog, Water, Industrial (cement dust, fly ash, acid emission etc.), Rough Weather Conditions
Other Properties	Non Hazardous to environment, surface after full cure shall be smooth

#### **4.3 Materials**

- 4.3.1 The RTV Silicone high voltage insulation coating shall be ultraviolet (UV) radiation exposure resistant. The finished product shall withstand the adverse atmospheric conditions due to weather, proximity to the coast, fumes, ozone, acids (particularly nitric acid in the coastal areas and sulphuric acid in the oil field areas), bases/alkalis, and hydrocarbon components, dust or rapid changes to air temperature (temperature extremes). There shall not be significant material degradation such as development of surface cracks and unacceptable increase in surface hardness etc.
- 4.3.2 The RTV Silicone high voltage insulation coating shall be resistant to atmospheric and chemical degradation. Salt air, airborne pollutants, industrial pollutants such as cement dust, sulphur, rain and humidity shall not result in flashover on the coating.
- 4.3.3 The RTV Silicone high voltage insulation coating shall be resistant to arcing and corona. The Coating shall exhibit high tracking resistance to reduce damage during salt-storms (storms arising from the sea) or other severe contamination events. The track resistance of the RTV Silicone Rubber Insulator Coating material shall meet the requirements of IEC 60587, Method 1, Class 1A 4.5kV.
- 4.3.5 The RTV Silicone high voltage insulation coating shall be a single component, ready-to-use after simple mixing. It shall not require excessive mixing/shaking and thinning/dilution before use. The Coating shall be moisture curable at room temperature.
- 4.3.6 The RTV Silicone high voltage insulation coating shall exhibit long-term water repellency and hydrophobicity.
- 4.3.7 The RTV Silicone high voltage insulation coating shall not require use of any primer on the ceramic insulators for adhesion purposes.
- 4.3.8 The RTV Silicone high voltage insulation coating shall be easy to be reapplied. The Coating shall have excellent arc resistance, excellent unprimed adhesion, easy to apply and spray-able as well as paint-able.
- 4.3.9 The RTV Silicone high voltage insulation coating shall have a minimum 12 months shelf life, which shall effect from the date of manufacturing. The manufacturer shall submit the warranty to this effect. The expiry date shall be marked on the containers. The remaining shelf life of the material shall be at least six (6) months when delivered to site. The coating shall be supplied in cans weighing not more than 25kg.

#### **4.4 Composition and Properties**

- 4.4.1 The RTV Silicone high voltage insulation coating shall be capable of withstanding high-pressure water power washing. To prove this property, a power wash test shall be performed per requirements stated hereafter in this standard.

**RTV Silicone high voltage insulation coating (HVIC)**

- 4.4.2 The RTV Silicone high voltage insulation coating shall protect the ceramic insulators (porcelain and glass) against flashovers caused by pollution.
- 4.4.3 The manufacturer shall advise/recommend suitable method of application and submit written application instructions and shall suggest suitable equipment set-up (size of pump and compressors, etc.) and the compatibility of his product to be reapplied on the RTV coating from other manufacturers.
- 4.4.4 The warranty for RTV coating on the equipments shall be for a period of 5 years

**4.5 Markings**

The packing and expiry dates of coating shall be labeled on the coating cans. The expiry date shall be considered from the packaging date and not from the date of shipment of the coating.

The cans shall be marked for “flammable” or “non-flammable” depending upon the type of solvent used for the dispersion of the coating.

**5.0 TESTS**

All test results shall be provided for review and acceptance by customer.

**5.1 Type Tests**

5.1.1 Type tests as prescribed in relevant standards shall be performed on RTV coated sample tiles or RTV coated insulators as applicable to verify the suitability of the design, materials and method of manufacture. Testing shall include, but not limited to following. These tests shall be performed only on the new design of RTV silicone high voltage insulation coating. The test reports shall be submitted from tests done in a NABL/International accredited lab.

a) Tracking and erosion resistance test (IEC 60587, Method 1, Class 1A 4.5kV). Samples shall consist of smooth porcelain plates of 6mm ( $\pm$  0.5mm) thickness coated with the thickness of the material as proposed by the manufacturer for the offered coating. Breaking of porcelain substrate shall not be allowed.

b) Salt-fog tests

The 1000 hour Tracking and erosion test outlined in IEC-62217 shall be carried out.

c) Dry arc resistance test

Dry arc resistance test shall be carried out as per ASTM D495.

d) Contact Angle Measurement Test:

Receding contact angle measurement test shall be performed in accordance with IEC TS 62073.

e) BDV testing of fully cured coating.

The test shall be carried out as per IEC:60243-1 or ASTM D149.

f) Volume Resistivity Test

**RTV Silicone high voltage insulation coating (HVIC)**

The test shall be carried out as per IEC:60093. Sample thickness shall be 2mm which can be obtained by using an open mould casting technique. The minimum volume resistivity as specified shall be achieved.

- g) Artificial Pollution Test in general with IEC 60507 without the pre-condition test.
- h) Adhesion Test as type test:

Adhesion test shall be performed in accordance with Canadian Electric Association (CEA) specification LWIWG-02 (96) or any other equivalent standard to verify the bonding characteristics of the RTV Silicone Rubber Coating when applied to ceramic insulators. Three (3) coated insulators shall be put in water having 0.1% by weight of NaCl and boiled for 100 hours (each sample separately). At the end of boiling, allow each insulator to remain in the water until the water cools to about 50°C. The coating shall not exhibit any water blisters at the interface between the insulator surface and the coating.

**5.2 Acceptance Tests (at Site or Factory)**

- a) Thickness measurement:

Dry film thickness (DFT) of the coating shall be measured at site on all Equipments randomly at least at one point of the Equipment.

- b) Adhesion Test as acceptance test:

Adhesion test shall be performed at site in accordance with CEA specification LWIWG-02 (96) or any other equivalent standard to verify the bonding characteristics of the RTV Silicone Rubber Coating when applied to ceramic insulators. Three (3) coated insulators shall be put in water having 0.1% by weight of NaCl and boiled for 2 hours (each sample separately). At the end of boiling, allow each insulator to remain in the water until the water cools to about 50°C. The coating shall not exhibit any water blisters at the interface between the insulator surface and the coating.

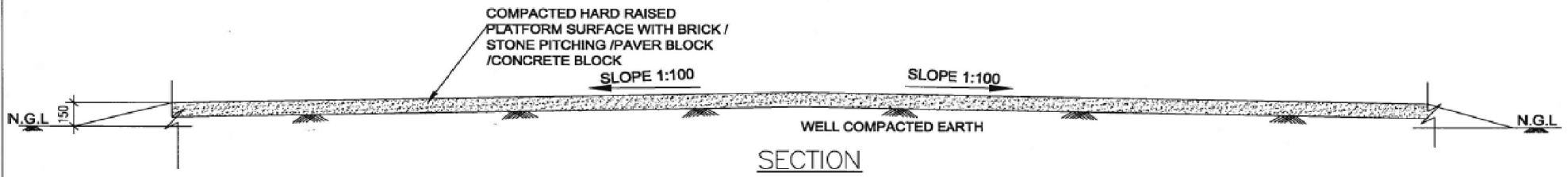
- c) High Pressure Water Withstand Test:

A power water wash test shall be performed at site on 5% sample in accordance with IEEE Std 957 to demonstrate that the RTV coated insulators can be power washed without any damage to RTV coating. The test shall be a water spray of a solid stream through a 6mm diameter nozzle at 3800 kPa for a period of 10 (ten) minutes. The nozzle of the spray equipment shall be at a distance of 3m from the insulator surface. There should not be any damage to the coating.

- d) Hydrophobicity test :

Hydrophobicity test shall be carried out on virgin material at site on 5% sample on 1-2 coated equipment as per STRI guidelines and the results shall be HC2 class or better. Hydrophobicity test shall be carried out after completion of high pressure water withstand test.

# Annexure-I



INDICATIVE DRAWING ONLY  
(SIZE SHALL BE AS PER WORK  
REQUIREMENT)

POWER GRID CORPORATION  
OF INDIA LIMITED  
(A Government of India Enterprise)



PROJECT: STANDARD DRAWING FOR OPEN PLATFORM

TITLE: INDICATIVE DRAWINGS FOR OPEN STORAGE PLATFORM

<i>Handwritten signature</i> 11/9/16	<i>Handwritten signature</i>	<i>Handwritten signature</i>	<i>Handwritten signature</i>	11/9/16
ACM(ENGG CIVIL)	CDB(ENGG CIVIL)	REV. BY ACM(ENGG CIVIL)	APVD. BY CM(ENGG CIVIL)	DATE

DRAWING NO.	C-ENGG-CVL-STD-PLATFORM-01	SCALE	NTS	REV	0
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**ANNEXURE-J**

**LIST OF THE MAKES FOR WHICH TYPE TEST REPORTS NOT REQUIRED TO BE SUBMITTED**

Sl. No.	ITEM DESCRIPTION	MAKE
<b>A.</b>	<b><i>Substation Accessories [Type Testing is not envisaged]</i></b>	
1.	Out door receptacles	CGL/B&C/BCH/Sakti, Chennai/Indo Asian/AVAIDS
2.	Trefoil clamp	Moulded Fibre Glass Products, Calcutta
3.	Diesel Engine	Cummins/Ruston & Hornsby/Greaves Cotton/Kirloskar/Mahindra/Ashok Leyland
4.	Alternator	AVK/KIRLOSKAR/STAMFORD/ Leroy Somer
5.	Motors	KEC/Siemens/NGEF/Crompton/ABB
6.	Cable Glands	Sunil & Co./Arup/ Comet/QPIE
7.	Junction Box	Sarvana/ECS/C&S/Vikas/ Maktel/Unilac/Jasper/ Amara raja/AVAIDS
8.	EPAX	MATRIX, BPL
9.	ACSR Conductor (Bersimis/Moose/Zebra)	Sterlite/Apar/HVPL/Sharavathy/Hiren Aluminium Ltd./Smita/Deepak Cables/Polycab wires/Cabcon/JSK
10.	AAC Conductor (BULL)	Sterlite/Cabcon /JSK
11.	G.S. Earthwire	Sharavathy/Bharat Wire Ropes/Ramswarup
12.	Lighting Fixtures	Phillips/CGL/Bajaj /Havels
13.	Lighting Transformer	Gujarat-Plug-In
14.	Lighting Panels	Vikas/Makel/Nitya/AVAIDS
15.	MCCB/ACB/Protective relays of LT Switchgear Boards	All approved makes as per Compendium of Vendors
16.	EOT Crane	Reva
<b>B.</b>	<b><i>ACCESSORIES FOR TRANSFORMER &amp; REACTOR [Earlier approved type test reports is applicable and not required to be submitted]</i></b>	
17.	BUCHHOLZ RELAY [Upto 765kV Transformer & Reactor]	(i) M/S CEDESPE, ITLAY [Model Type-EE 3 (Plug & Socket type)]/ (ii) M/s VIAT INSTRUMENTS PVT. LTD.KOLKATA [Model type-GOR-3M (Plug & Socket type)]
18.	PRESSURE RELIEF DEVICE [Upto 765kV Transformer & Reactor]	(i) M/S SUKRUT UDYOG, Pune [Model type-T-6-MS-15-SHB-PS (Plug & Socket type)] /
19.	MAGNETIC OIL LEVEL GAUGE [Upto 765kV Transformer & Reactor]	(i) M/S SUKRUT UDYOG PUNE [Model type-SO-HE-10-M-ATMS-PS (Plug & Socket type)], [Model Type:- SO-6-M-P-PS (Plug & Socket type)]/
20.	AIR CELL (FLEXIBLE AIR SEPARATOR) [Upto 765kV Transformer & Reactor]	Type test of following makes are not to be submitted (i) M/S PRONAL FRANCE / (ii) FUJIKURA,JAPAN / (iii) PRONAL ASIA, MALAYSIYA / (iv) SHENYANG HONGDA GENERAL RUBBER FACTORY /

**ANNEXURE-J**

**LIST OF THE MAKES FOR WHICH TYPE TEST REPORTS NOT REQUIRED TO BE SUBMITTED**

<b>Sl. No.</b>	<b>ITEM DESCRIPTION</b>	<b>MAKE</b>
		(v) BAODING XINKE RUBBER PRODUCT INSTITUTE, CHINA / (vi) M/S ZENITH INDUSTRIAL RUBBER PRODUCTS PVT. LTD. THANE / (vii) M/S UNIRUB TECHNO PUNE
21.	OTI & WTI [Upto 765kV Transformer & Reactor]	(i) M/S PRESIMEASURE BANGALORE [Model type-1005A]
22.	OIL PUMP [Upto 765kV Transformer & Reactor]	(i) FLOWWELL PUMPS & METERS, BANGALORE [Model type-1220D, 1250D]
23.	COOLING FAN AND MOTOR ASSEMBLY [Upto 765kV Transformer & Reactor]	(i) M/S MARATHON LTD KOLKATA [Model Type:- 36M/K75-P8, 0.7kW, 725RPM, 22J/K37-P6, 0.25kW, 940RPM, AFF 915103, 0.625kW, 550RPM]
24.	Sudden Pressure Relay [Upto 765kV Transformer & Reactor]	(i) Qualitrol [Model/Drawing No.900-003-02 CS-46518, 900-003-32 CS-46369] / (ii) Shenyang KEQI Electrical Equipment Co. Ltd. [Model/Drawing No.SYJ9-50-25 <sup>TH</sup> ]
25.	BUCHHOLZ RELAY [Upto 400kV Transformer & Reactor]	(i) M/S CEDASPE, ITALY [Model type-EE3 (Plug & Socket type)]/ (ii) VIAT INSTRUMENTS [Model type-GOR-3M (Plug & Socket type)]
26.	PRESSURE RELIEF DEVICE [Upto 400kV Transformer & Reactor]	(i) M/S SKURUT UDYOG, PUNE [Model type-T-6-MS-15-SHB-PS (Plug & Socket type)]
27.	MAGNETIC OIL LEVEL GAUGE [Upto 400kV Transformer & Reactor]	(i) M/S SUKRUT UDYOG PUNE [Model type-SO-HE-10-M-ATMS-PS (Plug & Socket type)], [Model Type: SO-6-M-P-PS (Plug & Socket type)]/ (ii) M/S YOGYA ENTERPRISES, JHANSI [Model type-SO-10 (Plug & Socket type)]
28.	AIR CELL (FLEXIBLE AIR SEPARATOR) [Upto 400kV Transformer & Reactor]	Type test of following makes are not to be submitted (i) M/S THE RUBBER PRODUCTS MUMBAI / (ii) M/S UNIRUB TECHNO PUNE / (iii) M/S PRONAL FRANCE / (iv) M/S ZENITH INDUSTRIAL RUBBER PRODUCTS PVT. LTD. THANE / (v) SHENYANG HONGDA GENERAL RUBBER FACTORY, CHINA
29.	Sudden Pressure Relay [Upto 400kV Transformer & Reactor]	(i) Qualitrol [Model/Drawing No.900-003-02 CS-46518, 900-003-32 CS-46369] / (ii) VIAT INSTRUMENTS [Model/Drawing No.950 / (iii) Shenyang KEQI Electrical Equipment Co. Ltd. [Model/Drawing No.SYJ9-50-25 <sup>TH</sup> ]
30.	RIP Bushing (52kV, 3150A)	ABB Micafil, Switzerland [Model/Drawing No. 1ZCD073617 (Rev F)]
31.	RIP Bushing (420kV, 1250A)	ABB, SWEDEN [Model/Drawing No.1ZSC005378A0001 REV. K]
32.	RIP Bushing (245kV, 1250A)	ABB, SWEDEN [Model/Drawing No.1ZSC005416A0001 (Rev. D)]
33.	RIP Bushing (245kV, 2000A)	ABB, SWEDEN [Model/Drawing No.1ZSC005373A0001

**ANNEXURE-J**

**LIST OF THE MAKES FOR WHICH TYPE TEST REPORTS NOT REQUIRED TO BE SUBMITTED**

<b>Sl. No.</b>	<b>ITEM DESCRIPTION</b>	<b>MAKE</b>
		(Rev. C)]
34.	RIP Bushing (420kV, 1250A)	HSP Germany [Model/Drawing No.327470]
35.	RIP Bushing (245kV, 2000A)	HSP Germany [Model/Drawing No.329260]
36.	RIP Bushing (52kV, 3150A)	HSP Germany [Model/Drawing No.329280]
37.	RIP Bushing (420kV, 1250A)	Izolyator, Russia [Model/Drawing No.686354.603]
38.	RIP Bushing (245kV, 2000A)	Izolyator, Russia [Model/Drawing No.686353.602]
39.	RIP Bushing (52kV, 3150A)	Izolyator, Russia [Model/Drawing No.686351.601]
40.	RIP Bushing (145kV, 1250A)	Izolyator, Russia [Model/Drawing No.686352.604]
41.	RIP Bushing (420kV, 1250A)	TRENCH, CHINA [Model/Drawing No.ECT 707 (C2)]
42.	RIP Bushing (245kV, 2000A)	TRENCH, CHINA [Model/Drawing No.ECT 617 (C3)]
43.	RIP Bushing (245kV, 1250A)	TRENCH, CHINA [Model/Drawing No.ECT 616 (C3)]
44.	RIP Bushing (145kV, 1250A)	TRENCH, CHINA [Model/Drawing No.ECT 516 (C3)]
45.	RIP Bushing (52kV, 1250A)	TRENCH, CHINA [Model/Drawing No.ECT 415 (C3)]
46.	RIP Bushing (52kV, 3150A)	TRENCH, CHINA [Model/Drawing No.ECT 419 (C3)]
47.	RIP Bushing (420kV, 1250A)	Xian China [Model/Drawing No.75706 (Rev 09)]
48.	RIP Bushing (245kV,2000A)	Xian China [Model/Drawing No.75618 (Rev 09)]
49.	RIP Bushing (52kV, 3150A)	Xian China [Model/Drawing No.75366 (Rev 03)]
50.	RIP Bushing (52kV, 3150A)	Xian China [Model/Drawing No.75332 (Rev 08)]
51.	OIP Bushing (800kV, 2500A)	ABB, SWEDEN [Model / Drawing No. GOE-2550-1600-2500-0.6-B, 1ZSC026186-AAM REV. H]
52.	OIP Bushing (420kV, 2500A)	ABB, SWEDEN [Model / Drawing No.GOE-1425-1150-2500-0.6, 1ZSC026186-AAL REV. F]
53.	OIP Bushing (800kV, 2500A)	TBEA, CHINA [Model / Drawing No.TBEA-500-765T-A0035-01, REV. 02]
54.	OIP Bushing (420kV, 2500A)	TBEA, CHINA [Model / Drawing No.TBEA-500-765T-A0035-02, REV. 02]
55.	OIP Bushing (420kV, 2500A)	TRENCH, CHINA [Model / Drawing No.OT-738-1 (C 5)]
56.	OLTC (500MVA, 765kV ICT)	MR Germany [Model/Drawing No. MI 1503 72.5/RC- 12231WR]
57.	OLTC (500MVA, 400kV ICT)	Easun MR, Chennai [Model/Drawing No. 3 x MI 1200 300/D 10.19.3W]
58.	OLTC (220kV & below rating transformer)	BHEL, Bhopal [Model/Drawing No.MIII 600 110/C 10.19.3W]
<b>C.</b>	<b>TESTING EQUIPMENT FOR TRANSFORMER &amp; REACTOR</b>	
59.	Oil BDV Test Kit	Baur [Model/Drawing No.DTA 100C]
60.	Oil BDV Test Kit	Megger [Model/Drawing No.OTS 100AF]

## ANNEXURE-J

### LIST OF THE MAKES FOR WHICH TYPE TEST REPORTS NOT REQUIRED TO BE SUBMITTED

Sl. No.	ITEM DESCRIPTION	MAKE
61.	Online Dissolved Gas (Multi-gas) and Moisture Analyser	A Eberle GmbH & Co. KG [Model/Drawing No.HYDROCAL 1008]
62.	Online Dissolved Gas (Multi-gas) and Moisture Analyser	Ningbo Ligong Online Monitoring Technology Co. LTD [Model/Drawing No.MGA2000]
63.	Online Dissolved Gas (Multi-gas) and Moisture Analyser	GE Energy [Model/Drawing No.KELMAN TRANSFIX]
64.	Online Dissolved Gas (Multi-gas) and Moisture Analyser	Qualitrol Company LLC [Model/Drawing No.SERVERON TM 8]
65.	On line Insulating Oil Drying System	CEE DEE Vacuum Equipment Pvt. Ltd. [Model/Drawing No.TRANSDRY CD-002]
66.	On line Insulating Oil Drying System	PTSS [Model/Drawing No.PTSS-TDS1GA6XS]
67.	Portable Dissolved Gas Analysis of Insulating Oil	GE Energy [Model/Drawing No. KELMAN TRANSPORT X]

#### NOTES:-

1. For sub-station accessories mentioned at Sr. No. A above, model specific separate approval of type test report is not required.
2. For Transformer/Reactor accessories & testing equipment mentioned at Sr. No. B & C above, wherever, model/drawing no. is specified separate approval of type test report and drawing/documents is not required, thus requirement of type test report validity of 10 years is not applicable.

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-K

<b>SL.NO.</b>	<b>Power System Equipment</b>
<b>A</b>	<b>Power System Equipment</b>
1	Transformers and Reactors (66 kV to 765 kV AC)
2	Air Insulated Switchgear (Circuit Breakers, Disconnectors), Surge Arrester, Wave trap (66 kV to 765 kV AC)
3	Gas Insulated Switchgear (66 kV to 400 kV AC)
4	Instrument Transformers (66 kV to 765 kV AC)
5	Bus Post Insulators
6	Substation structure material
7	Transmission line tower material
8	Conventional conductors and accessories
9	Porcelain Insulators and hardware fittings
10	Control & power cables
11	High Voltage Cables (upto 220 kV AC)
12	Control and Protection System including Substation Automation System
13	DG set
14	DC system (DC Battery & Battery Charger) in a substation
15	AC & DC Distribution Board for substation
16	Material for Grounding system
17	Items for illumination system
<b>B</b>	<b>Telecom Products, Services and Works</b>
1	Encryption/UTM platforms (TDM and IP)
2	IP/MPLS Core routers/ Edge/ Enterprise Router
3	Managed Leased line Network equipment
4	Ethernet Switches (L2 and L3), Hubs
5	IP based Soft Switches, IMS, Unified Communication Systems

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**ANNEXURE-K

6	Wireless/Wireline PABXs / IP PBX & / Media Gateways
7	CPE (including Wi-Fi Access points and Routers, Media Converters), 2G/3G/4G/LTE Modems, Leased-line Modems, NFV/SDN CPE
8	Set-Top Boxes
9	SDH/Carricr-Ethernct/MPLS- TP/Packet Optical Transport equipment/PTN/OTN systems
10	DWDM/CWDM systems
11	GPON/XGS-PON, NG-PON2 equipment (including ONT and OLT)
12	Optical/SDH/PDH Cross Connects/OTN Cross-connects and optical MUX, OADM
13	Small size 2 G/3 G GSM based Base Station Systems, with its various derivatives including rural & disaster response, Macro & Micro BTS, Small Cells, NIB, C-RAN BBU and RRH
14	2 G/3 G GSM based Base Station Systems, with its various derivatives including rural & disaster response, Macro & Micro BTS, Small Cells, NIB, C-RAN BBU and RRH
15	Small Size LTE/LTE-R Based Mobile Systems, with its various derivatives including rural & disaster communications, Macro & Micro eNodeB, Small Cells, EPC, NIB C-RAN BBU and RRH, LTE/LTE-R/4.5 G/ 5 G based broadband wireless access systems (eNodeB, gNB, EPC, etc.)
16	LTE/LTE-R Based Mobile Systems, with its various derivatives including rural & disaster communications, Macro & Micro eNode B, Small Cells, EPC, NIB C-RAN BBU and RRH, LTE/LTE-R/4.5 G/ 5 G based broadband wireless access systems (eNodeB, gNB, EPC, etc.)
17	Wi-Fi based broadband wireless access systems (Including Access Point, Aggregation Block, Core Block), Integrated Broadband system
18	Microwave Radio systems (IP/Hybrid), Mobile Front haul BBU and RRH (CPRI, eCPRI, FlexE, RoE, NGFI)
19	Software Defined Radio, Cognitive Radio systems
20	Repeaters (RF/RF-over-Optical), IBS, and Distributed Antenna system
21	Satellite based systems-Hubs, VSAT Disaster Communication Systems etc.
22	Copper access systems (DSL/DSLAM), high-speed xDSL (G.fast)
23	Network Management systems (NMS) with its various derivatives

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

**ANNEXURE-K**

24	Security and Surveillance Communication Systems (video and sensors based) including Perimeter Security Systems
25	Optical Fiber
26	Optical Fiber Cable
27	Telecom Power System (Including Solar Power)
28	Telecom Batteries (Lead Acid & Li-ion)
29	IP audio phones / IP video Phones / Analog adaptor
30	SDN Software Controllers, NVF and CNF software
31	Telecom Cloud infrastructure, Telecom Data centers
32	2 way Analog/Digital radio including Walkie-Talkie & Mobile Radio
33	Batteries of 2 way Analog/Digital radio including Walkie-Talkie
34	Fiber Monitoring System
35	M2M/IOT Subsystems
36	Telecom Services/Works

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

ANNEXURE-L

Major Changes in Section GTR ( Rev 15)

S.No	Clause ref	Existing Clause	Proposed Text	Reason/Back ground for proposed changes
1.	Clause 2.1 a)		<p>All equipment/materials/items, as per Annexure-K, as applicable under present scope of works, shall be procured and supplied from domestic manufacturers only</p> <p>Any imported equipment/material/item/parts/component (comprising of embedded systems) to be supplied under the contract shall be tested in the certified laboratories to check for any kind of embedded malware/trojans/cyber threats and for adherence to Indian Standards as per the directions issued by Ministry of Power/Govt. of India from time to time. In case of such import from specified “prior reference” countries, the requirement of prior permission from the Govt. of India including protocol for testing in certified and designated laboratories by Ministry of Power/Govt. of India shall also be complied with by the contractor.</p> <p>The bidder/contractor shall list out the products and components producing Toxic e-waste under the contract and shall furnish to the Employer the procedure of safe disposal at the time of closing of the contract</p>	New Clause Added..
2.	Clause 2.6	The bidder shall be responsible for safety of human and equipment during the working.....	The <b>contractor</b> shall be responsible for safety of human and equipment during the working.	
3.	Clause 3.2	The equipment to be furnished under this specification shall conform to latest issue with all amendments (as on the originally scheduled date of bid opening) of standard specified under Annexure-C of this section, unless specifically mentioned in the specification.	The equipment offered by the contractor shall at least conform to the requirements specified under relevant IS standard. In case of discrepancy between IS and other international standard, provisions of IS shall prevail. The Contractor shall also note that the list of standards presented in this specification at Annex-C is not complete. Whenever necessary, the list of standards shall be considered in conjunction with specific IS. If the IS standard is not available for an equipment/material, then other applicable International standard	Changes incorporated In line with recent Guidelines from GOI.

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**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

ANNEXURE-L

Major Changes in Section GTR ( Rev 15)

			(IEC/Equivalent), as per the specification, shall be accepted.	
4.	<b>Clause 3.3</b>	The Bidder shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to compliment each other.	The Contractor shall note that standards mentioned in the specification are not mutually exclusive or complete in themselves, but intended to compliment each other.	
5.	<b>Clause 3.4</b>	The Contractor 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.	<b>The equipment offered by the contractor shall confirm to relevant IS standard. The list of such IS standards are given at Annexure-C. In case There is discrepancy between IS and other international standard then provision in IS shall prevail.</b> The Contractor 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. <b>If the IS standard is not available for relevant equipment's/ Material is supplied from foreign country, then other internationally standard (IEC/Equivalent) will be accepted.</b>	Changes incorporated In line with recent Guidelines from GOI
6.	<b>Clause 4.1</b>	The 800kV and 420kV system is being designed to limit the switching surge over voltage of 1.9 p.u. and 2.5 p.u., respectively and the power frequency over voltage of 1.4 p.u. and 1.5 p.u., respectively. In case of the 420kV system, the initial value of the temporary overvoltages could be 2.0 p.u. for 1-2 cycles. The equipment furnished under this specification shall perform all its functions and operate satisfactorily without showing undue strain, restrike etc under such over voltage conditions.	<b>Switching surge over voltage and power frequency over voltage is specified in the system parameters below.</b> In case of the 420kV system, the initial value of the temporary over voltages could be 2.0 p.u. for 1-2 cycles. The equipment furnished under this specification shall perform all its functions and operate satisfactorily without showing undue strain, restrike etc under such over voltage conditions.	To avoid repetition.
7.	<b>Clause 4.4</b>	The bidder shall design terminal connectors of the equipment taking into account various forces that are required to withstand.	The <del>bidder</del> Contractor shall design terminal connectors of the equipment taking into account various forces <b>as mentioned at SI.No.4.3</b> that are required to withstand.	

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

ANNEXURE-L

Major Changes in Section GTR ( Rev 15)

8.	<b>Clause 4.6</b>	<p>4.6 System parameters 132kV,66kV,33kV &amp; 11kV System</p> <table border="1" data-bbox="439 300 992 427"> <thead> <tr> <th>S.No</th> <th>Description of parameters</th> <th>66kV System</th> </tr> </thead> <tbody> <tr> <td>9</td> <td>Rated Short circuit current</td> <td>31.5kA</td> </tr> </tbody> </table>	S.No	Description of parameters	66kV System	9	Rated Short circuit current	31.5kA	<p>4.6 System parameters 132kV,52kV 66kV,33kV &amp; 11kV System</p> <table border="1" data-bbox="1014 300 1608 547"> <thead> <tr> <th>S.No</th> <th>Description of parameters</th> <th>66kV System</th> </tr> </thead> <tbody> <tr> <td>9</td> <td>Rated Short circuit current</td> <td>31.5kA/25kA* for 3 Sec/</td> </tr> </tbody> </table> <p>* For Tertiary loading Equipment's fault level shall be 25kA for 3 Sec. For Other Switchyards shall be as specified in Section Project</p> <ul style="list-style-type: none"> <li>• Further Parameters of 52 kV System is also added</li> <li>• Sectional Clearance of 66kV System is updated in line with Safety regulation of CEA</li> </ul>	S.No	Description of parameters	66kV System	9	Rated Short circuit current	31.5kA/25kA* for 3 Sec/	
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9.	<b>Clause 5.2</b>	<p>The Contractor shall submit 4 (four) sets of drawings/ design documents /data detailed bill of quantity and 1 (one) set of test reports for the approval of the Employer. The contractor shall also submit the softcopy of the above documents in addition to hardcopy.</p>	<p>The Contractor shall submit <del>4 (four) sets of</del> All Engineering Documents ( drawings/ design documents /data / detailed bill of quantity and 1 (one) set of test reports) through Online Document Review and Engineering Approval Management System( Herein after DREAMS) for the approval of the Employer. <del>The contractor shall also submit the softcopy of the above documents in addition to hardcopy</del></p>													
10.	<b>Clause 5.7</b>	<p>Approval Procedure Note (2) All drawings should be submitted in softcopy form, however substation design drawings like SLD, GA, all layouts etc. shall also be submitted in AutoCAD Version. SLD, GA &amp; layout drawings shall be submitted for the entire substation in case of substation extension also</p>	<p>Approval Procedure Note (2) All drawings should be submitted in <del>softcopy form</del> DREAMS, however further substation design drawings like SLD, GA, all layouts etc. shall also be submitted in AutoCAD Version as supporting documents in DREAMS. SLD, GA &amp; layout drawings shall be submitted for the entire substation in case of substation extension also.</p> <p>For Civil drawings, associated documents shall be submitted in</p>													

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

**ANNEXURE-L**

Major Changes in Section GTR ( Rev 15)

			<b>STAAD/Excel format as supporting document in DREAMS.</b>	
11.	<b>Clause 6.1.7</b>	All oil, grease and other consumables used in the Works/Equipment shall be purchased in India unless the Contractor has any special requirement for the specific application of a type of oil or grease not available in India. If such is the case, he shall declare in the proposal, where such oil or grease is available. He shall help Employer in establishing equivalent Indian make and Indian Contractor. The same shall be applicable to other consumables too.	All oil, grease and other consumables used in the Works/Equipment shall be purchased in India unless the Contractor has any special requirement for the specific application of a type of oil or grease not available in India. If such is the case, he shall declare <b>source of oil/grease /other consumables</b> in the <del>proposal</del> <b>GTP/Drawings</b> , where such oil or grease is available. He shall help Employer in establishing equivalent Indian make and Indian Contractor. The same shall be applicable to other consumables too.	
12.	<b>Clause 6.2.4</b>	Degree of Protection  The degree of protection shall be in accordance with IS:13947(Part-I)/IEC-60947 (Part-I)/IS 12063/IEC-60529. Type test report for IP-55 or higher degree of protection shall be submitted for approval.	Degree of Protection  The degree of protection shall be in accordance with <b>IS/IEC60947; IS/IEC60529</b> . Type test report <b>of relevant Degree of Protection test</b> , shall be submitted for approval.	IS 13947 is superseded by IS/IEC 60947 IS 12063 is superseded by IS/IEC 60529
13.	<b>Clause 6.3.1</b>	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 Employer. The rating plate of each equipment shall be according to IEC requirement.	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, <b>Customer Name</b> , 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 Employer. The rating plate of each equipment shall be according to <b>IS/ IEC</b> requirement.	
14.	<b>Clause 9.2</b>	The reports for all type tests as per technical specification shall be furnished by the Contractor alongwith equipment / material drawings. However, type test reports of similar equipments/ material already accepted in POWERGRID shall	The reports for all type tests as per technical specification shall be furnished by the Contractor alongwith equipment / material drawings. However, type test reports of similar equipments/ material already accepted in POWERGRID shall be applicable for all projects with similar requirement. The type tests conducted earlier should have	In line with CEA Guidelines for Validity of Type tests

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

Major Changes in Section GTR ( Rev 15)

		<p>be applicable for all projects with similar requirement. The type tests conducted earlier should have either been conducted in accredited laboratory (accredited based on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by POWERGRID or representative authorized by POWERGRID or Utility or representative of accredited test lab.</p> <p>Unless otherwise specified elsewhere, the type test reports submitted shall be of the tests conducted within last 10 (ten) years from the date of NOA. In case the test reports are of the test conducted earlier than 10 (ten) years from the date of NOA, the contractor shall repeat these test(s) at no extra cost to the Employer</p>	<p>either been conducted in accredited laboratory (accredited based on ISO / IEC Guide 25 / 17025 or EN 45001 by the national accreditation body of the country where laboratory is located) or witnessed by POWERGRID/representative authorized by POWERGRID/representative of Utility /representative of accredited test lab/ representative of NABCB certified agency shall also be acceptable.</p> <p>Unless otherwise specified elsewhere, the type test reports submitted shall be of the tests conducted within the years specified below from the date of NOA. In case the test reports are of the test conducted earlier than the years specified below from the date of NOA, the contractor shall repeat these test(s) at no extra cost to the Employer.</p> <table border="1" data-bbox="1019 715 1601 1305"> <thead> <tr> <th>S. No</th> <th>Name of Equipment</th> <th>Validity of type test( in years )</th> </tr> </thead> <tbody> <tr><td>1</td><td>Power Transformer</td><td>5</td></tr> <tr><td>2</td><td>LT Transformer</td><td>5</td></tr> <tr><td>3</td><td>Shunt Reactor</td><td>5</td></tr> <tr><td>4</td><td>OLTC</td><td>10</td></tr> <tr><td>5</td><td>Bushing of Power Transformers/Reactors</td><td>7</td></tr> <tr><td>6</td><td>Fittings and accessories for Power transformers &amp; Reactors</td><td>10</td></tr> <tr><td>7</td><td>Circuit Breaker</td><td>10</td></tr> <tr><td>8</td><td>Isolator</td><td>10</td></tr> <tr><td>9</td><td>Lighting Arrester</td><td>10</td></tr> <tr><td>10</td><td>Wave Trap</td><td>10</td></tr> <tr><td>11</td><td>Instrument transformer</td><td>7</td></tr> <tr><td>12</td><td>GIS &amp; Hybrid GIS</td><td>10</td></tr> </tbody> </table>	S. No	Name of Equipment	Validity of type test( in years )	1	Power Transformer	5	2	LT Transformer	5	3	Shunt Reactor	5	4	OLTC	10	5	Bushing of Power Transformers/Reactors	7	6	Fittings and accessories for Power transformers & Reactors	10	7	Circuit Breaker	10	8	Isolator	10	9	Lighting Arrester	10	10	Wave Trap	10	11	Instrument transformer	7	12	GIS & Hybrid GIS	10	
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**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

ANNEXURE-L

Major Changes in Section GTR ( Rev 15)

			<table border="1"> <tr> <td>13</td> <td>LT Switchgear</td> <td>10</td> </tr> <tr> <td>14</td> <td>Cable and associated accessories</td> <td>10</td> </tr> <tr> <td>15</td> <td>Relays</td> <td>7</td> </tr> <tr> <td>16</td> <td>Capacitors</td> <td>10</td> </tr> <tr> <td>17</td> <td>Battery &amp; Battery Charger</td> <td>7</td> </tr> <tr> <td>18</td> <td>Conductor &amp; Earth wire</td> <td>10</td> </tr> <tr> <td>19</td> <td>Insulators ( Porcelain/Glass)</td> <td>10</td> </tr> <tr> <td>20</td> <td>Composite Insulators</td> <td>5</td> </tr> <tr> <td>21</td> <td>PLCC</td> <td>5</td> </tr> </table> <p>Note For all other equipment's validity of type test shall be 10 years from date of NOA</p> <p>Further, in the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes or due to non-compliance with the requirement stipulated in the Technical Specification or any/all type tests not carried out, same shall be carried out without any additional cost implication to the Employer.</p> <p>The Contractor shall intimate the Employer the detailed program about the type tests atleast two (2) weeks in advance in case of domestic supplies &amp; six (6) weeks in advance in case of foreign supplies</p>	13	LT Switchgear	10	14	Cable and associated accessories	10	15	Relays	7	16	Capacitors	10	17	Battery & Battery Charger	7	18	Conductor & Earth wire	10	19	Insulators ( Porcelain/Glass)	10	20	Composite Insulators	5	21	PLCC	5	
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15.	<b>Clause no. 9.5</b>	The list of makes of various items, for which Type test reports are not required to be submitted are specified in Compendium of Vendors (COV).	The list of makes of various items, for which Type test reports are not required to be submitted are specified <del>in Compendium of Vendor (COV)</del> <b>at Annex-J</b>																												
16.	<b>Clause 12.2</b>	The minimum weight of the zinc coating shall be 610 gm/sq.m and minimum average thickness of coating shall be 86 microns for all items having thickness 6mm and above <b>and 900 gm/sq.m for coastal area (30km from sea shore approximately ) or as specified in Section-</b>	The minimum weight of the zinc coating shall be 610 gm/sq.m and minimum average thickness of coating shall be 86 microns for all items having thickness 6mm and above <b>and 900 gm/sq.m for coastal area (30km from sea shore approximately if defined in Section Project) or as specified in Section-Project</b> . For items lower than 6mm thickness requirement of coating thickness shall be as per relevant ASTM. For																												

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

ANNEXURE-L

Major Changes in Section GTR ( Rev 15)

		<b>Project.</b> For items lower than 6mm thickness requirement of coating thickness shall be as per relevant ASTM. For surface which shall be embedded in concrete, the zinc coating shall be 610 gm/sq.m minimum <b>and 900 gm/sq.m for coastal area as specified in Section-Project</b>	surface which shall be embedded in concrete, the zinc coating shall be 610 gm/sq.m minimum <b>and 900 gm/sq.m for coastal area as specified in Section-Project</b>																	
17.	<b>Clause 12.3.2</b>	After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be “flash dried” while the second coat shall be stoved	<b>Hot Phosphating shall be done for phosphating process under pretreatment of sheets</b> After phosphating, thorough rinsing shall be carried out with clean water followed by final rinsing with dilute dichromate solution and oven drying. The phosphate coating shall be sealed with application of two coats of ready mixed, stoving type zinc chromate primer. The first coat may be “flash dried” while the second coat shall be stoved																	
18.	<b>Clause 12.3.6</b>	<table border="1"> <thead> <tr> <th>S.No</th> <th>PIPE LINE</th> <th>BASE COLOUR</th> <th>BAND COLOUR</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Hydrant and Emulsifier system pipeline</td> <td>Fire red</td> <td></td> </tr> </tbody> </table>	S.No	PIPE LINE	BASE COLOUR	BAND COLOUR	1	Hydrant and Emulsifier system pipeline	Fire red		<table border="1"> <thead> <tr> <th>S.No</th> <th>PIPE LINE</th> <th>BASE COLOUR</th> <th>BAND COLOUR</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Hydrant and Emulsifier system pipeline /NIFPS</td> <td>Fire red</td> <td></td> </tr> </tbody> </table>	S.No	PIPE LINE	BASE COLOUR	BAND COLOUR	1	Hydrant and Emulsifier system pipeline /NIFPS	Fire red		
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19.	<b>Clause no. 12.3.8</b>		Band colour is required for Emulsifier system detection line only if both water and air detection lines are present at the same substation. Further, band colour shall be applied at an interval of 2 meters approx. along the length and minimum width of band shall be 25mm.	New Clause added																
20.	<b>Clause No. 13.14</b>		Erection, testing and commissioning of Transformers, Reactors, Circuit breakers, Isolators, Substation automation system, Control & protection panels, PLCC, PMU, Telecommunication Equipments, NIFPS System ,	New Clause added																

**SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)**

ANNEXURE-L

Major Changes in Section GTR ( Rev 15)

			etc. shall be done by the contractor under the supervision of respective equipment manufacturers. Charges for the above supervision shall be included by the bidder in the erection charges for the respective equipment in the BPS.																
21.	<b>Clause no. 15.2</b>		Pickup value of binary input modules of Intelligent Electronic Devices, Digital protection couplers, Analog protection couplers shall not be less than 50% of the specified rated station auxiliary DC supply voltage level.	New Clause added															
22.	<b>Clause no. 16.2</b>	The minimum vertical distance from the bottom of the lowest porcelain part of the bushing, porcelain enclosures or supporting insulators to the bottom of the equipment base, where it rests on the foundation pad shall be 2.55 metres.	The minimum vertical distance from the bottom of the lowest porcelain/ <b>polymer</b> part of the bushing, porcelain/ <b>polymer</b> enclosures or supporting insulators to the bottom of the equipment base, where it rests on the foundation pad shall be 2.55 metres.																
23.	<b>Clause 17.1</b>	<table border="1"> <thead> <tr> <th>S.No</th> <th>Description</th> <th>Material</th> </tr> </thead> <tbody> <tr> <td>a</td> <td>For connecting ACSR conductors/AAC conductors/Aluminium tube</td> <td>Aluminum alloy casting, conforming to designation A6 of IS:617 and all test shall conform to IS:617</td> </tr> <tr> <td>b</td> <td>For connecting equipment terminals made of</td> <td>Bimetallic connectors made from aluminum alloy casting, conforming</td> </tr> </tbody> </table>	S.No	Description	Material	a	For connecting ACSR conductors/AAC conductors/Aluminium tube	Aluminum alloy casting, conforming to designation A6 of IS:617 and all test shall conform to IS:617	b	For connecting equipment terminals made of	Bimetallic connectors made from aluminum alloy casting, conforming	<table border="1"> <thead> <tr> <th>Sl. No.</th> <th>Description</th> <th>Materials</th> </tr> </thead> <tbody> <tr> <td>a)</td> <td>For connecting ACSR conductors/AAC conductors/Aluminium tube</td> <td>Aluminum alloy casting, conforming to designation <del>A6</del> <b>4600</b> of IS:617 and all test shall conform to IS:617</td> </tr> </tbody> </table>	Sl. No.	Description	Materials	a)	For connecting ACSR conductors/AAC conductors/Aluminium tube	Aluminum alloy casting, conforming to designation <del>A6</del> <b>4600</b> of IS:617 and all test shall conform to IS:617	
S.No	Description	Material																	
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			<p>copper with ACSR conductors/AAC conductors/Aluminium tube</p> <p>to designation A6 of IS:617 with 2mm thick bimetallic liner/strip and all test shall conform to IS:617</p>		<p>b)</p> <p>For connecting equipment terminals made of copper with ACSR conductors/AAC conductors/Aluminium tube</p> <p>Bimetallic connectors made from aluminum alloy casting, conforming to designation A64600 of IS:617 with 2mm thick bimetallic liner/strip and all test shall conform to IS:617</p>	
24.	<b>Clause 17.11</b>	<p>Clamps and connectors should be type tested on as per IS:5561 and shall also be subjected to routine tests as per IS:5561. Following type test reports shall be submitted for approval. Type test once conducted shall hold good. The requirement of test conducted within last ten years, shall not be applicable</p> <p>i) Temperature rise test (maximum temperature rise allowed is 35°C over 50°C ambient)</p> <p>ii) Short time current test</p> <p>iii) Corona (dry) [for 400kV and above] and RIV (dry) test [for 132kV and above voltage level clamps]</p>	<p>Clamps and connectors should be type tested on <b>minimum three samples</b> as per IS:5561 and shall also be subjected to routine tests as per IS:5561. Following type test reports shall be submitted for approval. <b>Type test once conducted shall hold good. The requirement of test conducted within last ten years, shall not be applicable</b></p> <p>i) Temperature rise test (maximum temperature rise allowed is 35°C over 50°C ambient)</p> <p>ii) Short time current test</p> <p>iii) Corona (dry) [<del>for 400kV and above</del>] and RIV (dry) test [for 132kV and above voltage level clamps]</p> <p>iv) Resistance test and <del>tensile test</del> <b>Pullout strength test</b></p> <p><b>v) Cantilever strength test on bus support clamps &amp; connectors</b></p>			

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		iv) Resistance test and tensile test		
25.	<b>Clause 18.1</b>	All types of boxes, cabinets etc. shall generally conform to & be tested in accordance with IS-5039/IS-8623, IEC-60439, as applicable, and the clauses given below:	All types of boxes, cabinets etc. shall generally conform to & be tested in accordance with <del>IS-5039/IS-8623, IEC-60439</del> <b>IS/IEC 61439-0</b> , as applicable, and the clauses given below:	
26.	<b>Clause 18.2</b>	Control cabinets, junction boxes, Marshalling boxes, & terminal boxes shall be made of stainless steel of atleast 1.5 mm thick or aluminum enclosure of atleast 1.6 mm thick and shall be dust, water and vermin proof. Stainless steel used shall be of grade SS304 (SS316 for coastal area) or better. 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. In case of aluminum enclosed box the thickness of aluminum shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.	Control cabinets, junction boxes, Marshalling boxes & terminal boxes, <b>Out door ACDB cum DCDB panels</b> shall be made of stainless steel of atleast 1.5 mm thick or aluminum enclosure of atleast 1.6 mm thick and shall be dust, water and vermin proof. Stainless steel used shall be of grade SS304 (SS316 for coastal area) or better. 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. In case of aluminum enclosed box the thickness of aluminum shall be such that it provides adequate rigidity and long life as comparable with sheet steel of specified thickness.  <b>Control cabinets, junction boxes, marshalling boxes &amp; terminal boxes, out-door ACDB cum DCDB panels shall have adequate space/clearance as per guidelines/technical specifications to access/replace any component. Necessary component labelling to be also done on non-conducting sheet.</b>  <b>For CONTROL CABINETS, JUNCTION BOXES, TERMINAL BOXES MARSHALLING BOXES FOR OUTDOOR EQUIPMENT Junction Box, wire should be as per IS or equivalent IEC with FRLS grade</b>  <b>Machine laid PU Foam gasket may be permitted for use in Control Cabinets etc.</b>	

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27.	<b>Clause 18.4</b>	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	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.  Cabinet boxes with width more than 700 mm shall be double door double hinged with padlocking type.	
28.	<b>Clause 18.13</b>	The enclosure of bay marshalling kiosk, junction box, terminal box and control cabinets shall conform to IP-55 as per IS:13947 including application of 2KV rms for 1 (one) minute, insulation resistance and functional test after IP-55 test	The enclosure of bay marshalling kiosk, junction box, terminal box and control cabinets shall conform to IP-55 as per <b>IS/IEC60947</b> including application of <b>minimum 1KV rms for 1 (one) minute, insulation resistance and functional test</b> after IP-55 test	
29.	<b>Clause 20.13</b>	The Contractor shall furnish all wire, conduits and terminals for the necessary interphase electrical connections (where applicable) as well as between phases and common terminal boxes or control cabinets. <b>For equipments rated for 400 kV and above the wiring required in these items shall be run in metallic ducts or shielded cables in order to avoid surge over voltages either transferred through the equipment or due to transients induced from the EHV circuits.</b>	The Contractor shall furnish all wire, conduits and terminals for the necessary interphase electrical connections (where applicable) as well as between phases and common terminal boxes or control cabinets. <del>For equipments rated for 400 kV and above the wiring required in these items shall be run in metallic ducts or shielded cables in order to avoid surge over voltages either transferred through the equipment or due to transients induced from the EHV circuits.</del>	
30.	<b>Clause 20.14</b>	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 Contractor 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.	-	Clause deleted
31.	<b>Clause 21.3.2</b>	All fuses shall be of HRC cartridge type	All fuses shall be of HRC cartridge type conforming to <b>relevant IS</b>	

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		conforming to IS:9228 mounted on plug-in type fuse bases. Miniature circuit breakers with thermal protection and alarm contacts will also be accepted. All accessible live connection to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage	mounted on plug-in type fuse bases. Miniature circuit breakers with thermal protection and alarm contacts will also be accepted. All accessible live connection to fuse bases shall be adequately shrouded. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage	
32.	<b>Clause 22.8</b>	<b>Tests</b>  In bushing, hollow column insulators and support insulators shall conform to type tests and shall be subjected to routine tests in accordance with IS:2099 & IS:2544 & IS:5621.	-	Clause deleted
33.	<b>Clause No. 22.10</b>		All switchgear/equipments, insulator strings, bushings, bus post insulators shall be designed for minimum creepage distance of 31mm/kV or 25mm/kV as mentioned against each substation in section project under “PHYSICAL AND OTHER PARAMETERS” Zinc coating for galvanized lattice and pipe structures, all ferrous parts of composite long rod insulators and earthing conductors shall not be less than 900 gm/sq-m irrespective of other values mentioned elsewhere in technical specification/drawings at substations where creepage distance is considered as 31mm/kV. In case, different designs of lattice and pipe structures other than Employer supplied structures are required to be adopted in view of higher creepage (31mm/kV) of the switchgear/equipments, insulator strings, bushings & bus post insulators etc., Design, supply & erection of such structures shall be in the scope of contractor against respective standard structure. However dimensional details (except height) shall not be less than that specified in standard structure drawing of respective equipments.  <b>Silicon RTV coating:-</b> Equipment/insulators (except equipments with polymer insulator) including mandatory spares being supplied at	New Clause added

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			substations where creepage distance is considered as 31mm/kV shall be with Silicon RTV coating. The price of RTV coating shall be included in the installation cost of respective equipment.	
34.	<b>Clause No. 24</b>	<b>TECHNICAL REQUIREMENT OF EQUIPMENTS</b> Following equipment shall be offered from the manufacturer(s) who meets the technical requirements as stipulated here, provided the same equipment are not covered under the Bidder's Qualifying requirement of the Bidding Documents.	<b>24. TECHNICAL REQUIREMENT OF EQUIPMENTS</b> <b>24.1</b> Following equipment shall be offered from the <b>Indian Manufacturing Facilities</b> of manufacturer(s) who meets the technical requirements as stipulated here, provided the same equipment are not covered under the Bidder's Qualifying requirement of the Bidding Documents.	
35.	<b>Clause 24.1</b>	<b>24.1 Technical requirements for 765/400/220/132/110kV* Air Insulated Switchgear (AIS) Equipment* (i.e Circuit Breaker, Isolator, Current Transformer, Capacitive Voltage transformer, Inductive Voltage transformer, Surge Arrester and Wave Trap)</b>  (i) The manufacturer(s) whose 765/400/220/132/110kV* equipment(s) are offered, must have, manufactured, type tested (as per IEC/IS or equivalent standard) and supplied 715/345/220/132/110kV* or higher voltage class equipment(s), which are in satisfactory operation# for atleast two (2) years as on the date of NOA.	<b>24.1 Technical requirements for 765/400/220/132/110kV* Air Insulated Switchgear (AIS) Equipment* (i.e Circuit Breaker, Isolator, Current Transformer, Capacitive Voltage transformer, Inductive Voltage transformer, Surge Arrester and Wave Trap)</b>  (i) The manufacturer(s) whose 765/400/220/132/110kV* equipment(s) are offered, must have, manufactured, type tested (as per IEC/IS or equivalent standard) and supplied 715/345/220/132/110kV* or higher voltage class equipment(s), which are in satisfactory operation# for atleast two (2) years as on the date of NOA.  (ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India for the offered equipment and not meeting the requirement stipulated in (i) above, can also be considered provided that	

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		<p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India for the offered equipment and not meeting the requirement stipulated in (i) above, can also be considered provided that</p> <p>a) 715/345/220/132/110kV* or higher Voltage class equipment(s) must have been manufactured in the above Indian works &amp; type tested (as per IEC/IS standard) and supplied as on the date of NOA.</p> <p>Contractor shall furnish performance guarantee for an amount of 10% of the ex-works cost of the equipments(s)* and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor.</p>	<p>a) 715/345/220/132/110kV* or higher Voltage class equipment(s) must have been manufactured in the above Indian works &amp; type tested (as per IEC/IS standard) and supplied as on the date of NOA.</p> <p>In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two(2) years over &amp; above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of the offered equipment to be supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 3% of the ex-works cost of the equipments(s)* for the additional warranty period in addition to the contract performance guarantee to be submitted by the contractor.</p>	
25.	<b>Clause No. 24.2</b>	<p><b>Technical Requirement for 765kV class Transformer</b></p> <p>(i) The Manufacturer whose 765kV Transformer(s) are offered must have designed, manufactured, tested &amp; supplied 715 kV or higher voltage class one (1) number three phase Transformer of atleast 500 MVA capacity (or equivalent capacity in a bank of three (3) numbers single phase units). These transformer(s) must have been in satisfactory operation# for atleast two</p>	<p><b>Technical Requirement for 765kV class Transformer</b></p> <p>(i) The Manufacturer whose 765kV Transformer(s) are offered must have designed, manufactured, tested &amp; supplied 715 kV or higher voltage class one (1) number 1-phase Transformer of at least 500 MVA capacity or at least three (3) numbers 1-phase Transformers each having a capacity of at least 166 MVA, and the same transformer (s) should have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p>	

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		<p>(2) years as on the date of NOA.</p> <p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that</p> <p>a) 715kV or higher voltage class one (1) number three phase Transformer of atleast 500 MVA capacity (or equivalent capacity in a bank of three (3)numbers single phase units) must have been manufactured in the above Indian works based on technological support of collaborator, type tested (as per IEC/IS standard) and supplied as on the date of NOA.</p> <p>b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply 765kV transformer in India, shall be submitted.</p> <p>c) the collaborator shall furnish performance guarantee for an amount of 10% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor.</p>	<p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that</p> <p>a) 715 kV or higher voltage class either One (1) no. 1-phase Transformer of at least 166 MVA capacity or One (1) no. 1-phase Reactor of at least 80 MVAR capacity must have been manufactured in the above Indian works based on technological support of collaborator, type tested (as per IEC/IS standard) and same should have been supplied as on the date of NOA.</p> <p>b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply 765kV transformer in India, shall be submitted.</p> <p>c) the collaborator shall furnish performance guarantee for an amount of 10-3% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor</p>	
26.	<b>Clause No. 24.3</b>	<del>24.3— Technical Requirement for 765kV class Reactor</del>	<b>24.3 Technical Requirement for 765kV class Reactor</b>	
			(i) The Manufacturer whose 765kV Reactor(s) are offered must have designed, manufactured, tested & supplied 715 kV or	

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		<p><del>(i) The Manufacturer whose 765kV Reactor(s) are offered must have designed, manufactured, tested &amp; supplied 715kV or higher voltage class one (1) number three phase Reactor of atleast 240 MVAR capacity (or equivalent capacity in a bank of three (3) numbers single phase units). These Reactor(s) must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</del></p> <p align="center"><del>OR</del></p> <p><del>(ii) The Manufacturer must have designed, manufactured, tested &amp; supplied 715kV or higher voltage class one (1) number three phase Transformer of atleast 500MVA capacity (or equivalent capacity in a bank of three (3) numbers single phase units). These Transformer(s) must have been in satisfactory operation# for atleast two (2) years as on the date of NOA. And the manufacturer must have designed, manufactured, tested &amp; supplied 345kV or higher voltage class one (1) number three phase Reactor of atleast 50MVAR capacity (or equivalent capacity in a bank of three (3) numbers single phase units). These Reactors must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</del></p> <p><del>(iii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that</del></p>	<p>higher voltage class one (1) number 1-phase Reactor of at least 110 MVAR capacity or at least three (3) numbers 1-phase Reactors each having a capacity of at least 36.7 MVAR and the same Reactor(s) should have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p align="center"><b>OR</b></p> <p>The Manufacturer must have designed, manufactured, tested &amp; supplied 715 kV or higher voltage class one (1) number 1-phase Transformer of at least 500 MVA capacity or at least three (3) numbers 1-phase Transformers each having a capacity of at least 166 MVA and the bidder should have designed, manufactured, tested &amp; supplied 345 kV or higher voltage class one (1) number 3-phase Reactor of at least 50 MVAR capacity or at least three (3) numbers 1-phase Reactors each having a capacity of at least 16.7 MVAR and the same Transformer(s) &amp; Reactor(s) should have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that</p> <p>a) 715 kV or higher voltage class either One (1) no. 1-phase Reactor of at least 80 MVAR capacity or One (1) no. 1-phase Transformer of at least 166 MVA capacity must have been manufactured in the above Indian works based on technological support of collaborator, type tested (as per IEC/IS standard) and same should have been supplied as on the date of NOA.</p> <p>b) The collaborator meets the requirements stipulated in (i)</p>	
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		<p>(iv) <del>715kV or higher voltage class one (1) number three phase Reactor of atleast 240MVAR capacity (or equivalent capacity in a bank of three (3) numbers single phase units) must have been manufactured in the above Indian works based on technological support of collaborator, type tested (as per IEC/IS standard) and supplied as on the date of NOA.</del></p> <p>(v) <del>The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer/license to design, manufacture, test and supply 765kV Reactor in India, shall be submitted.</del></p> <p>(vi) <del>the collaborator shall furnish performance guarantee for an amount of 10% of the ex works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor.</del></p>	<p>above. A valid collaboration agreement for technology transfer/license to design, manufacture, test and supply 765kV Reactor in India, shall be submitted.</p> <p>c) the collaborator shall furnish performance guarantee for an amount of 3% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor.</p>	
27.	Clause 24.4	<p><b>24.4 Technical Requirement for 400kV, 220kV, 132kV and 110kV class Transformer</b></p> <p>(i) The manufacturer whose transformer(s) are offered must have designed, manufactured, tested and supplied 400kV/220kV/132kV/110kV* or</p>	<p><b>24.4 Technical Requirement for 400kV, 220kV, 132kV and 110kV class Transformer</b></p> <p>(i) The manufacturer whose transformer(s) are offered must have designed, manufactured, tested and supplied transformers as per table below:</p>	

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		<p>higher voltage class transformers. These Transformer(s) must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that</p> <p>a) 220kV (applicable for supply of 400kV and 220kV class Transformer)/ 132kV (applicable for supply of 132kV &amp; 110kV class Transformer) or higher voltage class transformers must have been designed, manufactured in the above Indian works based on technological support of collaborator, type tested (as per IEC/IS standard) and supplied as on the date of NOA.</p> <p>b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply</p>	<table border="1" data-bbox="1075 303 1740 986"> <tr> <td data-bbox="1075 303 1460 544">345kV or above class 3-phase transformers of at least 200 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 66.7 MVA</td> <td data-bbox="1460 303 1740 544">applicable for supply of 400kV class Transformer</td> </tr> <tr> <td data-bbox="1075 544 1460 746">220kV or above class 3-phase transformers of at least 50 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 16.7 MVA</td> <td data-bbox="1460 544 1740 746">applicable for supply of 220kV class Transformer</td> </tr> <tr> <td data-bbox="1075 746 1460 986">commissioned 132kV or above class 3-phase transformers of at least 20 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 6.7 MVA</td> <td data-bbox="1460 746 1740 986">applicable for supply of 132kV class Transformer</td> </tr> </table> <p>These Transformer(s) must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the</p>	345kV or above class 3-phase transformers of at least 200 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 66.7 MVA	applicable for supply of 400kV class Transformer	220kV or above class 3-phase transformers of at least 50 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 16.7 MVA	applicable for supply of 220kV class Transformer	commissioned 132kV or above class 3-phase transformers of at least 20 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 6.7 MVA	applicable for supply of 132kV class Transformer	
345kV or above class 3-phase transformers of at least 200 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 66.7 MVA	applicable for supply of 400kV class Transformer									
220kV or above class 3-phase transformers of at least 50 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 16.7 MVA	applicable for supply of 220kV class Transformer									
commissioned 132kV or above class 3-phase transformers of at least 20 MVA or at least three (3) nos. 1-phase Transformers each having capacity of at least 6.7 MVA	applicable for supply of 132kV class Transformer									

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		<p>400kV/220kV/132kV/110kV* transformer in India, shall be submitted.</p> <p>the collaborator shall furnish performance guarantee for an amount of 10% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor.</p>	<p>requirement stipulated in (i) above, can also be considered provided that</p> <p>a) <b>220kV (applicable for supply of 400kV and 220kV class Transformer)/ 132kV (applicable for supply of 220kV class Transformer)/ 66kV (applicable for supply of 132kV class Transformer)</b> or higher voltage class transformers must have been designed, manufactured in the above Indian works based on technological support of collaborator, type tested (as per IEC/IS standard) and supplied as on the date of NOA.</p> <p>b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply 400kV/220kV/132kV/110kV* transformer in India, shall be submitted.</p> <p>the collaborator shall furnish performance guarantee for an amount <b>of 3%</b> of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor.</p>	
28.	<b>Clause 24.5</b>	<p><b>24.5 Technical Requirement for 400kV, 220kV and 132kV class Reactor</b></p> <p>(i) The Manufacturer whose 400kV/220kV/132kV* Reactor(s) are offered must have designed, manufactured, tested &amp; supplied</p>	<p><b>24.5 Technical Requirement for 400kV, 220kV and 132kV class Reactor</b></p> <p>(i) The Manufacturer whose 400kV/220kV/132kV* Reactor(s) are offered must have designed, manufactured, tested &amp; supplied Reactor as per table below:</p>	

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		<p>400kV/220kV/132kV* or higher voltage class. These Reactor(s) must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that</p> <p>a) Such manufacturer has designed, manufactured based on technological support of collaborator, type tested (as per IEC/IS standard) and supplied 400kV class transformer or 220kV or above class shunt reactors as on the date of NOA.</p> <p>b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer/license to design, manufacture, test and supply the</p>		<p>345kV or above class 3-phase shunt reactor of at least 50 MVAR capacity or at least three (3) nos. 1-phase Shunt Reactors, each having capacity of at least 16.7 MVAR</p> <p>220kV or above class 3-phase shunt reactor of at least 20 MVAR capacity or at least three (3) nos. 1-phase Shunt Reactors each having capacity of at least 6.67 MVAR</p> <p>132kV or above class 3-phase shunt reactor of at least 15 MVAR capacity or at least three (3) nos. 1-phase Shunt Reactors each having capacity of at least 5 MVAR</p> <p>These Reactor(s) must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated</p>	<p>applicable for supply of 400kV class Reactors</p> <p>applicable for supply of 220kV class Transformer</p> <p>applicable for supply of 132kV class Transformer</p>	
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		<p>Reactor in India, shall be submitted.</p> <p>the collaborator shall furnish performance guarantee for an amount of 10% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor.</p>	<p>in (i) above, can also be considered provided that</p> <p>a) Such manufacturer has designed, manufactured based on technological support of collaborator, type tested (as per IEC/IS standard) and supplied 400kV class transformer or 220kV or above class shunt reactors (applicable for supply of 400kV class Reactors) / 220kV class transformer or 132kV or above class shunt reactors (applicable for supply of 220kV class Reactors)/ 132kV class transformer or 66kV or above class shunt reactors (applicable for supply of 132kV class Reactors) as on the date of NOA.</p> <p>b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer/license to design, manufacture, test and supply the Reactor in India, shall be submitted.</p> <p>the collaborator shall furnish performance guarantee for an amount of 3% of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor.</p>	
29.	<b>Clause 24.6</b>	<p><b>24.6 Technical Requirement for 400 kV Grade XLPE Power Cables</b></p> <p>(i) The manufacturer(s) whose XLPE Power Cables are offered must have designed, manufactured, type tested and</p>	<p><b>24.6 Technical Requirement for 400 kV Grade XLPE Power Cables</b></p> <p>(i) The manufacturer(s) whose XLPE Power Cables are offered must have designed, manufactured, type tested and supplied in a single contract atleast 5 (five) km of single core, 400kV grade</p>	

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		<p>supplied in a single contract atleast 5 (five) km of single core, 400kV grade XLPE insulated cable which must be in operation for atleast 2 (two) years as on the date of NOA.</p> <p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that</p> <p>a) The manufacturer must have designed, manufactured, type tested and supplied 400kV grade XLPE insulated cable and which must be in satisfactory operation# for atleast one (1) year as on the date of NOA.</p> <p align="center">OR</p> <p>b) The manufacturer must have designed, manufactured, type tested and completed Pre-qualification (PQ) tests as per IEC for 400kV grade XLPE insulated Cable as on the date of NOA.</p>	<p>XLPE insulated cable which must be in operation for atleast 2 (two) years as on the date of NOA.</p> <p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that</p> <p>a) The manufacturer must have designed, manufactured, type tested and supplied 400kV grade XLPE insulated cable and which must be in satisfactory operation# for atleast one (1) year as on the date of NOA.</p> <p align="center">OR</p> <p>b) The manufacturer must have designed, manufactured, type tested and completed Pre-qualification (PQ) tests as per IEC for 400kV grade XLPE insulated Cable as on the date of NOA.</p> <p><b>Note: In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two(2) years over &amp; above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of cable to supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 3% of the ex-works cost of the equipments(s)* and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor.</b></p>	
30.	<b>Clause 24.7</b>	<b>24.7 Technical Requirement for 220KV Grade XLPE Power Cables</b>	<b>24.7 Technical Requirement for 220KV, 132KV,110KV Grade XLPE Power Cables</b>	

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			<p>(i) The manufacturer(s) whose XLPE Power Cables are offered must have designed, manufactured, type tested and supplied in a single contract atleast 5 (five) km of single core, 220kV/<b>132kV/110kV*</b> or higher grade XLPE insulated cable which must be in operation for atleast 2 (two) years as on the date of NOA.</p> <p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that</p> <p>a) The manufacturer must have designed, manufactured, type tested and supplied 220kV/<b>132kV/110kV*</b> or higher grade XLPE insulated cable and which must be in satisfactory operation# for atleast one (1) year as on the date of NOA.</p> <p style="text-align: center;">OR</p> <p>b) The manufacturer must have designed, manufactured, type tested and completed Pre-qualification (PQ) tests as per IEC for 220kV/<b>132kV/110kV*</b> or higher grade XLPE insulated Cable as on the date of NOA.</p> <p><b>Note: In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two(2) years over &amp; above the warranty period as specified in the bidding documents shall be applicable for the</b></p>	
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			entire quantity of cable to supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 3% of the ex-works cost of the equipments(s)* and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor.	
31.	Clause 24.8	<p><b>24.8 Technical Requirement for 132KV, 110kV, 66kV Grade XLPE Power Cables</b></p> <p>(i) The manufacturer(s) whose XLPE Power Cables are offered must have designed, manufactured, type tested and supplied in a single contract atleast 5 (five) km of single core, 132KV/110kV/66kV* or higher grade XLPE insulated cable which must be in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i)above, can also be considered provided that</p>	<p><b>24.8 Technical Requirement for <del>132KV, 110kV</del>, 66kV Grade XLPE Power Cables</b></p> <p>(i) The manufacturer(s) whose XLPE Power Cables are offered must have designed, manufactured, type tested and supplied in a single contract atleast 5 (five) km of single core, <del>132KV/110kV</del>/66kV* or higher grade XLPE insulated cable which must be in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p>Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i)above, can also be considered provided that the manufacturer must have designed, manufactured, type tested and supplied <del>132KV/110kV</del>/66kV* or higher grade XLPE insulated cable and which must be in satisfactory operation# for atleast one (1) year as on the date of NOA.</p>	

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		a) The manufacturer must have designed, manufactured, type tested and supplied 132KV/110kV/66kV* or higher grade XLPE insulated cable and which must be in satisfactory operation# for atleast one (1) year as on the date of NOA.		
32.	<b>Clause No. 24.9</b>	<b>Technical Requirement for 1.1 KV Grade PVC Control Cable</b>  The manufacturer(s), whose PVC control cables are offered, must have designed, manufactured, tested and supplied in a single contract atleast 100 Kms of 1.1kV grade PVC insulated control cables as on the originally scheduled date of bid opening. Further the manufacturer must also have designed, manufactured, tested and supplied atleast 1 km of 27C x 2.5 Sq.mm or higher size as on the date of NOA	<b>Technical Requirement for 1.1 KV Grade PVC Control Cable</b>  The manufacturer(s), whose PVC control cables are offered, must have designed, manufactured, tested and supplied in a single contract atleast 100 Kms of 1.1kV grade PVC insulated control cables as on <del>the originally scheduled date of bid opening</del> <b>the date of NOA</b> . Further the manufacturer must also have designed, manufactured, tested and supplied atleast 1 km of 27C x 2.5 Sq.mm or higher size as on the date of NOA	
33.	<b>Clause No. 24.10</b>	<b>Technical Requirement for 1.1 KV Grade PVC Power Cable</b>  The manufacturer(s), whose PVC Power Cables are offered, must have designed, manufactured, tested and supplied in a single contract atleast 100 Kms of 1.1kV or higher grade PVC insulated power cables as on the date of NOA/award. Further the manufacturer must also have designed, manufactured, tested and supplied atleast 1 km of 1C x 150 Sq. mm or higher size as on the date of NOA.	<b>Technical Requirement for 1.1 KV Grade PVC Power Cable</b>  The manufacturer(s), whose PVC Power Cables are offered, must have designed, manufactured, tested and supplied in a single contract atleast 100 Kms of 1.1kV or higher grade PVC insulated power cables as on the date of NOA/award. Further the manufacturer must also have designed, manufactured, tested and supplied atleast 1 km of 1C x 150 Sq. mm or higher size as on the date of NOA.	
34.	<b>Clause 24.15</b>	<b>24.15 Technical Requirements for LT</b>	<b>24.15 Technical Requirements for LT Transformer</b>	

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		<p><b>Transformer</b></p> <p>i) The manufacturer, whose LT transformer(s) are offered, must have designed,manufactured, type tested including short circuit test as per IEC/IS or equivalent standards and supplied transformer(s) of atleast 33kV class of 630kVA or higher. The transformer must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p>ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that</p> <p>a) At least 33kV class of 630 kVA or higher rating LT transformer(s) must have been designed, manufactured in the above Indian works, type tested (as perIEC/IS standard) including short circuit test and supplied as on the date of NOA.</p> <p>b) the contractor shall furnish performance guarantee for an amount of 10% of the ex-works cost of the equipment(s) and this performance guarantee shall be in addition to contract performance guarantee to be submitted by the contractor.</p>	<p>i) The manufacturer, whose LT transformer(s) are offered, must have designed, manufactured, type tested including short circuit test as per IEC/IS or equivalent standards and supplied transformer(s) of atleast 33kV class of <del>630kVA</del> <b>315kVA</b> or higher. The transformer must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p>ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that At least 33kV class of <del>630 kVA</del> <b>315kVA</b> or higher <del>rating</del> LT transformer(s) must have been designed, manufactured in the above Indian works, type tested (as perIEC/IS standard) including short circuit test and supplied as on the date of NOA.</p> <p><b>In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two(2) years over &amp; above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of the offered equipment to be supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 3% of the ex-works cost of the equipments(s)* for the additional warranty period in addition to the contract performance guarantee to be submitted by the contractor</b></p>	
35.	<b>Clause 24.16</b>	<p><b>24.16 Technical Requirements for Composite Long Rod Polymer Insulator (765kV &amp; 400kV)</b></p> <p>(i) The manufacturer whose Composite Long rod Insulator are</p>	<p><b>24.16 Technical Requirements for Composite Long Rod Polymer Insulator (765kV &amp; 400kV)</b></p> <p>(i) The manufacturer whose Composite Long rod Insulator are offered, must have designed, manufactured, tested and supplied Composite Long</p>	

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		<p>offered, must have designed, manufactured, tested and supplied Composite Long rod Insulator of 120KN or higher electro-mechanical strength for 765kV/400kV* or higher voltage class and the same must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that</p> <p>a) The manufacturer must have designed, manufactured, type tested and supplied Composite Long rod Insulator of 120KN or above electro-mechanical strength for 765kV/400kV* or higher voltage class and the same must have been in satisfactory operation# as on the date of NOA.</p>	<p>rod Insulator of 120KN or higher electro-mechanical strength for 765kV/400kV* or higher voltage class and the same must have been in satisfactory operation# for atleast two (2) years as on the date of NOA.</p> <p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that</p> <p>a) The manufacturer must have designed, manufactured, type tested and supplied Composite Long rod Insulator of 120KN or above electro-mechanical strength for 765kV/400kV* or higher voltage class and the same must have been in satisfactory operation# as on the date of NOA.</p> <p>In case manufacturer meets the technical requirement through clause (ii) above, warranty obligations for additional warranty of two(2) years over &amp; above the warranty period as specified in the bidding documents shall be applicable for the entire quantity of the offered equipment to be supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 3% of the ex-works cost of the equipments(s)* for the additional warranty period in addition to the contract performance guarantee to be submitted by the contractor.</p>	
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		Contractor shall furnish performance guarantee for an amount of 10% of the exworks cost of the equipments(s)* and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor		
36.	<b>Clause 24.19</b>	<p><b>24.19 Technical Requirement of Communication Equipment</b></p> <p><del>The SDH equipment shall be offered from a manufacturer(s) who has been manufacturing SDH equipments for the last three (3) years and SDH equipment manufactured by such manufacturer(s) shall have been satisfactory operation in 110kV or higher voltage Power Substations for at least two (2) years as on the date of NOA.</del></p>	<p><b>24.19 Technical Requirement of Communication Equipment</b></p> <p>The SDH equipment shall be offered from a manufacturer(s) who is a <b>“Local Supplier”</b> as per DPIIT PP notification &amp; has been Manufacturing SDH equipments for the last three (3) years and SDH equipment Manufactured by such manufacturer(s) shall have been satisfactory operation in 110kV or higher voltage Power Substations for at least two (2) years as on the date of NOA</p>	
37.	<b>Clause 24.20</b>	<p><b>24.20 Technical Requirement of “Indian Associate” for execution of on shore supply and services for 765 kV Transformer &amp; Reactor package</b></p> <p>Indian associate must have erected at least two (2) or more circuit breaker equipped bays of 345 kV or above voltage level or at least two (2) nos. of 345 kV or above voltage class transformer/reactor; during last seven (7) years and above bays/transformer/reactors must be in satisfactory operation# as on the date of NOA</p>	.	Clause Deleted
38.	<b>Clause 24.20</b>		<b>24.20 Technical Requirement for 400kV GIS Equipment</b>	New Clause added

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			<p>(i) The manufacturer whose 400kV GIS bays are offered must have designed, manufactured, type tested** (as per IEC or equivalent standard), supplied and supervised erection &amp; commissioning of at least two (2) nos. Gas Insulated Switchgear (GIS) circuit breaker bays@ of 345kV or above voltage class in one (1) Substation or Switchyard during the last seven (7) years and these bays must be in satisfactory operation# for at least two (2) years as on the date of NOA.</p> <p>(ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can also be considered provided that</p> <p>a) Atleast one no. 345kV or above voltage class GIS Circuit Breaker bay@ must have been manufactured in the above Indian works based on the technological support of the Collaborator(s) and either supplied or type tested the above CB bay (as per IEC or equivalent standard) as on the date of NOA.</p> <p>b) The collaborator(s) meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply 400kV or above voltage level GIS equipment in India, shall be submitted.</p> <p>c) The Collaborator(s) shall furnish performance guarantee for an amount of 3 % of the ex-works cost of such equipment(s) and this performance guarantee shall be in addition to Contract Performance Guarantee to be submitted by the bidder.</p>	
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			<p>Note :-</p> <p>(**) Type test reports of the collaborator/ parent company/ subsidiary company/ group company shall also be acceptable</p>	
39.	Clause 25.0		<p><b>25.0 Technical Requirement of Sub-contractors:</b></p> <p>The sub-contractor must have either of the following experience of having successfully completed similar works during last 7 years as on the last day of month previous to the one in which the sub-contractor is proposed to be engaged:</p> <p>a) Three similar works costing not less than the amount equal to 40% of the cost of the work to be sub-contracted.</p> <p align="center"><b>OR</b></p> <p>b) Two similar works costing not less than the amount equal to 50% of the cost of the work to be sub-contracted.</p> <p align="center"><b>OR</b></p> <p>c) One similar work costing not less than the amount equal to 80% of the cost of the work to be sub-contracted.</p> <p>1. Minimum Average Annual Turnover <b>** (MAAT)</b></p>	New Clause added

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			<p>for best three years i.e. 36 months out of last five financial years of the sub-contractor should be.....:</p> <p><b>**Annual Gross Revenue from operations/ Gross operating income as incorporated in the profit &amp; loss account excluding Other Income.</b></p> <p><b>Note:</b></p> <p>a) Similar work shall mean the work which are of similar in nature to the work to be sub-contracted e.g. for the scope of civil work to be sub-contracted, the experience should be of civil work.</p> <p>b) The aforesaid qualifying requirement shall however, not be applicable for engaging labour as per extant policy.</p> <p>c) The cost of the work to be sub-contracted shall be considered as available in the Contract Agreement. However, if the value is not available in the Contract Agreement, the same shall be the estimated value for such work.</p> <p>d) The above criteria is in addition to extant policy on selection of sub-contractor as per WPPP, Vol-II.</p> <p>e) The MAAT requirement shall be worked out basis the following formula:</p>	
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		Minimum Annual Turnover (MAAT)	Average =	Cost of the work contractedx1.5/Completion years**	work to be completed in period	sum															
		**The completion period shall be considered as 1 year even if the same is less than 1 year.																			
40.		<p><b>26.0 Technical Requirement of Sub-contractors of GIS Packages</b></p> <p>In case of GIS is supplied from Indian GIS manufacturer, the erection, testing &amp; commissioning of GIS shall be executed either by the bidder himself or by the Subcontractor meeting the following technical requirement:</p> <p>The bidder/Subcontractor must have erected, tested and commissioned at least two (2) nos. GIS/AIS Circuit breaker equipped bays@ of voltage class** as specified below or higher in one (1) substation or switchyard during the last seven (7) years and these bays must be in satisfactory operation# as on the date of NOA.</p> <table border="1"> <thead> <tr> <th>S. no</th> <th>Voltage class of GIS Package</th> <th>Minimum Voltage class Circuit Breaker Equipped of Bay(**)</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>765kV &amp; 400kV GIS</td> <td>345kV</td> </tr> <tr> <td>2</td> <td>220kV</td> <td>220kV</td> </tr> <tr> <td>3</td> <td>132kV</td> <td>110kV</td> </tr> <tr> <td>4</td> <td>66kV</td> <td>66kV</td> </tr> </tbody> </table>				S. no	Voltage class of GIS Package	Minimum Voltage class Circuit Breaker Equipped of Bay(**)	1	765kV & 400kV GIS	345kV	2	220kV	220kV	3	132kV	110kV	4	66kV	66kV	New Clause added
S. no	Voltage class of GIS Package	Minimum Voltage class Circuit Breaker Equipped of Bay(**)																			
1	765kV & 400kV GIS	345kV																			
2	220kV	220kV																			
3	132kV	110kV																			
4	66kV	66kV																			

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			<p>Further, the sub-contractor shall also meet the requirement specified at Clause No. 25.0 of this section.</p> <p><b>Note:</b></p> <p>1. (@) For the purpose of technical requirement, one no. of circuit breaker bay shall be considered as a bay used for controlling a line or a transformer or a reactor or a bus section or a bus coupler and comprising of at least one circuit breaker, one disconnecter and three nos. of single phase CTs / Bushing CTs. GIS means SF6 Gas insulated Switchgear. AIS Means Air Insulated Switchgear.</p> <p>2. # satisfactory operation means certificate issued by the Owner/Utility certifying the operation without any adverse remark.</p>	
41.	<b>Section GTR Rev 14 Annexure-A</b>	Annex-A: Corona and Radio Interface Voltage(RIV) Test		Annexure updated
42.	<b>Section GTR Rev 14 Para-1 at Annexure-B</b>		<p>“The seismic withstanding test on the complete equipment (for 400kV and above) shall be carried out along with supporting structure. <b>Seismic Withstand Test carried out using either lattice or pipe structure is acceptable.</b>”</p> <p><b>Seismic Calculations certified by NABL Labs shall also be acceptable</b></p>	Annexure updated
43.	<b>Annexure-D</b>	List of General Standard/Document for second advance		The Annexure is updated with incorporation of requirement for GIS & EHV cables (

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				above 132kV)
44.	<b>Annexure F</b>	Assessment report from main Contractor for proposed sub vendors list of enclosure		The Annexure is updated
45.	<b>Annexure-G</b>	MOP & Inspection Level Requirement		The Annexure is updated
46.	<b>Section GTR Rev 14 Annexure-H</b>	Annex-H:RTV Silicon high voltage insulation coating(HVIC)		Annexure updated
47.	<b>Annexure J</b>		List of make for which type test reports are not required	The New Annexure is added
48.	<b>Annexure K</b>		List of Equipment's to be supplied from domestic manufacture only	The New annexure added

Note: The details mentioned in this annexure are only for the purpose of identification of changes in this revision of Technical Specification only, how ever details mentioned at respective clause shall be referred for execution purpose.