BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS GROUP
SUBCONTRACTS MANAGEMENT
PLOT NO. 25, SECTOR 16A, NOIDA,
DISTT. – GAUTAM BUDDH NAGAR (U.P.) - 201301

TENDER DOCUMENTS

FOR

ERECTION WORK OF STRUCTURE AND STRINGING AT 765/400/220 KV AIS SWITCHYARD AT POWERGRID, BIKANER-III PROJECT IN BIKANER, RAJASTHAN.

CUSTOMER

POWERGRID CORPORATION OF INDIA LIMITED (PGCIL)

TENDER SPEC. NO.: TBSM/BIKANER-III/EREC-STR/TENDER/24-25

DATE: 16.01.2025

TRANSMISSION BUSINESS GROUP

SUBCONTRACTS MANAGEMENT

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BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS GROUP

SECTOR-16A, NOIDA -201301

e-mail: akmeena@bhel.in

NOTICE INVITING TENDER

REF.: TBSM/BIKANER-III/EREC-STR/TENDER/24-25 **DATE: 16.01.2025**

SUB: TENDER FOR "ERECTION WORK OF STRUCTURE AND STRINGING AT 765/400/220 KV AIS SWITCHYARD AT POWERGRID, BIKANER-III PROJECT IN BIKANER, RAJASTHAN".

Dear Sirs,

1. **Sealed tenders are invited for the following:**

NAME OF WORK	TIME OF COMPLETION	EARNEST MONEY DEPOSIT	TENDER SUBMISSION DATE AND TIME	TENDER OPENING DATE & TIME
Erection work of Structure and Stringing at 765/400/220 kV AIS Switchyard at POWERGRID, Bikaner-III Project in Bikaner, Rajasthan.	05 months from the date of LOI	Rs. 2,00,000/- As per Annexure to conditions of contract for ETC works	28.01.2025 11.00 hrs.	28.01.2025 16.00 hrs. (Technical bid only)

2. Bidder **has** to submit offer directly through E-PROCURMENT MODE. Bidder may visit **https://eprocurebhel.co.in**

Procedure for Submission of Tenders through e-tendering: The tender is also floated online through our E-Procurement Site https://eprocurebhel.co.in . The bidder may respond by submitting their offer online in our e-Procurement platform at https://eprocurebhel.co.in

Offers are invited in two-parts only.

Documents Comprising the e-Tender

The tender shall be submitted online EXCEPT EMD (which shall be submitted in physical form (as described in NIT cl. No.1) above as mentioned below:

a) Technical Bid (Un priced Tender)

All Technical details (e.g. Eligibility Criteria requested (as mentioned below)) should be attached in e-tendering module, failing which the tender stands invalid & may be REJECTED. Bidders shall furnish the following information along with technical tender (preferably in pdf format):

i) Earnest money Deposit (EMD) furnished in accordance with NIT Clause 4.0

ii) Technical Bid (without indicating any prices).

b) Price Bid:

i) Prices are to be quoted in the attached Price Bid format online on e-tender portal.

ii) The price should be quoted for the accounting unit indicated in the e-tender document.

iii) Note: It is the responsibility of tenderer to go through the Tender document to ensure furnishing all required documents in addition to above, if any. Any deviation would result in REJECTION of tender and would not be considered at a later stage at any cost by BHEL.

iv) A person signing (manually or digitally) the tender form or any documents forming part of the contract on behalf of another shall be deemed to warrantee that he has authority to bind such other persons and if, on enquiry, it appears that the persons so signing had no authority to do so, the purchaser may, without

prejudice to other civil and criminal remedies, cancel the contract and hold the signatory liable for all cost and damages.

v) A tender, which does not fulfil any of the above requirements and/or gives evasive information/reply against any such requirement, shall be liable to be ignored and rejected.

c) Uploading of the price bid in prequalification bid or technical bid may RESULT IN REJECTION of the tender.

d) Tenders shall be uploaded with all relevant PDF/zip format. The relevant tender documents should be uploaded by an authorized person having Class 3- SHA2- 2048 BIT- SIGNING & ENCRYPTION digital signature certificate (DSC).

3. **Tender must be accompanied by the prescribed amount of Earnest Money Deposit (EMD) in the manner described in "Annexure to the Conditions of contract for ETC work "which shall be part of the Technical Bid.**

   In case of E-Tenders, no paper bids shall be accepted, therefore, the scanned copy of the Banker's Cheque/ Demand Draft/ Pay Order/ Details of payment made through Electronic Fund Transfer/ Fixed Deposit Receipt (FDR) / Bank Guarantee should be uploaded in the E-Procurement Portal and hard copy of the same should reach to following address at before the due date and time of bid submission. BHEL shall not be responsible for postal or any other delays in this regard.)

TO,

Ashok Kumar Meena
Sr. DGM (TBSM)
BHARAT HEAVY ELECTRICALS LIMITED,
TRANSMISSION BUSINESS GROUP,
6th Floor, BHEL SADAN, Plot no.: - 25, Sector- 16A, Noida,
Distt. – Gautam Buddh Nagar, UP-201301
TELEPHONE: 0120-6748545, 9831038136
E-mail: akmeena@bhel.in

4. **Bidders may please note that no other mode of bid submission shall be considered for evaluation apart from Clause no. 02 to 03 mentioned above.**

5. The prospective bidders who have downloaded the tender documents from our website are requested to send their acknowledgement and willingness to participate in the tender to the undersigned, through fax or email.

6. Offers should be strictly in accordance with the Tender Specifications and General Instructions to Tenderer enclosed herewith.

7. "BHEL shall be resorting to Reverse Auction (RA) (Guidelines as available on www.bhel.com) for this tender. RA shall be conducted among the techno-commercially qualified bidders as per RA Guidelines.

   Price bids of all techno-commercially qualified bidders shall be opened and same shall be considered for RA. In case any bidder(s) do(es) not participate in online Reverse Auction, their price bid along with applicable loading, if any, shall be considered for ranking."

8. The contractor shall give his explicit confirmation without any deviations to the HSE (Health, Safety and Environment) requirements as per enclosed specification No. TBSM/HSE/NIT-01, Rev-02 Date 31.01.2024. Contactors are also required to furnish details as per Annexure (HSE) to NIT along with their offer. Offers received without compliance & data about HSE requirements are liable to be rejected.

9. All documents submitted with the offer shall be signed and stamped in each page by authorized representative of the bidder.

10. Clarifications, if any, can be obtained from the undersigned but such requests should be submitted well before the due date for submission of tenders. Due date for submission and opening of tenders will not be extended on such grounds.

11. Please note that wherever there is a contradiction between the 'ANNEXURE TO CONDITIONS OF CONTRACT FOR ETC WORKS' and 'Conditions of contract for ETC works', the 'ANNEXURE TO CONDITIONS OF CONTRACT FOR ETC WORKS' clauses shall be governing and binding on the contractor.

12. Drawings & FQP enclosed with the NIT (if provided) are for tender purpose only. Drawings & FQP may get change during execution stage and work to be carried as per latest RFC drawings & Field Quality Plan (FQP).

13. Construction/ RFC drawing/ Fronts shall be furnished progressively as per project requirement and no claim towards idling charges/ project overheads etc. borne by the contractor on account of non-availability of drawings/ fronts shall be entertained.

14. Completion period of the work has been envisaged under best possible conditions. Any changes/ deviation during execution shall be dealt as per relevant clauses mentioned in general/ special conditions of contract for ETC works.

15. *"In case this tender is awarded to first time contractor*, then the bidder shall be eligible to qualify for the next tender of similar work# of BHEL, TBG; only after successful executing of 50% (fifty percent) of this work prior to the date of next tender (in which bidder desires to quote) and on satisfactory performance feedback by BHEL site Incharge."*

    ** First time contractor: The bidders who have not successfully executed more than 50% (fifty percent) of awarded similar work by BHEL (TBG/ ISG/Power Sector/Any BHEL Unit) in last 5 years from date of NIT.*

    The bidders who have taken any order from BHEL under 1st time category, and desires to further participate in BHEL tenders, needs to submit a certificate/ undertaking mentioning the reason of not executing 50% of awarded work, hence the criteria under 1st time bidder shall not be applicable to them. The certificate/ undertaking shall be duly certified by Site In charge of BHEL

    # Similar work: Similar to nature of work of the tender under consideration.

16. **Before submission of offer, the tenderer is advised to inspect the work & the environments and be well acquainted with the actual working and other prevalent conditions, facilities available, sourcing of material and labour, means of transport and access to site, accommodation, etc.** No claim will be entertained later on the grounds of lack of knowledge on any of these conditions/ resources.

17. The offers of the bidders who are under suspension as also the offers of the bidders, who engage the services of the banned firms, shall be rejected. The list of banned firms is available on BHEL web site www.bhel.com.

18. Integrity commitment, performance of the contract and punitive action thereof:

    18.1. Commitment by BHEL:

    BHEL commits to take all measures necessary to prevent corruption in connection with the tender process and execution of the contract. BHEL will during the tender process treat all Bidder(s) in a transparent and fair manner, and with equity.

    18.2. Commitment by Bidder/ Supplier/ Contractor:

    18.2.1. The bidder/ supplier/ contractor commits to take all measures to prevent corruption and will not directly or indirectly influence any decision or benefit which he is not legally entitled to nor will act or omit in any manner which tantamount to an offence punishable under any provision of the Indian Penal Code, 1860 or any other law in force in India.

    18.2.2. The bidder/ supplier/ contractor will, when presenting his bid, disclose any and all payments he has made, and is committed to or intends to make to agents, brokers or any other

intermediaries in connection with the award of the contract and shall adhere to relevant guidelines issued from time to time by Govt. of India/ BHEL.

18.2.3. The bidder/ supplier/ contractor will perform/ execute the contract as per the contract terms & conditions and will not default without any reasonable cause, which causes loss of business/ money/ reputation, to BHEL.

If any bidder/ supplier/ contractor during pre-tendering/ tendering/ post tendering/ award/ execution/ post-execution stage indulges in mal-practices, cheating, bribery, fraud or and other misconduct or formation of cartel so as to influence the bidding process or influence the price or acts or omits in any manner which tantamount to an offence punishable under any provision of the Indian Penal Code, 1860 or any other law in force in India, then, action may be taken against such bidder/ supplier/ contractor as per extant guidelines of the company available on www. bhel.com and/or under applicable legal provisions".

19. Also, offer of the bidders who are suspended (under hold/ delist) for business dealings by BHEL, TBG shall not be considered. Please note that lifting/ restoration of suspension (Ban/Hold/ De-list) of business dealing is not automatic after expiry of specified suspension period. Hence, vendor shall be considered as suspended for business till suspension is lifted by BHEL in writing on specific request of the vendor as per extant guidelines.

20. BHEL Fraud Prevention Policy, "The Bidder along with its associate/ collaborators/ sub-contractors/ sub-vendors/ consultants/ service providers shall strictly adhere to BHEL Fraud Prevention Policy displayed on BHEL website http://www.bhel.com and shall immediately bring to the notice of BHEL Management about any fraud or suspected fraud as soon as it comes to their notice."

21. Offers will be scrutinized based on the qualifying requirements and only those who are technically and financially capable to execute the Job and who fulfil the Pre-Qualifying Requirements (PQR) are eligible to quote against the above NIT. However, final acceptance of the bidder/ offer shall be subject to acceptance of our customer.

22. The evaluation currency for this tender shall be INR.

23. The Submission of EMD is compulsory for subject tender. In case requisite Amount of EMD not submitted by the bidder before tender opening or along with offer, the offer shall not be considered for evaluation and the offer shall be rejected.

24. In the course of evaluation, if more than one bidder happens to occupy L-1 status, effective L-1 will be decided by soliciting discounts from the respective L-1 bidders.

    In case more than one bidder happens to occupy the L-1 status even after soliciting discounts, the L-1 bidder shall be decided by toss/ draw of lots, in the presence of the respective L-1 bidder(s) or their representative(s).

    Ranking will be done accordingly. BHEL's decision in such situations shall be final and binding.

25. Technical Bid will be opened in the office of undersigned. If required, technical discussions will be held with only those bidders who have taken any deviations. The price bids will be opened subsequently, after Technical Bids of all the bidders have been evaluated and freezed. Bidders should quote their most competitive rates as there will not be any price negotiation. However, if felt necessary by BHEL, price negotiation will be held with lowest bidder (L-1) only. **IT WOULD BE PREFERRED THAT YOUR OFFER IS WITHOUT ANY DEVIATION w.r.t. TENDER SPECIFICATIONS AND THE SAME MAY BE CLEARLY MENTIONED ON THE COVERING LETTER ACCOMPANYING THE TECHNICAL BID.** Offers with deviations are likely to be rejected.

26. In case any adverse information is received concerning performance, capability or conduct of the bidder after issue of tender enquiry, BHEL reserves the right to reject the offer at any stage as deemed fit.

27. **Integrity Pact (IP)**

    (a) IP is a tool to ensure that activities and transactions between the Company and Its Bidders/ Contractors are handled in a fair, transparent and corruption free manner. Following

Independent External Monitors (IEMs) on the present panel have been appointed by BHEL with the approval of CVC to oversee implementation of IP in BHEL

Sl no.	IEM	E- mail
1	Shri Otem Dai, IAS (Retd.)	iem1@bhel.in
2	Shri Bishwamitra Pandey, IRAS (Retd.)	Iem2@bhel.in
3.	Shri Mukesh Mittal, IRS (Retd.)	Iem3@bhel.in

(b) The IP as enclosed with the tender is to be submitted (duly signed by authorized signatory) along with techno-commercial bid (part-I in case of Two/ Three Part Bid). Only **those bidders who have entered into such an IP with BHEL would be competent to participate in the bidding**. In other words, entering into this Pact would be a preliminary qualification,

(c) Please refer Section-8 of the IP for Role and Responsibilities of IEMs. In case of any complaint arising out of the tendering process, the matter may be referred to any of the above IEM(s). All correspondence with the IEMs shall be done through e-mail only.

Note: -

No routine correspondence shall be addressed to the IEM (phone/ post/ email) regarding the clarifications, time extensions or any other administrative queries, etc. on the tender issued. All such clarification/ issues shall be addressed directly to the tender issuing (procurement) department's officials whose contact details are provided below":

Details of contact person (s): -

1) Name: - Ajay Kumar Chowdhary Department: - TBG, Subcontracting Address: - BHEL/ TBG, Noida Phone: - 01206748129 E mail: - akchowdhary@bhel.in	2) Name: - Ashok Kumar Meena Department: - TBG, Subcontracting Address: - BHEL/ TBG, Noida Phone: - 01206748545 E mail: - akmeena@bhel.in

28. Any materials (if required) for ETC works have to be procured from Customer approved sources only. It will be the bidder's responsibility to get the approval of materials and vendors for materials.

29. The purchase preference for central P.S.U.s shall be given as per the prevailing Government policy.

30. Work schedule and the deployment of manpower and T&P resources committed by the contractor in their offer, to match the scheduled completion, shall be submitted by contractor and mutually agreed with site In-charge immediately after the award of work. Further, the contractor shall mobilise at site within two weeks of award of work.

31. In case an offer is not being submitted by the prospective bidders against this tender, they may send their "regret" letter to this office, for information.

32. Details of qualifying work(s) executed by the bidder will be forwarded to the principal employer for verification of the work with respect to completion, commencement & completion date and value of the work executed. Performance feedback of the bidder will also be sought from the principal employer.

33. The bidder representative may be called for discussion with the committee. His originals may be verified by the committee. In addition to above their organisation chart and detail list of manpower, tools & plants and technically capability will be discussed and ascertained by the committee.

34. **Conflict of Interest among bidders/Agents:** -

"A bidder shall not have conflict of interest with other bidders. Such conflict of interest can lead to anti-competitive practices to the detriment of Procuring Entity's interests. ***The bidder found to have a conflict of interest shall be disqualified****. A bidder may be considered to have a conflict of interest with one or more parties in this bidding process, if:*

a) they have controlling partner (s) in common; ***or***

b) *they receive or have received any direct or indirect subsidy/ financial stake from any of them;* ***or***

c) *they have the same legal representative/agent for purposes of this bid;* ***or***

d) *they have relationship with each other, directly or through common third parties, that puts them in a position to have access to information about or influence on the bid of another Bidder;* ***or***

e) *Bidder participates in more than one bid in this bidding process. Participation by a Bidder in more than one Bid will result in the disqualification of all bids in which the parties are involved. However, this does not limit the inclusion of the components/ sub-assembly/ Assemblies from one bidding manufacturer in more than one bid;* ***or***

f) *In cases of agents quoting in offshore procurements, on behalf of their principal manufacturers, one agent cannot represent two manufacturers or quote on their behalf in a particular tender enquiry. One manufacturer can also authorise only one agent/dealer. There can be only one bid from the following:*

1. *The principal manufacturer directly or through one Indian agent on his behalf; and*
2. *Indian/foreign agent on behalf of only one principal;*

or

3. *A Bidder or any of its affiliates participated as a consultant in the preparation of the design or technical specifications of the contract that is the subject of the Bid;* ***or***
4. *In case of it holding company having more than one independently manufacturing units, or more than one unit having common business ownership/management, only one unit should quote. Similar restrictions would apply to closely related sister companies. Bidders must proactively declare such sister/ common business/ management units in same/ similar line of business.* "

Thanking you,

Yours faithfully,
For and on behalf of BHEL,

(Ashok Kumar Meena)

Sr. DGM /TBSM

TO BE FILLED BY TENDERER OVER THEIR LETTERHEAD

ANNEXURE – X

REF: TBSM/BIKANER-III/EREC-STR/TENDER/24-25 **DATE: 16.01.2025**

SUB: Tender for "ERECTION WORK OF STRUCTURE AND STRINGING AT 765/400/220 KV AIS SWITCHYARD AT POWERGRID, BIKANER-III PROJECT IN BIKANER, RAJASTHAN".

It is certified that General Instructions and Information for tenderer have been read/ complied/ agreed to and each page of tender offer has been initialled and stamped.

Also It is being declares that we (……Bidder Name …….) will not enter into any illegal or undisclosed agreement or understanding, whether formal or informal with other Bidder(s). This applies in particular to prices, specifications, certifications, subsidiary contracts, submission or non-submission of bids or any other actions to restrict competiveness or to introduce cartelization in the bidding process.

In case, the Bidder is found having indulged in above activities, suitable action shall be taken by BHEL as per extant policies/ guidelines

(Signature of Tenderer)

Name and Designation of Authorised person (s)
Signing the tender on behalf of the tenderer

(TO BE FILLED BY TENDERER OVER THEIR LETTERHEAD)

ANNEXURE – Y

REF: TBSM/BIKANER-III/EREC-STR/TENDER/24-25 **DATE: 16.01.2025**

SUB: Tender for "ERECTION WORK OF STRUCTURE AND STRINGING AT 765/400/220 KV AIS SWITCHYARD AT POWERGRID, BIKANER-III PROJECT IN BIKANER, RAJASTHAN".

Subject: Declaration confirming knowledge about Site conditions

I/We, _____ hereby declare and confirm that we have visited the Project Site with reference to above BHEL Tender Specifications and acquired full knowledge and information about the Site conditions including Wage structure, Industrial Climate, the Law & Order and other conditions prevalent at and around the Site. Also, we have acquired information about availability of manpower, construction material, water, electricity etc.

We further confirm that the above information is true and correct and we shall not raise any claim of any nature due to lack of knowledge of Site conditions.

I/We, hereby offer to carry out work as detailed in above mentioned Tender Specification, in accordance with Terms & Conditions thereof.

Site Visited Official Name & Contact Details:

(Signature of Tenderer)

Name and Designation of Authorised person (s)
Signing the tender on behalf of the tenderer

ANNEXURE – Z

Ref:- TBSM/BIKANER-III/EREC-STR/TENDER/24-25 **DATE: 16.01.2025**

SUB: Tender for "ERECTION WORK OF STRUCTURE AND STRINGING AT 765/400/220 KV AIS SWITCHYARD AT POWERGRID, BIKANER-III PROJECT IN BIKANER, RAJASTHAN".

Subject: Authorization of representative who will participate in the Online Reverse Auction Process:

1	NAME & DESIGNATION OF OFFICIAL	
2	POSTAL ADDRESS (COMPLETE)	
3	TELEPHONE NOS. (LAND LINE & MOBILE BOTH)	
4	FAX NO.	
5	E-MAIL ADDRESS	
6	NAME OF PLACE / STATE / COUNTRY, WHEREFROM S/HE WILL PARTICIPATE IN THE REVERSE AUCTION	

BHARAT HEAVY ELECTRICALS LIMITED
TRANSMISSION BUSINESS GROUP, NOIDA
PRE-QUALIFYING REQUIREMENTS

REF.: TBSM/BIKANER-III/EREC-STR/TENDER/24-25 **DATE: 16.01.2025**

SUB: TENDER FOR "ERECTION WORK OF STRUCTURE AND STRINGING AT 765/400/220 KV AIS SWITCHYARD AT POWERGRID, BIKANER-III PROJECT IN BIKANER, RAJASTHAN".

Tenders (Under two-part bid system) are invited from competent contractors for subject works. Only those who are technically and financially capable to execute the Job and who fulfil the Pre-Qualifying Requirements [PQR] given under are eligible to quote against the above NIT. Tenderers should submit their offer as per the procedure specified in tender documents. The PQR of contractor for tender submission shall be is as under:

Sl. No.	Criteria	Description
A	Turn Over	Bidders should have a minimum average annual turnover (Annual Gross Revenue from operations/ Gross operating income as incorporated in the profit & loss account excluding Other Income) of **₹ 2,25,55,016/-** for best three fin. Years i.e. 36 months out of last five financial years **(2019-20, 2020-21, 2021-22, 2022-23 & 2023-24)** and should submit audited balance sheet and Profit & Loss Account Sheet of these years. The audited financial statements must be signed by the owner and the auditor. Auditors seal, Name, Membership No., Firm Registration No. & firm name (if applicable), UDIN and the capacity in which he is signing (Proprietor/Partner), must be mentioned on the Profit & Loss A/c and Balance Sheet. In case of proprietorship and partnership firms where Audited Profit & Loss A/c and Balance Sheet is not mandatory as per extant rules, CA certificate certifying turnover and profit for the required financial years must be submitted. CA certificate must be on his letter head mentioning his/her name, Membership No., Firm Registration No. & firm name (if applicable), UDIN, capacity in which he is signing (Proprietor/Partner), date and place of signing.
B	Profit & Networth	Bidder should have earned profit in at least one financial year during the period of last three Financial Years as per Sl. No. A above and Net worth of the Bidder based on the latest Audited Accounts as furnished for 'A" above should be positive. Net worth = Paid up share capital + Reserves. (Net worth is required to be evaluated in case of companies)
C	Similar Work*	Bidder should have successfully completed "**Erection/ installation of Switchyard/ transmission lines including erection of tower/ beam & stringing work of voltage rating 220kV & above"** during last seven years ending on **31.12.2024** and should be either of the following: i. Three similar jobs costing (except service tax/GST) not less than **₹ 1,05,25,674/-** each. OR ii. Two similar jobs costing (except service tax/GST) not less than **₹ 1,31,57,093/-** each. OR iii. One similar job costing (except service tax/GST) not less than **₹ 2,10,51,348/-**

Note:

1. The Bidder shall submit the Contract Agreement/Work Order/LOI along with BOQ and Performance/completion/execution certificate issued by customer/contractor along with technical bid in support of qualification.
2. Only those work credentials will be considered that already completed and completion certificate available for that work.
3. In order to technically qualify in this tender, bidder should meet all criteria i.e. A, B & C mentioned above.
4. If the job is completed in the last seven years period, as specified above, even if it has been started earlier, the same will also be considered meeting the qualifying requirements.
5. Consortium/ JV bidding is not allowed.
6. BHEL reserves the right to:
   (a) Accept or reject any bid received at its discretion without assigning any reasons whatsoever.
   (b) Postpone the above-mentioned date, split and distribute the work among more than one bidder without assigning any reason whatsoever.
   (c) May ask for further qualification during techno commercial scrutiny of bids received.
   (d) May ask for further proofs including TDS certificates/ Form 26AS/ Final bill/ payment detail for the said job for cross- verification.
7. BHEL shall not be responsible for any delay, loss, damage for bids sent by post.
8. BHEL shall not be liable for any expenses incurred by bidder in preparation of bid irrespective of whether it is accepted or not.
9. Quotations received from bidders who do not fulfil the PQR shall be summarily rejected without any further evaluation and information to bidders.
10. Canvassing i.e. soliciting favour, seeking advantage etc. in any form is strictly prohibited and any bidder found to have engaged in canvassing shall be liable to have his bid rejected summarily.
11. If the bidder deliberately gives any wrong information in his tender to create in circumstances for the acceptance to his bid, BHEL reserves the right to reject such application.
12. Bidder's selection is subject to approval of BHEL's customer for this work. The approval/acceptance of bidders from Customer is mandatory requirement for subject tender.
13. All corrigenda, addenda, amendments and clarifications to this Tender will be hosted in web page, www.bhel.com and https://eprocurebhel.co.in and not in the newspaper. Bidders shall keep themselves updated with all such amendments.

PROJECT INFORMATION

1.0 CUSTOMER:

M/s POWERGRID CORPORATION OF INDIA LIMITED (PGCIL)

2.0 PROJECT LOCATION AND DETAILS:

TENDER FOR "**ERECTION WORK OF STRUCTURE AND STRINGING AT 765/400/220 KV AIS SWITCHYARD AT POWERGRID, BIKANER-III PROJECT IN BIKANER, RAJASTHAN".**

SITE ADDRESS:

POWERGRID BIKANER NEEMRANA TRANSMISSION LIMITED,
765/400/220 kV POWERGRID Sub-Station
Village – Barjoo, Tehsil – Pugal, District – Bikaner, Pin – 334001 (Rajasthan)

Contact person: - Sh. Shiv Kumar- Sr. DGM- 9816686376

3.0 CONTACT PERSON: FOR CONTRACTUAL ISSUES

Ashok Kumar Meena
Sr. DGM (TBSM)
SUBCONTRACTS MANAGEMENT,
TRANSMISSION BUSINESS GROUP,
Plot No. 25, Sector-16A, Noida,
Distt. Gautambudh Nagar, UP-201301

PHONE: 0120-674-8545/ 9831038136
E-mail: **akmeena@bhel.in**

CONTACT PERSON: FOR ENGINEERING ISSUES

SHOBHNA SINGH
DGM (TBEM-Electrical)
TRANSMISSION BUSINESS GROUP,
Plot No. 25, Sector-16A, Noida,
Distt. Gautambudh Nagar, UP-201301

PHONE: 0120- 674- 8514
E-mail: **shobhna@bhel.in**

CONTACT PERSON: FOR CONTRACT EXECUTION ISSUES

Sunil Kumar
AGM & Sector Head/TBNS
TRANSMISSION BUSINESS GROUP,
Plot No. 25, Sector-16A, Noida,
Distt. Gautambudh Nagar, UP-201301
PHONE: 9761724520
E-mail: **sunil.kumar@bhel.in**

HSE CONDITIONS
at a GLANCE (for bidders)

Health Safety and Environment Management

BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS GROUP

Transmission Business Group, Noida

DOCUMENT CONTROL			
Document number:	**TBG/HSE/NIT-01**		
Issue number:	00	Issue date:	08.01.2020
Revision number:	01	Revision date :	22.10.2021
Revision number:	02	Revision date :	31.01.2024

	Prepared by	Approved and Issued for use by
Name	Arvind Kumar Pandey	RS Pathwar
Designation	Sr. Engineer	Dy. General Manager
Signature	-sd-	-sd-
Date	31.01.2024	31.01.2024

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BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS GROUP

BHEL TBG through its long experience and policy, has developed a culture to consider wellbeing of the society, protection of environment and occupational health and safety of its workers first. TBG has also a culture of transparency in all its business activities. In line to this culture, this NIT annexure is prepared as a peeping window in to the TBG HSE requirements which need to be 100% complied by the successful bidders while executing the contract. Interested bidders should go through these HSE conditions:

1. BHEL HSE Policy

2. Legal Compliances:

a. Statutory Provisions: All the sub-contractors are to comply with client specific rules and procedures, the National legislations and codes, in particular the following or their revised versions:

Srl. No	Acts/Rules Name	Srl. No	Acts/Rules Name
1	The Factories Act 1948, Amendment Act 1947	11	Contractor labour Act, 1970 (Regulation and abolition)
2	The Environment Act 1986	12	Provident fund Act, 1952
3	Workmen's Compensation Act, 1923	13	Payment of gratuity Act, 1972
4	Building and Other Construction Workers (Regulation of employment and condition of service) Act, 1996	14	Indian Explosives Act and the explosives Rules 2008
5	Buildings and Other Construction Workers Welfare Act, 1996	15	The Gas Cylinder Rules, 2016, Static and Mobile Pressure Vessels (Unfired) Rules 2016
6	Payment of wages Act, 2017 Equal remuneration Act,	16	The Indian Electricity Act 2003 and Indian Electricity Rules 2005
7	Minimum wages Act.1948	17	The Atomic Energy Act, 2015
8	Employers liability Act, 1938	18	The atomic energy (Radiation Protection) Rules. 2004
9	Industrial dispute Act, 1947	19	National Fire Protection Association (NFPA),
10	maternity benefit amendment act 2017	20	National Building Code of India 2016 etc.

b. Indian Standard (IS) Codes related to HSE

All the sub-contractors are to comply with client specific rules and procedures, the National legislations and codes in particular the following or their revised versions:

Srl	IS Code	Applies on
1	IS: 4081 -1986	Safety code for Blasting and Related Drilling operations
2	IS: 3764 -1992	Safety code for excavation work

3	IS: 5121 -1969	Safety code for pilling and other deep foundations
4	IS: 2750 -1964	Specification for steel scaffoldings
5	IS: 3696 (Part-I)-1987	Safety code for scaffolds and Ladders: Part- I Scaffolds
6	IS: 3696 (Part-II) -1991	Safety code for scaffolds and Ladders: Part –II Ladders
7	IS: 4082 -1977	Recommendations on stacking and storage of construction materials at site (First revision)
8	IS: 4130-1976	Safety code for demolition of building (First revision)
9	IS: 4912-1978	Safety requirements for floor and wall openings, railings and toe boards (First revision)
10	IS: 5916- 1970	Safety code for constructions involving use of hot bituminous materials
11	IS: 7205 -1974	Safety code for erection of structural steel work
12	IS: 7969 -1975	Safety code for handling and storage of building materials
13	IS: 8989 -1978	Safety code for erection of concrete framed structures
14	IS: 7293 -1974	Safety code for working with construction machinery
15	IS: 2212 -1991	Pipe lines –Identification –Colour code
16	IS: 5216 -1982	Recommendations on safety procedures &practices in Electrical works (Part -I &II)
17	IS: 875 -1964	Code of practice for structural safety of buildings and loading standards
18	IS: 10386 -1983	General aspects Part-1 -1983, Part-2 -1982, Part-6 -1983, Part-10 -1983- Amenities, Protective clothing and equipment, construction, storage, handling, detection and Safety measures for gases, chemicals and flammable liquids
19	IS: 10500-2012	Drinking water (Specification)
20	IS: 10291 -1982	Code of dress in civil engineering works
21	IS: 2925-1984	Safety helmets
22	IS: 1179-1967	Welding helmets
23	IS: 7524 -1979 (Part-I)	Safety goggles
24	IS: 9167 -1979	Ear muff /Ear plugs
25	IS: 6994 -1973 (Part-I)	Canvas hand gloves, Cotton hand gloves, Chrome leather gloves
26	IS: 4770 -1991	Rubber hand gloves tested for 15,000 volts
27	IS: 3521 -1999	Full body safety harness
28	IS: 11057 -1984	Specification for Industrial safety nets

29	IS: 13415 -1992	Protective Barriers in & around buildings (Code of safety)
30	IS: 13416 -1992	Preventive measures against Hazards at work places-Recommendations part-I Falling materials hazards Prevention part-I
31	IS: 13416 -1992	Preventive measures against Hazards at work places-Recommendations part-II Fall Prevention
32	IS: 15298 -2011 (Part 1&2)	Personal Protective Equipment -Safety shoes
33	IS: 12254 -1993	Poly vinyl chloride (PVC) industrial boots
34	IS: 5557:2004	Industrial and Protective Rubber knee and Ankle boots
35	IS: 2878 -2004	Co2 Type fire extinguisher
36	IS: 2171 -1999	Dry chemical powder fire extinguisher
37	IS: 13849 – 1993	Fire extinguisher for ABC fires
38	IS: 10204-2001	Mechanical Foam type extinguisher (Foam used shall conform to IS: 4989 -1974 and Co2 cartridge shall conform to IS: 4947 -1985)
39	IS: 3786 -1983	Methods for computation of Frequency rate and Severity rates for Industrial injuries and classification of Industrial accidents (First revision)

c. The Sub-contractors need to

- Attend HSE familiarization program at TBG-HQ with his site management team. This will be a half day long awareness session on HSE requirements and compliances which the agency is supposed to fulfil during contract execution at site. The session shall be taken by TBG HSE department on intimation by TBSM. **(Rev-01)**
- Request for issuance of Form-V in their name from customer on behalf of BHEL
- Get the Labour license registration from concerned Labour office.
- Get the BOCW Registration done along with the labour license.
- Get their labourers registered under BOCW for benefits provided by the office.
- Maintain Seven registers of labours as per BOCW requirement.
- Ensure payment of wages to labours not less than the current minimum wages applicable in the premises.
- Ensure PF deduction of labourers and submission of proof to BHEL office (Wage sheet, ECR & Challan copies) duly signed.
- Submit Labour Payment Certificate by 10th of Every month.
- File timely returns, get renewals done and submit a copy to BHEL office.

- Get Workmen's Compensation policy before the start of work, covering all the labourers and staff,
  - Policy should clearly mention the project name and location,
  - should be as per labour class and wage.
  - Should cover all the height workers with clear mention of Max. height.
  - Policy should be submitted to BHEL office and renewal before expiry.
- Issue employment card to every worker.

3. Labour Welfare and Medical Facilities

a. Labour Welfare

1. Declaration of normal working hours and weekly off day, Payment day & intervals
2. Paid rest days & holidays.
3. Payment of overtime @ twice the normal wage rate.
4. No labour shall be allowed overtime >12 hrs/week, limited to 48 hrs/month.
5. Rest and lunch area.
6. Separate Male/Female Toilets and Lavatories, clearly marked in local Language and provided with signage.
7. Cold and clean drinking water facility suitable to strength and near workplace
8. Creche for children of female workers as per BOCW requirements
9. Arranging labour accommodation in hygienic environment with the facilities of Water (Drinking, Sanitation), washing and bathing area, toilets in sufficient nos., clean and safe camps and surrounding, access road, well illuminated camp and roads, mode of contact, transport facility, first aid centre, 24x7 Security etc.
10. Cooking and eating place to be maintained in hygienic condition
11. General awareness of health and hygiene.

b. Medical facilities and Health centres

- Availability of first aid box at every work location and agency office, with contents as per BOCW requirement.
- Emergency vehicle (four-wheeler) at work place
- Availability of stretchers in emergency vehicle and in office.
- Trained first aider
- Medical check-up for all the supervisors and workers including cooks, at the time of induction and annually thereafter.
- Tetanus Vaccination for all in every six months.
- Identification and tie-up with nearby reputed hospital(s) and display of their contact number in Emergency contact list.

4. House Keeping & Storage

Housekeeping is a continuous process and is the part of work. Agencies shall maintain safe and presentable housekeeping all the time in their respective areas, common work locations and passage areas. Roads, passages, staircases, entrance/exit gates shall always be maintained obstruction free. No material shall be left or stacked at the roof edges. Agency shall make arrangements to remove scraps on regular basis and dispose them at a space provided by customer, clearly fenced and marked by the sub-contractor as **"SCRAP YARD"**. Suitable arrangement like dedicated housekeeping team and tractor/hydra should be identified for this work.

Construction materials like shuttering materials, staging materials, cables, re-bars, cements bags, earthing flats and rods, FF pipes, surplus soil etc should be stored/stacked properly such that it should neither pose threat to safety of man nor should obstruct the free movement of man and machineries.

Every sub-contractor should have separate and well-maintained storage area for his own materials, T&Ps, PPEs and BHEL issued materials. Consumables like diesel, cotton, grease, oil, paint, admixtures and other fire potential materials should be stored separately with suitable firefighting facility.

Fire capacity of store area to be assessed and accordingly fire extinguishers shall be planned suiting the class and capacity of fire. Sand heaps may also be stacked in open store yards suitably to use in case of fires.

5. Site Safety

a. Induction and others safety trainings

Every sub-contractor shall make arrangement to provide induction training as per BHEL and/or customer requirement on a pre-approved and fixed module to all its new inductees irrespective of class or grade of appointment/hire. He shall also arrange the required facilities for induction training such as board, marker, dummy, posters/banners with all the mandatory PPEs.
Sub-contractor shall also arrange for periodic trainings on fire-fighting, first aid, CPR, importance and use of PPEs, electrical safety, hot work safety, Height work safety, confined space, deep excavations and barricading, concreting work safety etc.

b. Appointment of Safety Officer/Supervisor

Every sub-contractor shall appoint full time **safety officer(s)** as per **Schedule VIII** of **BOCW Act-1996**. The safety officer so appointed, shall not be assigned any duty/work other than assisting in fulfilment of legal and contractual obligations at site. He shall perform his duties in line to meet the requirements of TBG HSE MANAGEMENT SYSTEMS, such as ensuring daily TBT, conducting induction and other HSE training and awareness programs, organising HSE campaigns, health check-ups, periodic mock drills, reporting & record keeping and other such compliances as per **HSE Plan for Site Operation (TBG/HSEP-14)** on regular basis. **(Rev-01)**, **(Rev-02)**

c. Safety organisation, Safety committees and meetings

Safety officer shall report directly to the head of the projects of the sub-contractor management. There shall be some appointed or nominated **safety stewards** from each sub-group like shuttering, bar-bending, concreting, brick work, material handling, structure erection, cable laying, pipe work, maintenance, batching plant, housekeeping, etc.

A **safety committee** shall be formed including members from different agencies, BHEL and customer covering at-least 50% participation from workers. Safety committee shall meet on weekly basis or as may be decided by customer, outcomes shall be complied as committed.

d. Personal Protective Equipment.

Unless mentioned otherwise, there will be three mandatory PPEs- Safety shoes, Safety Helmet and Reflective jackets conforming to relevant IS codes as mentioned above. Every person entering in the project premises shall use above mandatory PPEs.
There will be other PPEs too, based on the work requirement like: Twin lanyard full body harness, fall arresters and life lines for height workers, Face shield for welders and grinders, Induction helmets and Electrical resistant shoes with FRP/PVC toe for electricians and commissioning engineers, Gum boots for concrete workers and manual excavators, Goggle for gas cutters and grinders, Aprons for welders, shoulder pads for material handlers, Hand gloves – Leather for binders/welders/grinders, certified Rubber gloves for electricians, PVC for concrete/cement

handlers, cotton-housekeeping team/brick coolies/erectors, cable laying men and other material handlers. Dust mask for cement handlers.

e. Material Handling

BHEL as a policy discourages continuous manual handling. Material handling contributes a major portion in the project and hence proper means (mechanical/ electrical powered) should be deployed appropriately for this work. Cranes/Faranas/hydras should not be used for material transportation for long distances(>100m), if such movement is un-avoidable, it must be accompanied by a trained signal man. Long materials should be guided by tagline. Roads for material movement should be free from obstructions. Lifting appliances must be in good condition and must have test/inspection certificates.
Lifting tackles like- D-shackles, chains, ropes, slings, belts shall be periodically inspected and shall have valid test certificate and/or third-party inspection certificates.
Painted/galvanized structures/materials to be lifted by adequate capacity nylon belts only.
If a machine undergoes a major maintenance, fresh TPI shall be required before use. Hydraulic/pneumatic machines shall be free from leakages. Daily checklist to be filled and witnessed by the concerned supervisor before start of the work.

f. Vehicle/Machinery Documents and other safety requirements

- Crawler mounted boom cranes/Tyre mounted telescopic cranes/tower cranes
  1. Valid third-party inspection certificate.
  2. Valid Insurance policy
  3. Registration Certificate (if applicable)
  4. Valid Pollution under control (PUC) (if applicable)
  5. Fitness certificate from RTO (if applicable)
  6. Operator's valid license, experience and/or competence certificate.
  7. Swing horn
  8. Reverse horn
  9. Boom aviation light
  10. Approved Load chart (inside cabin)
  11. Fire extinguisher (inside cabin)
  12. First aid kit (inside cabin)
  13. Boom angle indicator
  14. Hook Latch
  15. Reflector strips on around cabin and on boom

- Loader backhoe (JCB), crawler excavators (Poclain), Hydra,
  1. Valid third-party inspection certificate.
  2. Valid Insurance policy
  3. Registration Certificate (if applicable)
  4. Valid Pollution under control (PUC) (if applicable)

5. Fitness certificate from RTO (if applicable)
6. Operator's valid commercial license, experience and/or competence certificate.
7. Reverse horn
8. Approved Load chart (inside cabin) (Hydra)
9. Fire extinguisher (inside cabin)
10. First aid kit (inside cabin)
11. Hook Latch (Hydra)
12. Reflector strips on around cabin and on boom

- Tipper, Transit mixtures (TM), Self-loading concrete mixture (Ajax Fiori), Tractors
    1. Valid third-party inspection certificate.
    2. Valid Insurance policy
    3. Registration Certificate
    4. Valid Pollution under control (PUC)
    5. Fitness certificate from RTO
    6. Operator's valid commercial Heavy license, experience and/or competence certificate.
    7. Reverse horn
    8. Fire extinguisher (inside cabin)
    9. First aid kit (inside cabin)
    10. Reflector strips on around cabin and on body

Note: 1. Tractors may be allowed with Light Commercial/non-commercial license on customer's consent.

- Cars, Taxis, scooters, motor cycles and other public carriers
    - Valid 2/4-wheeler license (as applicable- commercial/non-commercial)
    - Registration Challan
    - Valid Insurance
    - Pollution under control

g. Man-lifts (Cherry pickers), Scissors Lifts

1. Trained operator with experience/competence certificate and license
2. Valid third-party inspection certificate.
3. Valid Insurance policy
4. Registration Certificate (if applicable)
5. Valid Pollution under control (PUC) (if applicable)
6. Swing horn
7. Reverse horn
8. Boom aviation light
9. Fire extinguisher (inside cabin)
10. First aid kit (inside cabin)
11. Reflector strips on around cabin and on boom

Note:

1. No one shall ride man-lift bucket without safety belt, safety shoes, helmet and reflective jacket.
2. Not more than 3 persons at a time will board in bucket of man-lift (without any heavy materials) including operator.
3. Operator will not leave the machine while persons are elevated and working.
4. No one other than the authorised operator will operate the man lifts/Scissors lifts.

h. Excavation

Prior permission/clearance from customer is a must for excavations in areas where underground service services such as gas/water/oil/chemical/electrical lines may be routed. Due precautions shall be taken during excavation in such area. Excavations near water bodies (ponds/canals etc.) shall be done with sand/soil bags ready to plug water from accidental damaged/burst of edges. All the excavations shall be done by either step cutting (min. 600mm step at every 1.5m depth) or slope cutting at 1:2(X:Y axis) (or greater depending upon the soil condition). Where step cutting/slope cutting is not possible due to space constraints, shoring/shuttering or sheet piling to be used to check collapse of soil.

Excavated soil shall be stacked away from edge of the pit, at-least 1.5 meters or half of the depth whichever is higher. Height of the stack shall not exceed 2m in height.

Ramps shall be provided for access of the workers in large pits and ladder of metal/good built for small pits. Ladders shall be of sufficient length protruding at least 1m above the ground level.

Pumps of adequate capacity shall be available for pumping out of water. No lone worker shall be allowed to work in any excavation. Overloaded vehicle shall not be allowed near excavated pits.

i. Bar bending and Binding

Bar bending machine shall be installed under shed/roof. It shall be properly earthed and maintained for operation. Housekeeping of the area shall be team's responsibility on daily basis. All be bar benders shall be given hand gloves (leather/cotton) in addition to mandatory PPEs. Scrap shall be segregated and moved to scrap yard on regular basis. Bar bending station shall be located away from Main plying roads/passages. The station shall be well illuminated, shall have a maintained first aid kit and potable water. Station shall be located in such a way that the movement of the material be minimised.

j. Concreting

No electric vibrators shall be allowed to use. All the concrete workers shall be issued gum boots, safety helmets, reflective jackets and PVC hand gloves. Free fall of concrete from chute shall not exceed 1m in height. Heavy machineries/ vehicles shall be kept at least 2m away from the edge. Emergency vehicle shall be available near concreting work. Late night works shall be avoided, if it is unavoidable, a prior permission from BHEL/Customer is mandatory.

k. Welding, Gas Cutting & other hot works

Welding: Only experienced welders should be deployed for welding jobs. Welders shall be provided with apron, hand gloves, arm pads, leg pads, face shield and safety shoes. Welding leads shall be joint less and insulated. Power input point shall be fully covered at machine.

Gas cutting: If LPG is being used, domestic cylinder is strictly prohibited inside the project premises, (not allowed for site kitchen too). Hose pipes shall be in good condition without cracks, cuts, punctures or joints. Ends should be clamped with worm clamps. Dial gauges shall be of good quality and duly calibrated. Flash back arresters is a must for both oxygen/acetylene or LPG/Oxygen combination. Cylinders shall be stored, transported and used in vertical position only. When not in use, they shall be capped. Empty and filled cylinders to be stored separately with distinct marking.
Cylinders shall neither be rolled on the ground nor thrown during loading/unloading.

Grinding: Grinder shall be given clear glass face shield, apron, safety shoes, ear muffs and hand gloves. Grinder machines shall have wheel guard. Plug tops to be used for power connection preferably three wire type. Only trained persons shall be allowed to use grinders, abrasive cutters. Electrical connection shall be free from cuts, joints etc.

l. Erection & Height Work

Only trained filters and experienced helpers shall be engaged in erection work. Step bolts of lattice towers shall be checked for full tightness with spring washers before use. Height pass shall be issued to the identified group of erectors who have passed medical test and have working experience at height. Name of such workers shall be displayed at appropriate place. These workers only shall be allowed to work at height. Height work shall not be permitted in high wind/bad weather condition, during raining or in night/dark.

m. Electrical Safety

BHEL usually provided single point power source and sub-contractors draw power from there. Otherwise agencies make their own arrangement for construction power like DG sets etc. Sub-contractors shall submit their load requirement (amperage & phase) to BHEL before start of work. Accordingly, they shall make arrangements to draw power and distribution arrangements too in a safe way. MCCBs and HRC fuses to be put in circuit for short circuit and overload protections and RCCBs of 30mA sensitivity to be put at each distribution panel for human safety. Earthing pits shall be installed at each distribution point and maintained below three Ohm resistivity which shall be inspected randomly. The distribution points shall be clean, free from vegetation and water logging, easily accessible and covered/protected from three sides and top for rain. Earthing of DBs shall be done by 25x3mm GI flats connected from proper earth pits. Insulation mat, PVC Sheet/Wooden plank to be placed before DBs as platform. DB Sheds shall be legibly marked with name of agency, contact no of electrician and SLD of that DB. Only industrial plugs and sockets shall be allowed. Three wire (Phase, neutral and earth) system shall be used for tools, lights and machineries and two wire power draws shall be strictly prohibited. PTW and LOTO system shall be maintained to work on LT system. Name and contact no of authorised electricians who will be responsible of electrical power facility maintenance shall be submitted to BHEL by Agencies. Unauthorised sharing of power from one agency to other is strictly prohibited. Electricians shall use standard PPEs and insulated

tools only. Standard and tested/certified discharge rods to be used in the areas where there is a possibility of residual current or induction charge. The induction rod to be connected to the earth first and removed in the last. Induction helmets only to be used in the charged area. Electricians to be provided with electrical resistant safety shoes having FRP/PVC toe.

n. Dust Gases and fumes

Sub-contractor shall make arrangements to avoid accumulation of dust fumes and gases. Cement handlers inside store or at batching plant and gravel spreader shall be given effective nose masks and jaggery (at least 200g per person per day). DG sets and other machineries like cranes excavators etc. shall have valid and effective PUC certificate and shall have maintained engine with silencer. No IC engine operated machine shall be used in confined and covered area like hall, sheds, store etc. where accumulation due to lack of ventilation can increase to harmful levels. Dedicated arrangements (tanker or tractor with sprinkler) shall be made by the sub-contractors (individual or jointly) to continuously subside the dusts arising out of the movement of the vehicle's roads/passages. Welding activities near roof accumulates harmful gases. Welders in such positions shall be provided with effective masks conforming to IS standards.

o. Vehicular Traffic

Speed limits defined within the premises shall strictly be followed by the drivers/commuters of construction as well as other vehicles.
Every construction machinery, man-lift shall display the name, contact no and passport size photograph of the authorised operator (There can be one or more authorised operators).
No one other than operator and co-operator shall sit inside the cabin of any construction machine while it is working.
Construction machineries (tractor, trucks, tippers, JCBs, hydra, Fassi cranes etc. shall never be used as mode of public transport. Machineries like Ajax Fiori and hydra shall not be driven in back direction except for small distances. No overloaded vehicle shall be permitted entry in the project premises.
Over speeding shall be reported and driver/operator shall be barred from entry or shall be penalised.
Drunken drivers shall be barred from entry in the project.
Carrying harmful weapons like knives (>6"), guns etc. shall permanently disqualify the person from entry in project premises.

p. Barricading and floor openings

Every pit deeper than 4 feet (1.2m) shall be barricaded immediately after excavation and will remain barricaded till backfilling.

Pits/trenches drains near roads, passages whether temporary or permanent shall be hard barricaded and well illuminated. Roof edges and openings shall be strictly hard barricaded and illuminated. Height works like masonry works, structure erection, erection by cranes, Lattice tower/beam erection areas shall be barricaded to restrict entry. Areas under charging/commissioning shall be barricaded and caution boards shall be displayed on newly charged areas.

q. Scaffold & Ladder

No bamboo/wooden scaffold shall be allowed to be used. Only tubular steel scaffolds with couplers conforming to the relevant IS codes shall be allowed with base plates. Standard steel or wooden planks to be used as platforms and no packing materials shall be used. All the platforms shall be built with provisions of **top rail at 1m height, mid rail at 0.5m height and toe boards of min 6" height** at floor level. Minimum width of platform shall be 900mm and if wheel barrow is to be used then 1200mm. Means of access to be provided in the form of ladders, ramps or staircase. Multilevel work platforms or those platforms having passage underneath shall be provided with safety net, screen or canopy at each level for protection from falling objects. Platforms shall be free from concrete, debris or other materials. Platforms shall not extend out of the putlogs and shall be secured and fastened. Decking shall be made non-skidding.
Scaffolds under erection shall be tagged **"RED"**, under repair/maintenance/inspection shall be tagged **"YELLOW"** and ready for use shall be tagged **"GREEN"**

Only metal ladders in the construction site and FRP ladders in charged areas shall be allowed. Ladders made from packing materials shall not be used. Ladders shall be securely fixed at bottom, top and long ladders at middle points too at an interval not more than 2400mm and must have a landing at every 6m. Inclination angle should be approximately 1:4 (X:Y) or 75deg. Ladder must extend at least 1m above the platform/access area. Gap between two rungs shall not exceed 300mm. Portable ladder should not be more than 4m in length. Minimum width of the ladder shall not be less than 300mm.

Use of Mobile aluminium scaffold is preferably advisable for erection of transformers/reactors.

r. Illumination

The sub-contractor shall ensure that the areas such as work stations, buildings, batching plants, passages/roads, stores, rest areas, power sources, staircases etc. are illuminated sufficiently to make safe work conditions at site and shall not be less than the relevant IS standards. Excavations/ below ground level structures near passages/roads shall also be sufficiently illuminated.

s. Safety banners/posters, caution boards

Sub-contractors shall display boards and banners in sufficient quantity having safety signs, slogans, important messages, pictures, cautions at prominent locations to promote safety and spread awareness for important precautions such as "Deep Excavation Ahead", Speed Limit", "Charged Area", "Do not operate", "Hard hat area", "No smoking Zone" etc. Boards containing messages of Emergency contacts, First aid facility, rates of minimum wages, working hours, rest day etc. should be displayed at specific areas.

t. Waste management and disposal

Sub-contractor shall make suitable and effective arrangement to remove waste material from site on regular basis and store them in an identified and safe location. Disposal of wastes shall also be done as per manufacturer's instructions or as per the guidelines laid by legal authorities. Re-bars, Cement bags, packing material (wooden/metal/plastic/paper), paint, oil, grease, cables (armour, sheathing, insulation),

civil debris, metal chips, GI sheet scraps, batteries etc. are the common waste materials. Sub-contractor shall arrange disposal of the hazardous wastes/materials in conformance to the legal and contractual requirements only.

u. Inspection of PPEs, T&Ps, Machineries and lifting appliances

All the PPEs, T&P and lifting appliances purchased newly by sub-contractors shall have test certificates which shall be submitted to BHEL office periodically or on demand. There shall be at least monthly joint inspection schedule for inspection of healthiness of all the PPEs, T&Ps and lifting appliances. All the lifting appliances shall be tested and examined by a competent person before taking into use for the first time or after it has undergone any alterations or repairs liable to affect its strength or stability

and also once at least in every twelve months. To confirm quality of the PPEs as per the relevant IS codes, BHEL may ask sub-contractors to get any or all types of PPEs tested through NABL approved lab as per relevant IS codes. At any stage, the 100% cost of such tests shall be in the scope of respective sub-contractors.

v. Cable Laying

Sub-contractor shall ensure cable trenches free from water, mud, debris, snakes, Scorpios, lizards before start of the work in trenches. Cable drum rollers shall be used to pull cables out of drums to avoid twisting of cables. Hand gloves, Safety shoes/gum boots, reflective jackets, safety helmets shall be provided to the workers. Cable laying area shall be well illuminated.

w. Fire Protection

Every sub-contractor has to maintain their working area, store and office area free from bushes. Stacking of flammable materials like wood, paper, plastic, paint, oil, grease, fuel, cotton, gases etc. at isolated place disconnected from other storage and office areas. Adequate arrangements of firefighting means like suitable extinguishers, fire/water buckets, water tanks, sand dunes etc. shall be made by the agency depending upon the fire capacity assessed or as per MSDS. Fire drills and trainings on how to operate fire extinguishers and how to react in case of fire breakouts shall be the part of regular training program. Guards and store persons must be a regular participant of such training programs. A list of trained firefighting persons and periodicity of such training programs shall be submitted to BHEL by every agency and same to be adhered. Sufficient number of fire extinguishers with suitable class shall be placed at such locations where there can be fire hazard like stores, pantry, office, DG set, electrical distribution panels etc.

x. Fencing of exposed rotating parts

Exposed rotating parts poses great threat to the person in vicinity. Such parts need to be fenced/covered. Guards are mandatory of grinders, abrasive cutters. Flywheels of the engines of heavy machines, Diesel engines, DG sets need to be covered. Electric winch machines, pulleys, chains, shafts, exhaust fans at reachable height, table fans, need to be caged/fenced. Such fencing/guard shall not be removed while machinery is in operation.

y. Emergency preparedness response plan and periodic mock drills.

Sub-contractor shall comply JSA (Job Safety Analysis) and arrange to mitigate the effects of identified possible hazards. He shall also define following in response to emergency preparedness:
An emergency assembly point and put a board of the same with information to all in induction training.
Have facility of ambulance or tie-up with nearest hospital for service in minimum possible time (Max-30min) if there is not ambulance inside the premises.
Ensure availability of emergency vehicle with driver all the time at site during work.
Conduct mock-drills on possible risks like electrocution, fall from height, fire, heat stroke etc., record responses and take photographs to submit in BHEL office. Stretchers availability in emergency vehicle or at work place should be well accessible. Provide fire extinguishers of right type at right place in right quantity with information to all. Display emergency contact nos. to various risk locations and at office, service building or at major work locations. Provide first aid training by doctors for and display names of such trained first aiders and fire fighters. Rescue kit with trained staff or man lift or both to rescue a man hanging by safety belt at height. Provide running water tap near chemical storage and handling points. Agencies shall follow emergency response plan prepared by BHEL in each area of work, store and office.

z. Safety reports & Reporting of accidents

BHEL will provide ''formats and checklists'' for the purpose of records/documents pertaining to the compliance of aforesaid clauses. Agencies shall be responsible for strict adherence and compliance for timely generation and fill-up of the checklists and reports. These shall be submitted on weekly and monthly basis as specified in the formats.

Agency shall also promote such an environment that the near misses, incidents and accidents are reported by every person, whosoever witnesses them. These shall help in analysing the trend and taking measures in reducing/stopping the accidents/incidents. Initial reporting can be in any form-by call, SMS, WhatsApp, e-mail, letter etc.
Major and fatal accidents or high potential incidents shall be investigated for route cause and outcomes shall be immediately implemented to check recurrences.

6. General conditions and penalty clauses

Following are the general conditions:

PPEs shall not only bear the ISI mark but also be conforming to the required standards, 100% compliance of the PPEs is mandatory.
Over speeding of vehicles shall attract penalty/notice and recurrence will attract debarring from entry into project premises.
Hiding of facts like incidents, accidents, fake/forged reports/certificates shall also attract penalty/ notice or both. Only approved third party agencies shall be allowed to inspect the machines, T&Ps. Reports shall directly be sent to BHEL/customers by the third parties.

Insurance and TPIs to be renewed before expiry. Machines, T&Ps shall not be allowed to work if renewal delayed. Continuity of WC policy to be maintained religiously by the respective agencies.

Agency shall submit the status report of his labour license, BOCW registration, WC Policy, insurance & TPI validity on monthly basis with list of machineries and T&Ps

Sub-contractors shall also maintain a buffer stock of all the PPEs in at least 20% excess to the present strength of the work force.

If construction power is not drawn as per the guidelines laid in clause no. 5(m), given above, BHEL may take-up this work at the risk and cost of the agency and/or may withhold a sum of min. Rs. 50,000/- (Rs. Fifty Thousand) or more as the site in-charge deems fit till the system is aligned as per aforesaid requirement.

Agencies shall be responsible for the compliance of the above requirements. Failure in one or more clauses/area shall attract a notice or monitory penalty or a combination of above.

Monitory penalty will be

- Rs. 1000/- per person/incident per day for non-conformity in above areas.
- A Major/severe accident shall attract a penalty of Rs. 2,00,000/- per head
- Fatality or permanent disability with total loss of earning capacity, if any, will attract a penalty of Rs. 5,00,000/- (Rs. Five Lakh).
- Further fatality/permanent disability shall attract double the last penalty imposed on the agency.
- Above penalties are exclusive of medical expenses of the victim or compensation to the family through insurance policy (WC Policy or group insurance).
- **Penalties imposed by customer shall be fully transferable to the sub-contractor. In the event of above cases, penalties shall be imposed whichever will be higher.**
- Evaluation of agency's performance on HSE compliance shall be done as per BHEL guide lines/system.

Revision History

Revision Date	Revision No.	Old Text	New Text	Reason	Revised by (with sign)
03.05.2019	00	N/A	Full Document	New Release	
12.10.2021	01	Nil	Attend HSE familiarization program at TBG-HQ with his site management team. This will be a half day long awareness session on HSE requirements and compliances which the agency is supposed to fulfil during contract execution at site. The session shall be taken by TBG HSE department on intimation by TBSM. (at page no. 5)	For better understanding of HSE requirements to agency. (HSE Review meeting dated 23.08.2021)	
12.10.2021	01	Edition	Inclusion of penalty provisions in case of non-deployment of safety person(page-8)	Introduction of HSEP-14	
17.01.2024	02	Edition	Appointment and duties of qualified safety officer (Page-8)	As per BOCW 1996	

-:End of Document:-

BHARAT HEAVY ELECTRICALS LIMITED

TRANSMISSION BUSINESS GROUP,

NEW DELHI

CONDITIONS OF CONTRACT

FOR

ERECTION WORKS

DOC. NO. – TB-ETC-GCC,REV.-02
20th JUNE, 2005

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SECTION- A

GENERAL INSTRUCTIONS TO TENDERERS

SECTION - A

GENERAL INSTRUCTIONS AND INFORMATION FOR TENDERER

A.1.0 : PROCEDURE FOR SUBMISSION OF SEALED TENDERS

Please refer Annexure to the Conditions of Contract for Erection work attached with the tender documents

PART - II (PRICE - BID) COVER - II:

Rate/Price Schedule only shall be given in this part - II "Price Bid".

A.2.0 : PROCEDURE FOR EVALUATION OF PRICE BID

Please Refer "ANNEXURE TO CONDITIONS OF CONTRACT FOR ETC WORKS" attached with the tender document

A.3.0

Please Refer "ANNEXURE TO CONDITIONS OF CONTRACT FOR ETC WORKS" attached with the tender document

A.4.0

A.5.0

A.6.0

A.7.0

A.8.0

A.9.0

A.10.0

A.11.0

A.12.0

A.12.1

A.12.2 Please Refer "ANNEXURE TO CONDITIONS OF CONTRACT FOR ETC WORKS" attached with the tender document

A.12.3 Three years financial turn over (certified), present commitments with all orders in hand, value of total order, value completed, and balance with completion dates as per Annexure-A.

A.12.4 **ORGANISATION CHART & MANPOWER DEPLOYMENT**:

The organisation pattern and the manpower that are totally available with him & that will be deployed by the tenderer for this work in the form of month wise and category wise deployment plan duly indicating the number of Engineers, Supervisors, Skilled and Unskilled Workers etc. as per proforma at Annexure-B shall be submitted.

A.12.5 A list of machines, tools and plant that the tenderer is having and those that will be deployed on this job giving proof of ownership or any tie-up of equipment as per proforma enclosed at Annexure-C.

A.12.6 Analysis of unit rate quoted as per proforma enclosed at Annexure-D.

A.12.7 Declaration sheet as per proforma enclosed at Annexure-E.

A.12.8 Checklist as per proforma enclosed at Annexure-F.

A.12.9 Certificate from schedule Bank to prove his financial capacity to undertake the work or solvency certificate from the concerned Government Authority.

A.12.10 A certificate of Income Tax/Sales Tax verification from the appropriate authority in the forms prescribed duly indicating annual turnover. These certificates shall be valid for one year from the date of issue or for the period prescribed therein for all tenders submitted during the period.

A.12.11 In addition to the above, the particulars required elsewhere in the tender documents.

A.12.12 NOTE: In terms of clauses A.12.1 to A.12.11 above, all the data required to be enclosed with the tender need to be furnished neatly typed, signed & stamped in the given formats only (in the form of separate sheets) failing which the tender may be considered as incomplete and is liable for rejection. Documentary proof wherever necessary also need to be enclosed.

A.13.0 EARNEST MONEY DEPOSIT

A.13.1 Please refer " Annexure to conditions of contract for ETC Work" attached with the tender documents.

A.13.2

A.13.3

A.13.4

A.13.5 Please refer " Annexure to conditions of contract for ETC Work" attached with the tender documents.

A.13.6

A.13.7

A.13.8

Above clause No. A.13.0 stands deleted. Please refer Annexure to conditions of contract for ETC works.

A.14.0 **AUTHORISATION AND ATTESTATION:**

A.14.1 Tenders shall be signed by persons duly authorised / empowered to do so. Certified copies of such authority and relevant documents shall be submitted along with the tenders.

A.15.0 **VALIDITY OF OFFER:**

A.15.1 THE OFFER SHALL BE KEPT OPEN FOR ACCEPTANCE FOR A MINIMUM PERIOD OF FOUR MONTHS FROM THE DATE OF OPENING OF TENDERS. In case the BHEL calls for negotiations, such negotiations shall not amount to cancellation or withdrawal of the original offer which shall be binding on the tenderer.

A.16.0 **EXECUTION OF CONTRACT :**

A.16.1 The successful tenderer's responsibility under this contract commences from the date of issue of the Letter of Intent by BHEL. The successful tenderer shall be required to execute an agreement in the prescribed form as per Annexure-H with BHEL within a reasonable time after the acceptance of his tender and in any case before submitting the first bill for payment. The expenses for completion, stamping and registration of the agreement with prescribed authority if necessary, shall be borne by the contractor.

A.17.0 **SECURITY DEPOSIT:**

A.17.1 Please refer " Annexure to conditions of contract for ETC Work" attached with the tender documents.

e)

f)

Please refer " Annexure to conditions of contract for ETC Work" attached with the tender documents.

g)

h)

i)

j)

k)

l)

Note

A.17.2

Please refer " Annexure to conditions of contract for ETC Work" attached with the tender documents.

A.17.3

A.17.4

A.17.5

A.17.6

A.17.7

Above clause No. A.17.0 stands deleted. Please refer Annexure to conditions of contract for ETC works.

.

A.19.0 **REJECTION OF TENDER & OTHER CONDITIONS:**

A.19.1 Please Refer "ANNEXURE TO CONDITIONS OF CONTRACT FOR ETC WORKS" attached with the tender document

A.19.2

A.19.3

A.19.4

A.19.5

A.19.6

A.19.7

Please Refer "ANNEXURE TO CONDITIONS OF CONTRACT FOR ETC WORKS"
attached with the tender document

A.19.8

A.19.9

A.19.10

A.19.11

A.19.12

A.19.13 The tenderers must go through Annexure 'Q' of Section-B which details out the List of Tools, Tackles & Calibrated Test Equipments to be arranged by ETC contractor together with special purpose instruments which can be provided by BHEL free of cost for execution of work provided the same is informed to BHEL on award of contract.

Also, Annexure 'Q' gives the details of specialised Services which can be provided by BHEL for system commissioning on NO CHARGE basis with advance intimation to 'ENGINEER' in this regard. The tenderer must also see Clause E.4.2 & E.6.3 of Section E for more details.

A.19.14 IT WOULD BE PREFERRED THAT YOUR OFFER IS WITHOUT ANY DEVIATION w.r.t. TENDER SPECIFICATIONS AND THE SAME MAY BE CLEARLY MENTIONED ON THE COVERING LETTER ACCOMPANYING THE TECHNICAL BID. Offers with deviations are likely to be rejected. However if the bidder insists on any technical or commercial deviations, from the specification and/or tender conditions, the price implication if any, of withdrawing the deviations must be submitted along with the price bid in a separate sealed envelope superscribed "Price Implication for withdrawal of deviations". No price implication for withdrawal of deviation shall be accepted at a later date, after the opening of technical bid.

ANNEXURE - A

DETAILS OF WORK EXECUTED / BEING EXECUTED

A) WORK EXECUTED

SL. NO.	FINANCIAL YEAR	CUSTOMER	DESCRIPTION OF WORK	TOTAL ORDER VALUE	REMARKS

B) WORK BEING EXECUTED

SL. NO.	CUSTOMER	DESCRIPTION OF WORK	TOTAL VALUE	VALUE OF THE PORTION COMPLETED	ACTUAL START DATE	EXPECTED COMPLE-TION DATE	REMARKS

(SIGNATURE OF TENDERER)
WITH STAMP

ANNEXURE - B

(A) PROPOSED MANPOWER (ENGINEERS / SUPERVISORS) RESOURCES FOR EXECUTION OF WORK

SL. NO.	NAME OF STAFF	QUALIFICATION	EXPERIENCE IN YEARS	REMARKS

(B) MONTH WISE MANPOWER DEPLOYMENT PLAN

SL. NO.	CATEGORY	INDICATE NO. OF PERSONS TO BE DEPLOYED IN EACH MONTH								
		1st	2nd	3rd	4th	5th	6th	7th	8th	AND SO ON

(C) Total Man-days planned to be deployed for the work : .....Man-days

Plus man-days for unskilled labour as per site requirement.

(SIGNATURE OF TENDERER)
WITH STAMP

ANNEXURE - C

(A) STATUS OF TOOLS, PLANTS & INSTRUMENTS

Sl. No.	Name of Eqpt.	Quantity owned	Registration No. wherever applicable	Documents enclosed for proof of Ownership/Tie-up	Present Location	Quantity proposed to be deployed for this job

(B) MONTH WISE TOOLS, PLANTS & INSTRUMENTS DEPLOYMENT PLAN

Sl. No.	Description of Tools, Plants and Instruments	(Indicate No. to be deployed in each month)							
		1st	2nd	3rd	4th	5th	6th	7th	and so on

(SIGNATURE OF TENDERER)
WITH STAMP

ANNEXURE - D

ANALYSIS OF UNIT RATE

Sl. No.	DESCRIPTION	PERCENTAGE OF THE UNIT RATE	REMARKS
01	Salary & Wages for staff & workers		
02	Materials (a) .....) (b) .....) (c) .....) (d) .....)		
03	Depreciation & maintenance for T & P		
04	Depreciation & maintenance for other items		
05	Establishment & Admn. expenses of site		
06	Overheads		
07	Profit		

(SIGNATURE OF TENDERER)
WITH STAMP

ANNEXURE -E

DECLARATION SHEET

I ..... hereby certify that all the information and data furnished by me with regard to this Tender Specification No. ..... are true and complete to the best of my knowledge. I have gone through the specification, conditions and stipulations in detail and agree to comply with the requirements and intent of specifications.

(SIGNATURE OF TENDERER)
WITH STAMP

ANNEXURE - F

CHECKLIST & SCHEDULE OF GENERAL PARTICULARS

NOTE: Tenderers are requested to fill in the following details and no column should be left blank.

1.	Name & Address of the Tenderer	:	
2.	Telegraphic/telex address		:
3.	Phone/Fax No. (Office)	:	
4.	Name & designation of the official of the tenderer to whom all the references shall be made	:	
5.	Tenderer's Proposal No. & date	:	
6.	Whether EMD submitted (by cash/ Bank Guarantee/Bank Draft)	:	By.....
7.	Validity of offer/rates quoted for six months from the date of opening of tender	:	Yes/No
8.	Attested copy of power of attorney as per Clause-A.12.1	:	Yes/No
9.	Solvency Certificate submitted as per Clause-A.12.9	:	Yes/No
10.	Income Tax/Sales Tax Certificate submitted as per Clause-A.12.10	:	Yes/No
11.	Details of work executed/being executed as per Annexure-A	:	Yes/No
12.	Monthwise & Category wise manpower deployment plan as per Annexure-B	:	Yes/No
13.	Status of Tools, Plants and Instruments & their month wise deployment plan as per Annexure-C	:	Yes/No
14.	Analysis of unit rate quoted as per Annexure-D	:	Yes/No
15.	Declaration sheet as per Annexure-E	:	Yes/No
16.	Request for registration (for new tenderers) submitted	:	Yes/No

Date .....

(SIGNATURE OF TENDERER)
WITH STAMP

WITNESS : (Signature with full particulars)

1.
2.

ANNEXURE - H

C O N T R A C T A G R E E M E N T

CONTRACT NO. :
LETTER OF INTENT NO. :
WORK ORDER NO. :

1. The Contract Agreement entered into the day of ....., 20... (..... day of .....two thousand and……. ....) at New Delhi between M/S BHARAT HEAVY ELECTRICALS LIMITED, TRANSMISSION BUSINESS GROUP, New Delhi, having it's Registered Office at BHEL House, Siri Fort, New Delhi - 110 049 (hereinafter called the FIRST PARTY which expression shall include their executors, administrators, successors and permitted assigns)

   AND

   M/S ..... (hereinafter called the SECOND PARTY which expression shall include their executors, administrators, successors and permitted assigns).

2. And whereas the FIRST PARTY called for the offer for the work of..... as per approved specifications, drawings and quality plan at ..... as per Tender Specification No..... , dated .....

3. Whereas the SECOND PARTY submitted their offer No. ..... dated ..... against above.

4. Whereas the FIRST PARTY has accepted the offer referred to above & issued Letter of Intent No....., dt..... and also detailed Work Order No…….. dt .....

5. Whereas the SECOND PARTY has agreed to work as Sub-Contractor of the FIRST PARTY on the conditions specified in the Tender Specifications at a contract price of Rs...……..(Rupees.....)

6. Now, therefore it is hereby mutually agreed to by and between the parties hereto as under :

   a) The SECOND PARTY shall execute the works of ..... at ..... on the conditions specified in Tender Specifications of FIRST PARTY and Letter of Intent referred to herein before at a total contract price of Rs..... ……(Rupees .....)

   b) That the SECOND PARTY shall organise all activities and mobilisation of facilities so that the work specified herein before is completed by .....as per the time bound programme mentioned in the Tender Specifications.

c) That all disputes arising out of or relating to this agreement shall be referred to the sole Arbitrator as per arbitration clause mentioned in the Tender Specifications. The Arbitrator from time to time with the consent of the parties enlarge the time for making and publishing award without reference to the court for the purpose.

d) That the jurisdiction in all suits or claims arising out of this agreement shall be of New Delhi Courts only.

e) The Following documents shall form part of this agreement :-

i)
ii)
iii)
iv)
v)
vi)

7. Deviation Limit : The contract value is subject to deviations depending upon the actual requirement within plus or minus 30%. Quantities of individual items may vary to any extent or may get deleted.

8. Terms of Payment : The terms of payment applicable to this contract shall be those covered under Point No.... of Work Order dt. ..... and as per Tender Specifications.

9. Abandoning the work : In the event of the SECOND PARTY abandoning the work, FIRST PARTY reserves the right to get the unfinished work done at the risk and cost of the SECOND PARTY.

10. All other terms and conditions shall be as stipulated in the Tender Documents.

11. This contract agreement consists.... pages.

IT WITNESS WHEREOF, the parties have signed this agreement on the date, month and year first above written in presence of:

For and on Behalf of
(FIRST PARTY)

WITNESS (WITH ADDRESS)

For and on Behalf of
(SECOND PARTY)

1.
2.

ANNEXURE - I

MODEL FORM OF BANK GUARANTEE (FOR SECURITY DEPOSIT)

1.

Please Refer "ANNEXURE TO CONDITIONS OF CONTRACT FOR ETC WORKS" attached with the tender document

2.

b)

c)

5.

Please Refer "ANNEXURE TO CONDITIONS OF CONTRACT FOR ETC WORKS" attached with the tender document

6.

7.

NOTE

ANNEXURE - J

PROFORMA FOR PERFORMANCE GUARANTEE
(to be used in appropriate value non - judicial stamp paper)

1. This deed of guarantee made this ..... day of ..... 20… by ..... Bank Limited ..... in favour of Bharat Heavy Electricals Limited, having their registered office at BHEL House, Siri Fort, New Delhi - 110 049.

2. Whereas M/s ..... (hereinafter called the CONTRACTOR / SELLER have entered into a Contract bearing No. ..... dated..... (hereinafter called the CONTRACT) for supply / civil works /erection, testing and commissioning of M/s Bharat Heavy Electricals Limited (hereinafter called the COMPANY).

3. And whereas the said CONTRACT Inter - alia provides that the CONTRACTOR / SELLER shall pay to the COMPANY a sum of Rs. ..... only towards Performance Guarantee in the form and manner therein specified.

4. And whereas the SELLER / CONTRACTOR have approached ..... Bank Limited (hereinafter referred to as the GUARANTOR) and at their request and in consideration of the arrangement arrived at between the CONTRACTOR and the GUARANTOR, the GUARANTOR has agreed to give the Guarantee as hereinafter mentioned in favour of the COMPANY.

NOW THIS DEED WITNESSES AS FOLLOWS:

5. The GUARANTOR by the hand of Mr. ..... and its lawfully and fully constituted attorney and do hereby guarantee the due and faithful performance of the said CONTRACT and do hereby irrevocably undertake and promise to pay the COMPANY without any demur merely on demand made by them a sum not exceeding Rs. ..... only in case the COMPANY sustains any loss or damage by reason of any breach, default by the CONTRACTOR / SELLER of any of the terms, conditions, stipulations or undertakings or any one of them contained in the said CONTRACT and the tender documents attached hereto and for payment of any moneys payable by the CONTRACTOR / SELLER to the COMPANY under the terms and conditions of the said CONTRACT. The decision of the COMPANY regarding the breach, default, loss, damage and payment shall be conclusive and binding in the GUARANTOR, irrespective of the fact whether the CONTRACTOR / SELLER admits or denies such claims or questions its correctness in any court, tribunal or arbitration proceedings or before any other authority.

6. The COMPANY shall have the fullest liberty without effecting in any way the liability of the GUARANTOR under this guarantee, from time to time to vary any of the terms and conditions of the CONTRACT or extend time by the SELLER / CONTRACTOR or to postpone for any time and from time to time any of the powers exercisable by its against the SELLER / CONTRACTOR and either to enforce or forbear from enforcing any of terms and conditions governing the CONTRACT or securities available to the COMPANY and the GUARANTOR shall not be released from its liability under these presents by any exercise by the COMPANY of the liberty with reference to the matters aforesaid or by reason of time being given to the SELLER or any other forbearance, act or omission on the part of the COMPANY or any indulgence by the COMPANY to the SELLER / CONTRACTOR or of any other matter or thing whatsoever which under the law relating to sureties, would but for this provision have the effect of so releasing the GUARANTOR / CONTRACTOR from its liability under this Guarantee.

7. This Guarantee shall remain in full force and effect and the GUARANTOR shall be liable under the same irrespective of any concession or time being granted by the COMPANY to the CONTRACTOR in or for fulfilling the said CONTRACT and this Guarantee shall remain in full force irrespective of any change in terms and conditions, stipulations or any variations in the terms of CONTRACT irrespective of whether notice of such change and / or variation is given to the GUARANTOR or not and the claim to receive such notice of any change and or variation of the terms / or conditions of the CONTRACT is hereby specially waived by the GUARANTOR.

8. The GUARANTEE herein contained shall not be determined, prejudiced or effected by the liquidation or winding up or insolvency of or change in the constitution of the CONTRACTOR but shall in all respects and for all purposes be binding and operative until all payments or all moneys due or that may hereafter become payable to the COMPANY are paid in respect of any liability or obligation of the CONTRACTOR under the CONTRACT.

b) The GUARANTOR further agree that the Guarantee herein contained shall remain in full force and effect during the period that would be taken for the commencement of the CONTRACT till end of the CONTRACT and its claim satisfied or discharged and till the COMPANY certified that the terms and conditions of the CONTRACT have been fully and properly carried out by the SELLER and accordingly discharges this guarantee, subject, however, that the COMPANY shall have no claim under this Guarantee after ..... months from the date of completion of the Guarantee has been served on the GUARANTOR before the expiry of the said period in which case the same shall be enforceable against GUARANTOR not withstanding the fact that the same is enforced after expiry of said period.

The GUARANTOR undertake not to revoke this Guarantee during the period it is in force except with the previous consent of the COMPANY in writing and agree that any liquidation or winding up or insolvency or dissolution or any change in the constitution of the SELLER or the GUARANTOR shall not discharge the GUARANTOR's liability here under.

It shall not be necessary for the COMPANY to proceed against the SELLER before proceeding against the GUARANTOR and the Guarantee herein contained shall be enforceable against them not withstanding any security which the company may have obtained or obtained from the SELLER shall at the time when proceedings are taken against the GUARANTOR here under be outstanding or unrealized.

The GUARANTOR hereby declares that it has power to execute this Guarantee and the executant has full powers to do so on its behalf under the proper authorities granted to him / them by of the guarantor.

10. Not withstanding anything herein before contained, our liability under this Guarantee is restricted to Rs. ..... (Rupees .... only) and will expire on ..... and unless a claim in writing is presented to us or an action or suit to enforce the claim is filed against us, within six months from the date, all our rights shall be forfeited and we shall be relieved and discharged from all our liabilities thereunder.

IN WITNESS whereof the ..... (Bank) have hereunto set and subscribed their hands the day, month and year first above written.

SIGNED FOR AND ON BEHALF OF THE BANK

WITNESS:

NAME AND ADDRESS **SIGNATURE**

1.

2.

ANNEXURE - K

REVISED PRICE OFFER IN LIEU OF WITHDRAWAL OF DEVIATIONS/ CLARIFICATIONS OFFERED BY BHEL DURING TECHNICAL DISCUSSION

Sl. No.	Clause Ref.	Description of Deviation/ Clarification	Whether Increase/ Decrease in Price	Unit Rate (if applicable)	Total Increase/ Decrease	Remarks

NOTE: Total increase or decrease in total price shall be indicated either in percentage or in value (Rs.).

(SIGNATURE OF TENDERER)
WITH STAMP

ANNEXURE -L

(On Bank's Letter Head)

To,
AGM(Finance)
Transmission Business Group,
Block-VI, Central Annexe, IInd Floor,
Bharat Heavy Electricals Ltd.
Bhopal – 462 022

Ref & Date

Sub : Confirmation of Bank Guarantee no. <<BG No.>>

We are a Scheduled Bank other than Co-operative sector Bank under the RBI Act 1934. The aforesaid << BG No.>> for Rs. <<BG Amount>>/ (In Words Also) and valid up to <<validity date>> is issued by us on behalf of M/s << Beneficiary's Name>> in favour of BHARAT HEAVY ELECTRICALS LTD.
The format of the Bank guarantee is strictly as per the format prescribed by M/s BHEL and the stamp papers forming part of the BG are as per the state rules extant.

The signatures to the Bank Guarantee are duly authorised.

Thanking you,

For & On behalf of
Name of the Bank & Seal

(Please Sign here)

SECTION-B

GENERAL TERMS AND CONDITIONS

SECTION - B

GENERAL TERMS AND CONDITIONS

B.1.0 The following terms shall have the meaning hereby assigned to them except where the context requires otherwise:-

B.1.1 BHEL (or B.H.E. Ltd.) shall mean Bharat Heavy Electricals Limited, a Company registered under Indian Companies Act 1956, with its Registered Office at BHEL House, Siri Fort, New Delhi-110 049 or its Authorised Officers or its Engineer or other Employees authorised to deal with any matters with which these persons are concerned.

B.1.2 "GENERAL MANAGER" shall mean the Officer in Administrative charge of the Contracting Unit of BHEL.

B.1.3 "ENGINEER" OR "ENGINEER-IN-CHARGE" shall mean Engineer deputed by BHEL. The term includes "Deputy General Manager, Construction Manager, Resident Engineer, Assistant Site Engineer of BHEL/at the site as well as the officers in charge at Head Office.

B.1.4 "SITE" shall mean the place or places at which the plants/equipments are to be erected and services are to be performed as per the specification of this tender.

B.1.5 "CLIENTS OF BHEL" or "CUSTOMER/OWNER" shall mean the organisation to whom BHEL is responsible for this work.

B.1.6 "CONTRACTOR" or “ETC CONTRACTOR” shall mean the individual, firm or Company who enters into this Contract with BHEL and shall include their executors, administrators, successors and assigns.

B.1.7 "CONTRACT" or "CONTRACT DOCUMENT" shall mean and include the agreement, the work order, the accepted appendices of rates, Schedules of Quantities, if any, General Terms and Conditions of Contract, Special Conditions of Contract, Instructions to Tenderer, the drawings, the Technical Specifications, the Special Specifications, if any, the tender documents and the Letter of Intent\Accepting Letter issued by BHEL. Any conditions or terms stipulated by the tenderer in the tender documents or subsequent letters shall not form part of the Contract unless specifically accepted in writing by BHEL in the Letter of Intent and incorporated in the Agreement.

B.1.8 "GENERAL CONDITIONS OR CONTRACT" shall mean the "Instructions and Information for Tenderer and General Terms and Conditions" pertaining to the work detailed.

B.1.9 "TENDER SPECIFICATIONS" shall mean the Special Conditions, Technical Specifications, Appendices, Site Information and drawings pertaining to the work for which the tenderer are required to submit their offer. Individual Specification Numbers will be assigned to each technical specifications.

B.1.10 "TENDER DOCUMENTS" shall mean the General Terms and Conditions and Tender Specifications.

B.1.11 "LETTER OF INTENT" shall mean the intimation by a letter/telegram/telex/ fax to the tenderer that the tender has been accepted in accordance with provisions contained in the letter. The responsibility of the contractor commences from the date of issue of this letter and all the terms and conditions of contract are applicable from this date.

B.1.12 "COMPLETION TIME" shall mean the period by date specified in the Letter of Intent/Work Order or date mutually agreed upon for handing over of the erected equipment/plant which are found acceptable by the Engineer being of required standard and conforming to the specifications of the contract.

B.1.13 "ZERO DATE" shall mean the planned commencement date of work under this tender and shall be date of issue of Letter of Intent.

B.1.14 "PLANT OR PROJECT OR SWITCHYARD" shall mean and connote the entire assembly of the plant and equipments covered by the contract.

B.1.15 "EQUIPMENT" shall mean all equipments, machineries, materials, structural, electrical and other components of the plant covered by the contract.

B.1.16 “TESTS" shall mean and include such test or tests to be carried out by the contractor as are prescribed in the contract or considered necessary by BHEL, in order to ascertain the quality, workmanship, performance and efficiency of the contracted work or part thereof.

B.1.17 "APPROVED" "DIRECTED" or "INSTRUCTED" shall mean approved, directed or instructed by BHEL.

B.1.18 "WORK OR CONTRACT WORK" shall mean and include supply of all categories of labour, specified consumables, tools and tackles required for complete and satisfactory site transportation, handling, stacking, storing, civil and electrical works, erection, testing & commissioning of the equipment to the entire satisfaction of BHEL.

B.1.19 "SINGULAR AND PLURAL" etc. words carrying singular number shall also include plural and vice versa, where the context so requires. Words imparting masculine gender shall be taken to include the feminine gender and words imparting persons shall include any Company or Association or Body or Individuals, whether incorporated or not.

B.1.20 "HEADINGS" The headings in these General Conditions are solely for the purpose of facilitating reference and shall not be deemed to be part thereof or be taken into consideration in the interpretation of construction thereof or the contract.

B.1.21 "MONTH" shall mean calendar month.

B.1.22 "WRITING" shall include any manuscript typewritten or printed statement under the signature or seal as the case may be.

B.2.0 **LAW GOVERNING THE CONTRACT & COURT JURISDICTION**:

The Contract shall be governed by the Law for the time being enforce in the Republic of India. The Civil Court at New Delhi having ordinary Original Civil Jurisdiction shall alone have exclusive jurisdiction in regard to all claims in respect of this contract.

B.3.0 **ISSUE OF NOTICE**:

The contractor shall furnish to the Engineer, the name, designation and address of his authorised agent and all complaints, notices, communications and references shall be deemed to have been duly given to the Contractor, if delivered to the Contractor or his authorised agent and shall be deemed to have been so given in the case of posting on the day on which they would have reached such address in the ordinary course of post or at which they were so delivered or left.

B.4.0 **USE OF LAND:**

No land belonging to BHEL or its customer under temporary possessions of BHEL shall be occupied by the contractor without the written permission of BHEL.

B.5.0 **COMMENCEMENT OF WORK:**

B.5.1 The contractor shall commence the work within fifteen days of Letter of Intent or the time indicated in the Letter of Intent/Work Order and shall proceed with the same with due expedition without delay.

The Contractor shall have to give programme of work in Annexure 'M' to the ENGINEER-IN-CHARGE after mobilisation at site. This will have to be regularly updated / revised so as to meet the Project completion schedule as per requirement of BHEL /Owner.

B.5.2 If the successful tenderer fails to commence the work within the stipulated time, BHEL, at its sole discretion will have the right to cancel the Letter of Intent/ Contract. His Earnest Money and/or Security Deposit will stand forfeited without any further reference to him without prejudice to any and all of BHEL's other rights and remedies in this regard.

B.5.3 All the works shall be carried out under the direction and to the satisfaction of BHEL/Customer/Owner.

B.5.4 The transported equipment, erected/constructed plant or work performed under the contract, as the case may be, shall be taken over when it has been completed in all respect and/or satisfactorily put into operation at site.

B.6.0 **MEASUREMENT OF WORK AND MODE OF PAYMENT:**

B.6.1 All payments due to the contractor shall be made only by "Account Payee Cheques".

B.6.2 For progress/running bill payments, the contractor shall present detailed measurement sheets in duplicate duly indicating all relevant details based on technical documents, protocols & material test reports and connected drawings for the work done during the calendar month/period under different categories in line with terms of payment as per Letter of Intent. The basis of arriving at the quantities/ weights shall be the relevant documents and drawings released by BHEL.

These measurement sheets shall be prepared jointly with Engineer and signed by both parties. Where required, joint measurement with Customer/Owner shall have to be taken.

B.6.3 The measurement sheets will be checked by the Engineer and quantities and percentage eligible for payment under different groups shall be decided by him. The abstract of quantities and percentage so arrived at based on the terms of payment shall be entered in the Measurement Book & signed by both the parties. Where required counter signature of Customer/Owner shall have to be taken.

B.6.4 Based on the above quantities, contractor shall prepare the bills in the prescribed proforma and work out the financial value. These will be entered in the Measurement Book and signed by both the parties. Payment shall be made by BHEL after effecting the recoveries due from the Contractor.

B.6.5 All recoveries due from the contractor for the month/period shall be effected in full from corresponding running bills unless specific approval from Competent Authority is obtained to the contrary.

B.6.6 Measurement shall be taken jointly by person duly authorised by BHEL and the Contractor.

B.6.7 The Contractor shall bear the expenditure involved, if any, in taking the measurements and testing of materials to be used in the works. The Contractor shall without extra cost to BHEL, provide all the assistance with appliances and other things necessary for measurement.

B.6.8 If at any time due to any reason whatsoever, it becomes necessary to remeasure the work done, in full or in part, the expenses towards such re-measurement shall be borne by contractor.

B.6.9 Passing of bills covered by such measurement does not amount to acceptance by BHEL of the completion of the work measured. Any left out work has to be completed by the Contractor, as directed by BHEL.

B.6.10 Final measurement bill shall be prepared in the proforma prescribed for the purpose, based on the certificate issued by the Engineer that the entire work as stipulated in the tender specification has been completed in all respects to the entire satisfaction of BHEL.

The contractor shall give unqualified "No claim" and "No Demand" certificates. All the tools and tackles loaned to him should be returned in condition satisfactory to BHEL. The abstract of final quantities and financial values shall also be entered in the Measurement Book and signed by both the parties. The final bill shall be paid after completion of all the defects/deficiencies etc. pointed out by BHEL. The contractor should submit all the original documents such as material consumption, site order book etc. maintained at site. After payment of final bill only guarantee obligation, percentage value shall remain unpaid which shall be released in accordance with Clause A.15.0.

B.7.0 **RIGHTS OF BHEL:**

B.7.1 Please Refer "ANNEXURE TO CONDITIONS OF CONTRACT FOR ETC WORKS" attached with the tender document

B.7.2

B.7.3

B.7.4

B.7.5 Please Refer "ANNEXURE TO CONDITIONS OF CONTRACT FOR ETC WORKS" attached with the tender document

B.7.6

B.7.7

B.7.8

B.7.9

Please Refer "ANNEXURE TO CONDITIONS OF CONTRACT FOR ETC WORKS" attached with the tender document

B.7.10

B.7.11

B.8.0 **RESPONSIBILITY OF THE CONTRACTOR IN RESPECT OF LOCAL LAWS, EMPLOYMENT OF WORKERS ETC:**

The following are the responsibilities of the Contractor in respect of observance of local laws, employment of personnel, payment of taxes etc.

B.8.1 As far as possible, unskilled workers shall be engaged from the local areas in which the work is being executed. In case of any necessity is felt by the contractor to bring labourers from out side State, provisions of law governing such immigration by the concerned State are to be followed.

B.8.2 The Contractor at all times during the currency of this contract, shall in all his dealings with the local labour for the time being employed on or in connection with the work, have due regard to all local festivals, religious and other customs.

B.8.3 The contractor shall comply with all State and Central Laws, Statutory Rules, Regulations etc., such as : The payment of wages to, The Minimum Wages Act, The Workmen Compensation Act, The Employees Liability Act, The Industrial Dispute Act,The Employees Provident Fund and Miscellaneous Provisions Act 1952, Employees State Insurance Scheme, The Contract Labour (Regulations &Abolition) Act 1970 and other Acts, Rules and Regulations for labour as may be enacted by the Government during the tenure of the contract and having in force or jurisdiction at site. The Contractor shall give to the local Governing Body, Police and other concerned Authorities all such notice as may be required under law.

The contractor should have Provident Fund Code Number and shall ensure compliance of the EPF& MP Act, 1952 by the sub-contractors, if any engaged by the contractor for the said work,

B.8.4 The contractor, as required, will obtain independent license under the Contract Labour (Regulations and Abolition) Act 1970 from the concerned authorities based on the certificate (Form-V) issued by the Principal Employer/Customer.

B.8.5 The Contractor shall pay all taxes, fees, license charges, deposits, duties, tolls, royalty, commissions or other charges which may be Leviable on account of any of his operations connected with this contract. The Contractor is responsible to furnish documentary evidence towards GST Registration of the State wherein the site is located and any other documents as per GST Act which may be required from time to time by BHEL.The contractor should have to get the contract registered immediately after award of works as per rules and regulations of the State Government. The contractor will file regular return as per statute of the State/

Centre and provide all information to BHEL as required for the assessment of the project concerned . In case BHEL is forced to make any of such payments, BHEL shall recover the same from the contractor either from moneys due to him or otherwise as deemed fit.

B.8.6 Arrangements for the periodical visits of inspection agencies such as Electrical Inspector etc. to site, inspection certificates etc. will have to be made by the contractor at his cost. The contractor will also meet all expenses in connection with his welder's qualification/ re-qualification tests etc.

B.8.7 The contractor shall be responsible for provision of health and sanitary arrangements {more particularly described in the Contract Labour (Regulation & Abolition) Act 1970} and safety precautions as may be required for safe and satisfactory execution of the contract.

B.8.8 The Contractor shall be responsible for proper accommodation including adequate medical facilities for the personnel employed by him.

B.8.9 The Contractor shall be responsible for the proper behaviour and observance of all regulations by the staff employed by him.

B.8.10 The contractor shall ensure that no damage is caused to any person/property of other parties working at site. If any such damage is caused, it shall be the responsibility of the contractor to make good the losses or compensate them.

B.8.11 All the properties/equipment/components of BHEL/its customer loaned with or without deposit, to the contractor, shall remain the properties of BHEL/its customer. The contractor shall use such properties for the purpose of execution of this contract. All such properties/equipment/components shall be taken to in good condition unless notified to the contrary by the contractor within 48 Hrs. The Contractor shall return them in good conditions as and when required by BHEL/its customer. In case of non-return, loss, damage repairs etc., the cost thereof, as may be fixed by the Engineer, will be recovered from the contractor.

B.8.12 It shall not be obligatory on the part of BHEL to supply any tools and tackles or materials other than those specifically agreed to be given by BHEL. However, depending upon availability/possibility, BHEL/its customer's equipment and other materials may be made available to the contractor on payment of the hire charges as fixed by them, subject to the conditions laid down by BHEL/its Customer from time to time. Unless paid in advance, such hire and other charges shall be recovered from out of dues to the contractor or Security Deposit in one instalment.

B.8.13 The Contractor shall fully indemnify and keep indemnified BHEL/its customer against all claims of whatsoever nature arising during the course of execution of this contract.

B.8.14 In case the contractor is required to undertake any work outside the scope of this contract, the amount payable shall be as may be mutually agreed upon.

B.8.15 Any delay in completion of works or non-achievement of periodical targets, due to reasons attributable to the contractor, will have to be compensated by the contractor either by increased manpower and resources or by working extra hours or more than one shift at no extra cost to BHEL.

B.8.16 The contractor shall execute the work under the conditions usual to such construction work and in conjunction with numerous other operations at site and proceed in a manner that shall help in the progress of work at site as a whole.

B.8.17 The contractor will be directly responsible for payment of wages to his workmen. A pay roll sheet giving details of all payments made to the workmen duly signed by the contractor's representative should be furnished to BHEL, along with each Running Account Bill. Also, Contractor shall display wages paid by him as per The Minimum Wages Act.

B.8.18 In case of any class of work for which there is no specification laid down in the contract, such work shall be carried out in accordance with the instructions and requirements of the Engineer.

B.8.19 No levy, payment or charges made or imposed shall be impeached by reason of any clerical error or by reason of any mistake in the amount levied, demanded or charged.

B.8.20 No idle labour charges will be admissible in the event of any stoppage of work resulting in the contractor's workmen being rendered idle due to any reason any time.

B.8.21 The contractor shall take all reasonable care to protect the materials and the work till such time the place/equipment has been taken over by BHEL/its customer.

B.8.22 The contractor shall not stop work or abandon the site for whatsoever reason or dispute, excepting for force majeure conditions. All problems/disputes shall be separately discussed and settled without effecting the progress of work. Stoppage or abandonment of work, other than under force majeure conditions, shall be treated as breach of work of contract and dealt with accordingly.

B.8.23 The contractor shall keep the area of work clean and shall remove debris etc. while executing day-to-day work. Upon completion of work, the contractor shall remove from the vicinity of works, all scrap, packing materials, rubbish, unused and other materials and deposit them in places specified by the Engineer. The contractor will also demolish all the hutments, sheds, offices etc. constructed and used by him and shall clean the debris. In the event of his failure to do so, the same will be arranged to be done by the Engineer and the expenses recovered from the contractor.

B.8.24 The contractor shall execute the work in the most substantial and workman like manner in the stipulated time. Accuracy of work and timely execution shall be the essence of this contract. The contractor shall be responsible to ensure that the quality, assembly and workmanship conform to the dimensions and clearance given in the drawings and/or as per instructions of the Engineers.

B.8.25 The contractor shall furnish progress reports on work at regular intervals as required by the Engineer.

B.9.0 **RESPONSIBILITIES OF CONTRACTOR IN RESPECT OF SAFETY OF MEN, EQUIPMENT, MATERIAL & ENVIRONMENT**:

B.9.1 All safety rules and codes applied by BHEL/its customer at site shall be observed by the contractor and his workmen without exception. The contractor shall be responsible for the safety of the equipment/materials and work to be performed by him and shall maintain all lights, fencing guards, signs etc. or other protections 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 pilferage, accidents, fire hazards etc. and suitable number of clerical staff, watch and ward, store keepers to take care of equipment, materials and construction tools and tackles shall be posted at site by the contractor till the completion of the work under this contract. The contractor shall arrange for such safety devices as are necessary for this type of work and carry out the requisite site tests of handling equipment, lifting tools, tackles etc. as per usual standards and practices.

B.9.2 The contractor shall provide to its work force and ensure the use of required personal protective equipment as found necessary & as directed by the authorised BHEL officials in line with latest Amendments / Revisions of various Indian Standards.

i) Safety helmets conforming to IS-2925 : 1984.

ii) Safety belts conforming to IS-3521 : 1983.

iii) Safety shoes conforming to IS-1989 : 1978.

iv) Eye and face protection devices conforming to IS-8520 : 1977 and IS-8940 : 1978.

v) Hand and body protection devices conforming to IS-2573 : 1975, IS-6994 : 1973, IS-8807 : 1978 and IS-8519 : 1977.

B.9.3 All tools, tackles, fitting appliances, material handling equipment, scaffolds, cradles, safety nets, ladders, equipment, etc. used by the contractor (as per Annexure 'N') shall be of safe design and construction and maintained in good condition. However BHEL officials shall have the right to ban use of any of them or get them tested at their discretion.

All test & measuring instruments to be pre-calibrated through certifying agency before use. Also, please see. Cl. E.4.2 & E.6.3 of section - E for more details.

All electrical equipment, connections and wiring for construction power, its distribution and use shall conform to the relevant requirements of Indian Electricity Act and Rules. Only electricians licensed by the appropriate statutory authority shall be employed by the contractor to carry out electrical works.

B.9.4 All electrical appliances including portable electric tools used by contractor shall have safe plugging system to source of power and be appropriately earthed.

B.9.5 The contractor shall not use any hand lamp energised by electric power with supply voltage of more than 240 volts. For work in confined spaces, lighting shall be arranged with power source of not more than 240 volts.

B.9.6 Where it becomes necessary to provide and/or store petroleum products, explosives, chemicals and liquid or gaseous fuel or any other substance that may cause fire or explosion, the contractor shall be responsible for carrying out such provision and/or storage in accordance with the rules and regulations laid down in the relevant Government Acts, such as Petroleum Act, Explosive Act, Petroleum and Carbides of Calcium Manual of the Chief Controller of Explosives, Government of India etc. Prior approval of the authorised BHEL official at the site shall also be taken by the contractor in all such matters.

B.9.7 The contractor shall arrange at his cost appropriate illumination as required at all work spots for safe working, when natural day light may not be adequate for clear visibility.

B.9.8 In case of a fatal or disabling injury/accident to any person at construction sites pertaining to this work, the victim and/or his/her dependents shall be compensated by the contractor as per statutory requirements. However, if considered necessary, BHEL shall have the right to impose appropriate financial penalty on the contractor & recover the same from payments due to the contractor for suitably compensating the victim and/or his/her dependents. Before imposing any such penalty, appropriate enquiry shall be held by BHEL giving opportunity to the contractor to present his case.

B.9.9 In case of any damage to property due to lapse by the contractor, BHEL shall have the right to recover the cost of such damages from the payments due to the contractor.

B.9.10 In case of any delay in the completion of a job due to mishaps attributable to lapses by the contractor, BHEL shall have the right to recover cost of such delay

from the payments due to the contractor, after notifying the contractor suitably and giving him opportunity to present his case.

B.9.11 If contractor fails to improve the standards of safety in its operation to the satisfaction of BHEL after being given reasonable opportunity to do so and/or if the contractor fails to take appropriate safety precautions or to provide necessary safety devices and equipment or to carry out instructions regarding

safety issued by the authorised BHEL official, BHEL shall have the right to take the corrective steps at the risk and cost of the contractor after giving appropriate notice indicating the steps that would be taken by BHEL.

B.9.12 The contractor shall submit report of all accidents, fires, property damaged & dangerous occurrences connected with his area of work or caused due to his action/ inaction, to the authorised BHEL official immediately after such occurrence, but in any case not later than 12 hours of the occurrence.

B.9.13 During the course of construction, alteration or repairs scrap lumbers with protruding nails, sharp edges etc. and all other debris including combustibles scrap shall be kept cleared from working areas, passage ways and stairs in and around site.

B.9.14 Cylinders shall be moved by tilting and rolling them on their bottom edges. They shall not be intentionally/ negligently dropped, struck or permitted to strike each

other violently. When cylinders are transported by powered vehicles, they shall be secured in a vertical position.

B.9.15 The contractor shall be responsible for the safe storage of his radioactive sources if same have been permitted to use.

B.9.16 All contractor's supervisory personnel and sufficient number of workmen shall be trained for fire fighting and first aid duties and shall be assigned specific duties. Enough number of such trained personnel must be available during the tenure of the contract.

B.9.17 Contractor shall provide enough fire protecting equipment of the types & numbers at his office, stores, construction/erection site, other temporary structures, labour colony area etc. Access to such fire protection equipment shall be easy and kept open at all times. Compliance of the above requirement under fire protection system at project site shall in no way relieve the contractor of any of his responsibilities & liabilities to fire accident occurring. In the event of fire safety measures being not to BHEL's satisfaction, BHEL shall have option to provide the same and recover the cost plus incidentals from contractor's bills and/or impose penalty as deemed fit by the Engineer.

B.9.18 Before commencing the work, the contractor shall appoint/nominate a responsible officer to supervise implementation of all safety measures and liaison with BHEL Engineer at site.

B.9.19 If safety record of the contractor in execution of the awarded job is to the satisfaction of Safety Department of BHEL, issue of an appropriate certificate to recognise the safety performance of the contractor may be considered by BHEL after completion of the job.

B.10.0 **CONSEQUENCES OF CANCELLATION:**

B.10.1 Whenever BHEL exercises its authority to terminate the contract/withdraw a portion of work, the work may be got completed by any other means at the contractor's risk and cost provided that in the event of the cost of completion (as certified by the Engineer which shall be final and binding on the contractor) being less than the contract value, the advantage shall accrue to BHEL. If the cost of completion exceeds the money due to the Contractor under the Contract, the Contractor shall either pay the excess amount demanded by BHEL or the same shall be recovered from the contractor. This will be in addition to the forfeiture of Security Deposit and recovery of liquidated damages as per relevant clauses.

B.10.2 In case BHEL completes the work under the provisions of this clause, the cost of such completion to be taken into account for determining the excess cost to be charged to the contractor shall consist of cost of materials purchased and/or labour provided by BHEL with an addition of such percentage to cover supervision and establishment charges as may be decided by BHEL.

B.11.0 **INSURANCE:**

B.11.1 BHEL/its customer shall arrange for insuring the project materials/properties of BHEL/its customer covering the risks during transit, storage, construction, erection and commissioning.

B.11.2 It shall be the sole responsibility of the Contractor to insure his workmen against risks of accident and injury while at work as required by the relevant rules and to pay compensation, if any, to them as per Workmen's Compensation Act. The Contractor shall also insure his staff against accidents. The work will be carried out in a protected area and all the rules and regulations of BHEL/its client in the project area which are in force from time to time will have to be followed by the contractor.

B.11.3 If due to negligence and/or non-observance of safety and other precautions any accident/injury occurs to any other person/public, the contractor shall pay necessary compensation and other expenses, if so decided by the appropriate authority.

B.11.4 It shall be the responsibility of the contractor to provide security and insurance claim related information/reports, FIRs etc. for the equipment/material belonging to BHEL/its customer and handed over to the contractor for transportation/erection/ construction till these are taken over by BHEL after erection/construction or are returned to BHEL/its customer's store.

B.11.5 If due to Contractor's carelessness, negligence, non-observance of safety precautions, improper security arrangements or due to non-compliance of paper work needed for lodging insurance claim, damage to BHEL/its Customer's property and/or personnel should occur, and if BHEL is unable to recover its claim from the Insurance Company, the deficit will be recovered from the Contractor. **All losses arising out of theft of material from the contractor's store/erection site shall be recovered from the contractor irrespective of the insurance claims.**

B.12.0 **STRIKES & LOCKOUTS:**

B.12.1 The Contractor will be solely responsible for all disputes & other issues connected with his workmen. In the event of the contractor's workmen resorting to strike or the contractor resorting to lockout and if the strike or the lockout so declared is not settled within a period of one month, BHEL shall have the right to get the work executed by employing its own men or through other agencies or both. The cost incurred by BHEL in this regard shall be recovered from the Contractor.

B.12.2 For any purpose whatsoever, the employees of the contractor shall not be deemed to be in the employment of BHEL/its Customer.

B.13.0 **FORCE MAJEURE:**

B.13.1 The following shall amount to force majeure conditions:-

Acts of God, Act of any Government, war, Sabotage, riots, civil Commotion, Police Action, Revolution, Flood, Fire Cyclone, Earthquake, Epidemic and other similar causes over which the contractor has no control.

B.13.2 If the contractor suffers delay in the due execution of the contract, due to delays caused by force majeure conditions, as defined above, the agreed time of completion of the work covered by this contract may be extended by a reasonable period of time in consultation and after agreement of BHEL's clients / owner, provided that on the occurrence of any such contingency, the Contractor immediately reports to BHEL in writing the causes of delay. The Contractor shall not be eligible for any compensation on this account.

B.14.0 **GUARANTEE:**

B.14.1 Even though the work will be carried under the supervision of BHEL Engineers, the contractor will be responsible for the quality of the workmanship and shall guarantee the work done for a period of 12 months from the date of putting the complete system into commercial operation or 18 months from the date of system is declared completely erected duly tested and accepted by customer whichever is later and shall rectify free of cost all defects due to faulty erection detected during the guarantee period starting from the date of the completion of rectification. In the event of the contractor failing to repair the defective works within the time specified by the Engineer, BHEL may proceed to undertake the repairs of such defective works at the contractor's risk and expense without prejudice to any other rights and recover the same from Security Deposit/other dues.

B.15.0 **ARBITRATION:**

B.15.1

Please refer " Annexure to conditions of contract for ETC Work" attached with the tender documents.

Please refer " Annexure to conditions of contract for ETC Work" attached with the tender documents.

NOTE:

Above clause No. B.15.0 stands deleted. Please refer Annexure to conditions of contract for ETC works.

B.16.0 **VARIATIONS AND VALUATIONS:**

B.16.1 **QUANTITIES:**

The quantities set out in the Bill of Quantities are the estimated quantities of the work but they are not to be taken as the actual and correct quantities of the works to be executed by the Contractor in fulfilment of his obligations under the Contract.

B.16.2 **VARIATIONS:**

B.16.2.1 The Engineer shall have power to make any variation of the form, quantity of the Works or any part thereof that may in his opinion be necessary and for that purpose or if for any other reason it shall in his opinion be desirable shall have power to order the Contractor to do and Contractor shall do any of the following:-

a) Increase or decrease the quantity of any work included in the contract.

b) Omit any such work.

c) Change the character or quality or kind of any such work.

d) Execute additional work of any kind necessary for the completion of the works and no such variation shall in any way vitiate or invalidate the contract but the value (if any) of all such variation shall be taken into account in ascertaining the amount of the Contract Price.

e) Restrict the extent of work of any item covered under Clause E.10.0 of Section - E "Schedule of Equipment".

B.16.2.2 Orders for Variations to be in writing. No such variation shall be made by the contractor without an order in writing of the Engineer provided that, no order in writing shall be required for increase or decrease in the quantity of any work where such increase or decrease is not the result of an order given under this clause but is the result of the quantities exceed in for being less than those stated in the Bill of Quantities. Provided also that if for any reason the Engineer shall consider it desirable to give any such order verbally the Contractor shall comply with such order and any confirmation in writing of such verbal order given by the Engineer whether before or after the carrying out of the order shall be deemed to be an order in writing within the meaning of this clause. Provided further that if the contractor shall confirm in writing to the Engineer any verbal order of the Engineer and such confirmation shall not be contradicted in writing by the Engineer, it shall be deemed to be an order in writing by the Engineer.

B.16.3 **VALUATION OF VARIATIONS:**

The Engineer shall determine the amount (if any) which in his opinion should be added to or deducted from the sum named in the Contract in respect of any extra or additional work done or work omitted by his order. All such work shall be valued at the rates set out in the Contract if in the opinion of the Engineer the same shall be applicable. If the contract shall not contain any rates applicable to the extra or additional work then suitable prices shall be derived from the nearest item of BOQ or arrived at from the actual cost of manpower utilised (the cost of T&P and testing equipment etc. are not to be taken into account for arriving at the rates of additional/extra works) plus 10% for contractor's OH and profit. The rates for manpower shall be as per the minimum wages applicable for the project area.

Above clause No.B.16.3 shall be read in conjunction with clause No.1.of of Annexure to conditions of contract for ETC works.

B.16.4 **POWER OF ENGINEER TO FIX RATES:**

If the nature or amount of any omission or addition relative to the nature or amount of the whole of the contract work or to any part thereof shall be such that in the opinion of the Engineer the rate or price contained in the Contract for any item of the Work is by reason of such omission or addition rendered unreasonable or inapplicable then a suitable rate or price shall be agreed upon between the Engineer and the Contractor. In the event of disagreement the Engineer shall fix such other rate of price as shall in his opinion be reasonable and proper having regard to the circumstances and the same shall be binding on the contractor. But under no circumstance the contractor shall suspend the work on the plea of non-settlement of rates falling under the clause or claim any compensation on that account.

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ANNEXURE - M

PROGRAMME OF WORK

SL.NO.	ACTIVITY	DURAION
01.	Award of work.	Zero week
02.	Mobilisation & setting up of site office	..... weeks
03.	Start / finish of structure erection	..... weeks
04.	Start / finish of stringing of shielding wire and conductors	..... weeks
05	Start / finish of Circuit Breaker erection	..... weeks
06.	Start / finish of other equipment erection	..... weeks
07.	Start / finish of testing and precommissioning	..... weeks
08.	Start / finish of commissioning	..... weeks
09.	Final Handing over	..... weeks

(SIGNATURE OF TENDERER)
WITH STAMP

ANNEXURE - N

LIST OF TEST EQUIPMENTS TO BE ARRANGED BY ETC CONTRACTOR

All measuring and testing instrument shall be pre-calibrated through a certifying agency before use. The certificate of calibration shall be submitted to BHEL Site Engineer for records. Also see clause E.4.2 & E.6.3 under Section E of the tender specification for more details.

A -	**General purpose**	**Qty.**
1.	Digital multimeter - 4½ digits Accuracy ± 1% (Any reputed make - preferably Fluke - make)	4 Nos.
2.	Megger 2.5 kV - 5kV, range 0.5 MΩ - 10,000 MΩ (Motorised/Electronic) (Any reputed make)	1 No.
3.	Meggar having voltage multiplier 0-500V- 1000V, (Motorised / Electronic) Range 0.5 MΩ - 1000 MΩ (Any reputed make)	1 No.
4.	Single phase variac 8 A, 0.-250V, 50 HZ	2 No
5.	Three phase variac 15A, 0-440V, 50 HZ	1 No
6.	Single phase transformer 220V / 4000V, 500VA, 50HZ	1No
7.	Stop watch	1No
8	Micro- ohm- meter (mV drop test kit) 0-200ADC, 0-2000 micro ohm with suitable calibrated cable leads for current injection and mV drop.	1 No
9.	Phase sequence meter	1 No
10.	Two way intercom set with 50 to 100 M cables for checking of cable continuity	2 sets
11.	Walkie - Talkie sets with battery charging sets Receiver + Transmitter, Type GP 300 - Motorola - make	1 set
12.	Variable D.C. power supply 0-220VDC, 10 A	2 Nos
13.	4 pole Miniature moulded case breaker 16 A	3 No
14.	Capacitance meter having range 20 PF- 100mfd ± 1%	1 No
15.	Isolation Transformer 1KVA, 240V AC, 1 phase, 50Hz	2 Nos

B	**For testing of current transformer**	
1.	Primary injection test kit, range 0-2000A with a pair of leads & C clamps for testing of CT's	1 No
2.	Secondary injection test kit suitable for 5A& 1A with banana plug cable leads.	1 No
3.	Digital Tongue tester 0-2000A, 600VAC, 50 Hz (Any reputed make).	1 No
4	Digital Tongue tester 0-20A, 600V AC, 50 Hz (Any reputed make).	1 No
5.	Digital Tongue Tester, 0-1A, 600V AC, 50Hz	2 Nos.
C -	**For testing of oil cooled transformer and AC reactor**	
1.	Transformer winding resistance meter or Kelvin's double bridge	1 No
2.	Transformer turns ratio meter	1 No
3.	PPM tester for transformer oil	1 No
4.	BDV tester for transformer oil	1 No
D	**For testing of relays**	
	Single phase / 3 phase relay test kit having timer current source 5A, 1A, voltage source 0-220VDC, 0-110 VAC 50 HZ. (Any reputed make)	1set
E-	**For time measurement of breaker**	
	Breaker closing and / opening time measurement timer	1 No
F	**For testing of relays and distance protection**	1 Set
1.	CFB kit or equivalent - of any reputed make	
2.	ZFB kit or equivalent - of any reputed make	

G **For testing of transformer bushings CT, CVT & Circuit Breaker used in HV System**

Capacitance and tan Delta kit suitable for 12KV 1 Set
(Any reputed make)

H. **Safety / protective means**

- Protective earth rod suitable for 220Kv / 400 KV system 2 Nos
having leakage current meter, 70MM² copper cables and C clamps
(Any reputed make).
- Helmets and hand globes etc.

I. **For PLCC Equipment:**

b) Digital time interval meter and frequency counter, 8 digits with frequency range 10 Hz to 10MHz.

c) 200Hz to 620KHz Selective level meter.

d) 200Hz to 620KHz Selective level generator.

Note:

1. Above is only a specimen/indicative list and any other test equipment (s) as may be required by Owner / BHEL at site during the execution of work will be arranged by the contractor well in time.
2. The status of tools, plants and instruments mentioned in annexure C of section - A does not relieve the subcontractor of his responsibility to make available all the test equipments and tools & tackles mentioned in annexure N of section B as per requirement of project.

ANNEXURE - P

ACTIVITIES FOR TESTING AND COMMISSIONING BY ETC CONTRACTOR

1. Preparation of joint inspection records / observation by BHEL, BHEL customer and the contractor on the pending activities of erection holding for starting of testing and commissioning.
2. Issue of certificate for completion of erection activities to the satisfaction of BHEL customer.
3. Compilation of documents (scheme, cable schedules, FQP, technical literature, operation and maintenance manuals, technical reports, works test certificate for the equipments / components, and other relevant documents to expedite commissioning) in a systematic manner to present to customer/owner to meet the contractual requirement.
4. To expedite the testing activities contractor has to arrange the engineers and his staff and instruments at site for testing and commissioning of switchyard equipments as follows:

4.1 Testing of individual relay, energy meter, transducer and meters for their satisfactory operation.

4.2 Protection devices / relays will be tested with appropriate current and voltage injections.

4.3 Individual control and protection panels testing for their satisfactory operation as per scheme.

4.4 Individual CT, PT, CVT, Breaker, Transformer and Isolator LA, MB, Battery Charger etc. where ever possible to test them independently.

4.5 Wiring check as per scheme and cable schedule preferably in the following sequences:

- Between marshalling Kiosk in the yard to other yard equipments.
- Between equipments in the yard.
- Yard equipments to control room equipments.
- Inter connection between control room equipments.

5. All cables to be properly glanded, identified and terminated suitably.
6. Cables should have proper / accurate cross reference ferruling and necessary cable tags for identifications as per recommendation by BHEL/ Customer.

7 Green marking in cable schedule and scheme after wiring check. Contractor to make also “As Built” scheme and cable schedule for submission to BHEL/Customer.

8. List of wiring mistakes, component damage and mal-operation of components.

9. Successful completion of equipment level testing operative from local and remote and desired FQP filled up and approved by ultimate customer. Approval/acceptance on FQP results by customer has to be obtained by Contractor. For any technical clarifications, BHEL will only assist.

10. In case the contractor is finding difficulty to understand the technicalities to undertake testing and commissioning of a particular equipment, subsystem and system he has to inform BHEL in advance with in 2 months from the date of award of contract for necessary information and explanation.

11. For erection/commissioning of SF6 Circuit Breakers (If called for in BOQ), the services of experts +for supervision will be extended by BHEL free of cost. Contractor will provide adequate support by providing skilled manpower and tools & tackles**.** However the complete responsibility for erection and commissioning lies with subcontractor.

12. Contractor has to keep a senior and experienced person in the area of testing and commissioning associated with his skilled staff till charging and handing over of complete switchyard to the satisfaction of BHEL customer.

13. Contractor has to be well equipped at site with testing instruments and safety measures (like helmet and hand globes) while doing testing and commissioning.

14. Contractor will also carry out design validation tests as per BHEL / BHEL customer documents.

15 If the contractor fails to take up testing and commissioning work as per the requirement of contract or project requirement, then BHEL will be at liberty to hire services of third agency for this work at the risk and cost of subcontractor.

16 Testing of mandatory spares or any other spare (if required by customer / BHEL), cleaning and handing over to customer's stores is also included in the scope of this Tender Specification. The site Test Reports of these mandatory spares will also be generated by subcontractor in such a case.

17 In case contractor fails to arrange Test equipments as referred in Annexure 'N' (as per requirement of equipment covered in BOQ), BHEL will arrange the instruments at the risk and cost of contractor for providing such instruments.

18. Contractor has to repeat any tests free of cost, even if already conducted, whenever required to prove and check the healthiness of system before power flow, such tests could be primary injection and secondary injection in CT, CVT, meggering, and functional tests or any other tests as required by BHEL/customer.

19. Oil processing/filtering in a transformer, CT and CVT shall also be repeated free of cost if required before charging and handing over of the switchyard to the owner in case BDV and PPM of oil is not satisfactory.

20. As isolator is a rotating equipment and its alignment is likely to get disturbed. Therefore contractor has to do alignment of isolators and measurement of contact resistance repeatedly free of cost as and when required till handing over of the station.

21. Commissioning means charging of total system in a sub-station and inter connected equipments by power flow. Accordingly the payment will be made to the contractor as per payment terms.

22. Contractor has to deploy adequate and experienced man power at site as per project requirement and advice of BHEL site in-charge. Non compliance of this requirement will be treated as indiscipline and non cooperation of the contractor. Accordingly BHEL will hire the man power as required at the risk and cost of the contractor after giving a single notice.

23. Based on site requirement, for the works not stipulated in the contract, the contractor has to provide assistance of skilled manpower with required tools and test instruments.

24 If any Expert services of manufacturer for commissioning supervision of special protection relays / numerical relays / equipment is felt necessary by the contractor, the same shall be arranged by the contractor themselves at their cost. Contractor shall provide testing & Commissioning, Engineer, electrician, other tools tackles and consumables for these equipments and for total system.

Any delay in arranging special testing & commissioning equipment and expert supervisor shall not entitle the contractor to any claim (idle labour, additional time etc.) whatsoever.

25. Any idle days of the expert supervisor at site due to reasons attributable to the contractor, due to lack of readiness in erection, delay in arranging of manpower, tools etc. shall be to contractor's account.

NOTES :-

(1) Above is only an indicative list. Contractor has to mobilise and keep adequate competent commissioning staff at site to ensure that all mile stones & events and relevant commissioning activities are completed successfully in a scheduled time.

(2) In case contractor is not finding competent and adequate staff with him, he can hire the commissioning services from out side agencies approved and accepted by BHEL. Contractor will furnish the details (experience, qualification) of all commissioning staff and the commissioning tools and instruments available with the contractor OR obtained on loan basis with in 60 days from the date of award of the work.

ANNEXURE - Q

LIST OF TOOLS & TACKLES TO BE ARRANGED BY CONTRACTOR

Sl. No.	PARTICULARS
01.	Electrical Drilling Machine & Hand drilling Machine.
02.	Hydraulic Bending Machine for Al. pipes.
03.	Gas Welding Set & Gas Cutting Set.
04.	Hand Operated Winches.
05.	Electric Welding machine.
06.	Jack with axle for lifting Cable Drum.
07.	Jointers Tool Box.
08.	Blow Lamps.
09.	Compression Tools suitable for Cables.
10.	Pull Lifts.
11.	Pulley Blocks.
12.	Hooks/Chains
13.	Cable Rollers.
14.	Hydraulic Jacks - For cable laying.
15.	Aluminium Rollers.
16.	D- Shackles.
17.	Dynamometers.
18.	TIG, Welding machine (for Aluminium welding).
19.	High Vacuum 1000 GPH Oil Filtration Machine for Transformer / Reactor oil suitable for 760mm vacuum. In case 250 MVA / 315 MVA transformer ETC work is covered in the scope, Oil filtration equipment of 1500 GPH suitable for High Vacuum along with 30 kL capacity storage tank for oil storage and processing of oil should be provided.
20.	Hydraulic cranes including accessories (20 tonne or more and boom height of 15mts. Vertical or more) suitable for erection of transformer bushings accessories and other equipments.
21.	Hydraulic Crimping tools for conductor / Shield wire.
22.	Crimping tools for cable termination.
23.	Torque wrenches of different ranges in sufficient numbers.
24.	All general purpose hand tools in sufficient quantities.
25.	Shearing Machine for cutting of Earthing Flat.

26. Tool Kit for fitters.
27. Tool Kit for Electrician.
28. Bench Vice.
29. 'A' type collapsible Al. ladder height 8M.
30. 'H' type Al. ladder height 5M.
31. Pressure Gauge 0-1kg/Sq.cm for measurement of N2 pressure.
32. Vacuum gauges for measuring fire vacuum of less than 1 torr in transformer.
33. Nylon slings for 4T capacity with different lengths.
34. Turper
35. Angle meter for measurement of bushing angle during erection.
36. Nylon hammer.
37. Wedge for cutting of 'O' rings/neoprene gaskets.
38. Die/Drill tool for making holes in gland plates (All sizes in sufficient numbers)
39. Phoenix screw drivers for handling of Terminal Blocks.

IMPORTANT NOTE:

1. The Contractor shall submit the copies of latest test certificate of lifting tackles, slings, pulleys etc. after mobilisation at site to the ENGINEER-IN-CHARGE.
2. Above is only a specimen/indicative list and any other Tools & Tackles as may be required by Owner/ BHEL at site during the execution of work will be arranged by the contractor promptly.
3. The status of tools, plants and instruments mentioned in annexure C of section - A does not relieve the subcontractor of his responsibility to make available all the test equipments and tools & tackles mentioned in the annexures of section B as per requirement of project.

SECTION-C

SPECIAL CONDITIONS OF CONTRACT

SECTION - C

SPECIAL CONDITIONS OF THE CONTRACT

C.1.0 **QUALIFICATION OF THE CONTRACTOR :**

C.1.1 The contractor must have the experience of execution of identical work in the past as specified in the tender documents and must have executed contracts of similar nature. The contractor must furnish enough evidence to establish his capacity in erection, testing and commissioning of similar equipments covered under this specification.

C.1.2 The contractor should be able to obtain clearance from the Electrical Inspector/ State Authorities on completion of the installations. If required, the Contractor is supposed to obtain such clearances on part completion of the installation as required by BHEL / Owner time to time. Also, before the start of work the contractor should obtain the supervisory license from the concerned Electrical Authorities.

C.1.3 The Contractor will have following certificates.

a) Contractor electrical licence.

b) Supervisor competency certificates to deal with Electrical high voltage equipments for their installation and for their installation and testing.

Such certificates from two persons of subcontractors representatives who will be posted at site will be required.

C.1.4 The contractor should be aware of the local conditions and be well acquainted with the site.

C.1.5 The contractor shall be preferred who has worked for State Electricity Boards/BHEL/Steel Authorities/Public Undertakings.

C.1.6 The contractor should have a very good engineering background and capability of carrying out erection and commissioning work of large scale.

C.2.0 **TERMS OF PAYMENT FOR ERECTION, TESTING AND COMMISSIONING :**

C.2.1

C.2.2

C.2.3

Please refer " Annexure to conditions of contract for ETC Work" attached with the tender documents.

C.2.4

C.2.5

C.2.6

C.2.7

Please refer " Annexure to conditions of contract for ETC Work" attached with the tender documents.

C.2.8

Above clause No. C.2.0 stands deleted. Please refer Annexure to conditions of contract for ETC works.

C.3.0 **SECURITY DEPOSIT:**

C.3.1

C.3.2

Please refer " Annexure to conditions of contract for ETC Work" attached with the tender documents.

C.3.3

C.3.4

C.3.5 **RETURN OF SECURITY DEPOSIT:**

The contractor should refer the clause A.17.7.

No interest shall be payable by BHEL on Earnest Money/Security Deposit or on any money due to the contractor by BHEL.

C.4.0 **PERFORMANCE GUARANTEE:**

C.4.1 The contractor shall be responsible for any defects in the execution of work noticed in guarantee period of 12 months reckoned from the date of putting the complete system into commercial operation/handing over to customer or 18 months from the date of system is declared completely erected, duly tested and accepted by BHEL and customer. The Contractor shall submit a bank guarantee worth 10% of the total contract value of erection, testing and commissioning of equipment in the prescribed proforma form of BHEL. If the contract is for more than one sub-station and the substations are completed and taken over by customer in stages, then the performance BG for the substation completed and handed over may be submitted based on the contract value of individual substation at the time of submitting the final bill, substation wise.

C.5.0 **LD/PENALTY FOR DELAY IN EXECUTION:**

C.5.1

Please refer " Annexure to conditions of contract for ETC Work" attached with the tender documents.

Above clause No.C.5.0stands deleted. Please refer Annexure to conditions of contract for ETC works.

C.6.0 **RECEIPT/ UNLOADING, HANDLING, TRANSPORTATION, SECURITY AND PRESERVATION OF EQUIPMENT AT SITE:**

C.6.1 The contractor shall take the delivery of all the equipment, structures and materials etc. at site and their security shall be the responsibility of the contractor. Further transportation of materials to work place as per requirements will be in the scope of the contractor. For any delay, demurrage/wharfage/detention charges will be borne by the contractor.

In order to ensure timely completion of project, some of the equipment/material as covered under clause no. E.10.0 of Section-E (Schedule of equipment) may arrive at site and are unloaded and stacked/stored prior to mobilisation of ETC Contractor for the work covered under this Tender Specification. In such a case, the amount actually spent by BHEL on unloading and storage till the time of mobilisation by the ETC contractor shall be debited to their account. Immediately after mobilisation, the contractor shall take these into their custody and all the conditions as applicable for the material directly received by the contractor will be applicable for these material.

C.7.0 **FACILITIES TO BE PROVIDED AT SITE BY THE CONTRACTOR:**

C.7.1 Watch and ward by authorised/licensed agency for the safe custody of the equipment shall be responsibility of the contractor.

C.7.2 It is the responsibility of the contractor to dismantle and take away all the materials of his office accommodation as soon as the project in handed over to BHEL/Owner and clean the area off debris.

C.8.0 **TESTING AND COMMISSIONING:**

C.8.1 All the electrical/mechanical test of the materials and equipment will be arranged by the contractor as per standard Specification/Field Quality Plan/ Erection Manual/Directive of the Site Engineer and Owner. The contractor shall have to fill the check list (site inspection record forms)for receipt, storage, erection, testing and commissioning of all the equipments as per BHEL systems to ensure proper quality of work.

C.8.2 All the testing equipment required to carry out the site test for all the equipment or the erected equipment shall be calibrated and shall be arranged by the contractor at his own cost. However, necessary instruction and the guidelines will be given by BHEL/owner.

In case Contractor is unable to provide the calibrated measuring and test instruments to the satisfaction of 'ENGINEER' then as per his own wisdom/ judgement can recommend a deduction of maximum limit up to 5% from the Contractor's bill. But this in no way relieves the Contractor from arranging the test & measuring instruments / equipment as required for completion of the 'PROJECT' without affecting the quality of work and meeting any Contractual obligation whatsoever.

C.8.3 The contractor shall be completely responsible for the satisfactory erection and providing Test Equipment and skilled manpower for testing, commissioning of all equipment, not withstanding the fact that he may be assisted by BHEL or its authorised representative.

C.8.4 The installation of all electrical equipment shall be carried out only by an electrical contractor holding a valid License for carrying out installation work of the voltage classes involved, under the direct supervision of and by persons holding valid certificates of competency for the same voltage classes, issued or recognised by the State Government. Contractor shall submit the particulars of the License held by him.

C.8.5 The contractor shall furnish to BHEL the names and particulars of certificates of competency of the supervisors and workmen to be engaged for carrying out installation work against this specifications.

C.8.6 The work shall be executed in a workman like manner in accordance with the requirements specified in the General Specification of Electrical Equipment installation, testing and commissioning specifications. Copy of such specifications/ drawings will be given to successful bidder before starting the work.

C.8.7 All electrical work shall also comply with standard norms and practices adopted by the State Electricity Board. Site test reports shall be prepared and submitted by the contractor.

C.8.8 Before charging the installation in part or full, this shall have to be approved by Statutory Govt. Authorities like Electrical Inspector, other concerned agency and the contractor has to arrange approval for the same as and when required by BHEL/Owner.

C.8.9 Any feasible modification in the equipment or installation that may be demanded by Electrical Inspector shall have to be carried out by the contractor at no extra charges to BHEL. The contractor shall take all necessary steps to enable BHEL/Owner to get the installation approved by the above authorities & shall render all necessary assistance to BHEL/Owner in the matter.

C.9.0 **COMPLETION OF CONTRACT:**

C.9.1 All equipment, mountings, fittings accessories or apparatus which may not have been specifically mentioned but which are usual or necessary for completing the erection and commissioning work of system, shall be done by the contractor without any extra charges.

C.10.0 **TRIAL OPERATION AND HANDING OVER:**

C.10.1 On completion of erection of the equipment and before pre-commissioning tests of the equipment, each of the equipment shall be inspected by the BHEL/Owner for the correctness and completeness of the installation. Thereafter commissioning engineers shall carry out all pre-commissioning tests. The results of such pre-commissioning tests shall be signed jointly by the contractor`s representative and BHEL/Owner.

C.10.2 On conclusion of satisfactory pre-commissioning tests, the trial operation of the equipments shall start. The equipment shall be on trial operations during which period all necessary adjustments shall be made.

C.10.3 After completion of trial operation, the plant will be handed over to the owner, after the period to be specified by BHEL. On taking over the plant, the owner shall issue a certificate to that effect.

C.10.4 BHEL/Owner shall be at liberty from time to time or at any time before the completion of the works to take possession and use any part of the completed works and in such case the contractor shall completely finish the said uncompleted part or parts of the works as and when the engineer shall direct whether before or after the respective prescribed time or extended time (if any) for the completion of the works and if required by the engineer while the owner is in possession of the said part or parts, of the site or works.

C.10.5 If due to reason of any default on the part of Contractor, a taking over certificate has not been issued in respect of any portion of the works, within one month after the time for completion or extended time as the case may be, the Owner/BHEL shall be at liberty to use the works or any portion thereof in respect of which a taking over certificate has not been issued, provided that the works or the portion so used as aforesaid shall be reasonably capable of being used and that the Contractor shall be afforded the earliest opportunity of taking such steps as may be necessary to permit the issue of the taking over certificate.

C.11.0 **ADDITIONAL EXPENDITURE:**

In case any additional expenditure is incurred in the works arising out of the faulty execution of the works by the contractor, such additional expenditure shall be borne by the contractor.

C.12.0 **SPLITTING THE WORK:**

BHEL reserves the right to split the work and award any part of the work to any agency without assigning any reason whatsoever.

C.13.0 **SUPPLY OF MATERIAL:**

C.13.1 The Contractor shall in no case be entitled to any compensation or damage on account of any delay in supply or non- supply there of for all or any such materials and stores but the contractor shall be entitled to suitable extension of time as may be determined by the Engineer whose decision shall be final and binding.

C.13.2 The contractor shall satisfy himself of the quantity and quality of the materials at the time of taking delivery from the BHEL/Owner. No claim whatsoever will be entertained by the BHEL/Owner on account of quality or quantity after the materials are taken by the contractor from the BHEL/Owner.

C.14.0 **ELECTRICITY AND WATER:**

C.14.1 Electricity for construction work shall be provided at one point on chargeable basis at the rate prevailing at the time of drawal of power, unless specified otherwise. The contractor shall have to make their own arrangements, at their cost, for distribution to various locations for their works including proper switch/fuse units, distribution boards, cables, poles etc. to ensure safety of men and equipment. Where required the contractor shall employ diesel operative equipment in addition to electric operated ones to ensure timely completion of work.

In case BHEL is unable to provide Electricity on chargeable basis then the contractor has to arrange same at his end.

C.14.2 The contractor shall indicate in his offer the power load required by him along with the load details for which power is required.

C.14.3 The owner shall not be responsible for any inconvenience caused due to any failure of lighting and power supply and no compensation for delay in works can be claimed by the contractor due to such non-supply on the grounds of idle labour, machinery or any other grounds.

C.14.4 The contractor should ensure that the work in critical areas is not held up in the event of lighting and power breakdown and for the same he should have some standby arrangement at his cost. In the event of breakdown in the electric supply, if the progress of work is hampered, it will be the responsibility of the contractor to step up the progress after restoration of electric supply so that over all progress of work is not affected. The contractor shall make proper arrangement of illumination at work place while working in late hours or in darkness.

C.14.5 Unless stated otherwise in the scope of works, the contractor shall make his own adequate arrangement for procuring clear water to be used in the works.

C.15.0 **INSURANCE :**

C.15.1 Contractor shall take insurance cover(s) to cover his Tools and Plants, Assets, workmen compensation and third party liability. The contractor shall make available the original insurance cover(s) to the Engineer for necessary verification before commencement of work.

C.16.0 **ESCALATION/PRICE VARIATION :**

C.16.1 Under this contract, **No escalation/ Price variation** is allowed. The quoted prices are FIRM till complete commissioning and handing over of the Project to Customer/Owner.

C.17.0 **OVERRUN CHARGES:**

C.17.1 Above clause No.C-17.0 stands deleted. Please refer Annexure to conditions of contract for ETC works.

C.18.0 **CONSTRUCTION SCHEDULE:**

C.18.1 While submitting the offer the contractor shall furnish Bar Chart detailing out all major activities, as to how he proposes to complete the work maintaining the completion schedule as given in Notice Inviting Tender. If the contractor fails to achieve any milestone indicated in the Bar Chart/completion schedule mentioned elsewhere, the contractor shall be levied penalty as per clause C.5.0.

C.19.0 **HEAVY MATERIAL HANDLING EQUIPMENT:**

The contractor must clearly indicate the details of all Heavy Materials Handling Equipment owned by him in Annexure-C of Section-A, General Instructions to the Tenderer. The boom length, capacity of handling load and other relevant details must also be given.

C.20.0 **CALIBRATED TEST INSTRUMENTS:**

Contractor is required to bring all the required testing equipments and instruments for conducting pre-commissioning test. All instruments should be calibrated as this is an ISO System requirement and the contractor should furnish test certificate for calibration. Also, please see clause E.4.2 and E.6.3 of Section-E for more details.

C.21.0 Contractor should maintain moisture free store.

C.21.1 Illumination system in & around store should be maintained by the contractor.

C.21.2 All the material stored in the open yard shall be covered by tarpaulins to be arranged by the contractor.

C.22.0 **PROTECTION OF WORK :**

C.22.1 Contractor shall effectively protect his work, equipment, material from theft, damage or tempering at his own expenses till the work is finally taken over by the BHEL/Owner.

C.22.2 Finished work where required, shall be suitably covered to keep it clean and free from defacement or damage.

C.22.3 Necessary fire protection arrangement is to be made by the contractor for store and place of work.

C.23.0 **SAFETY MEASURES :**

C.23.1 All safety rules and codes as applicable to work shall be followed without exception.

C.23.2 All safety appliances and protective devices including safety belt, hand gloves, aprons, helmets, shield goggles etc. shall be provided by the contractor to his personnel. Also, the Contractor must follow BHEL Quality system to ensure safety in all activities of site work.

C.24.0 **QUALITY RECORDS (FQPs, MATERIAL MANAGEMENT ETC.)**

C.24.1 Contractor should follow field quality plan furnished by BHEL to ensure quality in all activities of work performed at site.

C.24.2 The contractor shall have to maintain records pertaining to Material Verification on receipt at site as well as Daily Receipt Register, Stock Register as per the various quality systems of BHEL.

C.25.0 The contractor shall remove all scaffolding, ladders, temporary structures etc. erected by him during erection in order to leave place neat and clean to the satisfaction of the owner.

C.26.0 All packing/items are to be checked immediately on receipt at site. Any shortages, damages are to be reported to BHEL within a week's time in writing.

C.26.1 All parts shall be thoroughly cleaned, all rust removed and surface polished as required before erection of any equipment.

C.26.2 Cleaned and polished parts shall be coated with anti-corrosive paints wherever necessary.

C.27.0 After completion of work, reconciliation is to be done for all the material issued to the contractor. Balance materials are to be returned to BHEL/Owner.

C.28.0 **WORKING HOURS:**

If in the opinion of BHEL, the progress of the erection work by the contractor at any stage needs expediting so as to ensure completion of work within stipulated time, BHEL shall have the right to instruct the Contractor to increase the Contractor's manpower and working hours and the contractor shall comply with such instructions without any Extra Charges.

C.29.0 **DIVISION OF WORK:**

Prices are to be quoted for schedule of Equipment - E.10.0 of Section-E. Work can be split-up and awarded to more than one contractor as per requirement of BHEL/Owner for timely completion of Project.

C.30.0 **INCOME TAX / SALES TAX / WORKS TAX/VAT**

~~The prices to be quoted by bidder should be EXCLUSIVE of service tax and~~

Please refer " Annexure to conditions of contract for ETC Work" attached with the tender documents.

Above clause No.C-30.0 stands deleted.Please refer Annexure to conditions of contract for ETC works.

C.31.0 DISCREPANCIES AND ADJUSTMENT OF ERRORS

C.31.1 The several documents forming the contract are to be taken as mutually explanatory of one another, detailed drawings being followed in preference to small scale drawings & figures dimensions in preference to scale & special conditions in preference to general conditions.

C.31.2 In case of discrepancies between schedule of quantities, the specification and/or the drawings the following order of preference shall be observed.

a) Description in Schedule of Quantities.
b) Special Conditions.
c) Drawings
d) Technical Specifications.
e) General Conditions of Contract.

C.31.3 If there are varying or conflicting provisions made in any one document forming part of the contract, the Engineer shall be deciding authority with regard to the document.

C.31.4 Any error in the description, quantity in schedule of quantities or any omission there from shall not vitiate the contract or release the contractor from the execution of the whole or any part of the works comprised therein according to the drawings and specifications or from any of his obligations under the contract.

C.31.5 If on check there are found to be differences between the rates given by the contractor in words and figures or in the amount worked out by him in the schedule of quantities and general summary, the same shall be adjusted in accordance with the following rules. :

a) In the event of discrepancies between description in words and figures quoted by tenderer, the description in words shall prevail.

b) In event of an error occurring in the amount column of schedule of quantities as a result of wrong extension of the unit rate and the quantity, the unit rate shall be regarded as firm and extension shall be amended on the basis of the rates.

c) All errors in totalling in the amount column and in carrying forward totals shall be corrected.

d) The totals of sections of bill of quantities amended shall be carried over to the general summary and the tendered sum amended accordingly. The tendered sum so altered shall, for the purpose of tender be substituted for the sum originally tendered and considered for acceptance instead of the original sum quoted by the tenderer. Any rounding of quantities or in sections of bill of quantities or in general summary, by the tenderer, shall be ignored.

C.31.6 If neither drawings nor specifications contain any mention of minor details of construction which in the opinion of the Engineer, whose decision shall be final and conclusive, are reasonable and obviously and fairly intended for satisfactory completion of work, such details shall be provided by the contractor without any extra cost, as if they were specially mentioned and shall be deemed to be included in the contract.

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SECTION-D

ERECTION CONDITIONS OF CONTRACT

SECTION - D

ERECTION CONDITIONS OF CONTRACT

D.1.0 **GENERAL:**

D.1.1 The following shall supplement the conditions already contained in the other parts of these specifications and documents and shall govern that portion of the work of this contract to be performed at site.

D.1.2 The contractor upon signing of the contract shall, in addition to a Project Coordinator, nominate another responsible officer as his representative at site suitably designated for the purposes of overall responsibility and co-ordination of the works to be performed at site. Such person shall function from the site office of the contractor during the pendency of the contract.

D.2.0 **REGULATION OF LOCAL AUTHORITIES AND STATUTES:**

D.2.1 The contractor shall comply with all the rules and regulations of local authorities during the performances of his field activities. He shall also comply with the **Minimum Wages Act, 1948 and the Payment of Wages Act** (Both of Government of India) and the rules made there under in respect of any employee or workman employed or engaged by him or his sub-contractor.

The Contractor should note that all instructions of Engineer shall be binding for example display of Minimum Wages paid to the workmen, construction of toilets etc. in the vicinity of working area from health and sanitation standpoint etc.

D.2.2 All registration and statutory inspection fees, if any in respect of his work pursuant to this contract shall be to the account of the contractor. However any registration, statutory inspection fees lawfully payable under the provision of the statutory laws and it's amendments from time to time during erection in respect of the plant equipment ultimately to be owned by the Owner/BHEL shall be to the account of the Owner/BHEL. Should any such inspection or registration need to be rearranged due to the fault of the Contractor or his sub-contractor, the additional fees for such inspection and/or registration shall be borne by the contractor.

D.3.0 **OWNER'S LIEN ON EQUIPMENT :**

The owner/ BHEL shall have lien on all equipments including those of the contractor brought to the site for the purposes of erection, testing and commissioning of the plants. The Owner/ BHEL shall continue to hold the lien on all such equipments through out the period of contract. No material brought to the site shall be removed from the site by the contractor and/ or his Sub-contractors without the prior written permission of BHEL.

D.4.0 **RE-WORKS ETC. :**

In case Owner/BHEL/consultant during inspection at site rejects an item already agreed and the same is agreed to by BHEL and any re-execution of works of other contractors and/or his agencies, which might have got damaged or affected by the replacements will have to be attended to by the contractor free of cost.

D.5.0 ACCESS TO SITE AND WORKS ON SITE :

D.5.1 Suitable access to and possession of the site shall be provided to the contractor by Owner/ BHEL in reasonable time.

D.5.2 The works so far as it is carried out on the owner's premises shall be carried out at such time as the owner/BHEL may approve and the Owner/ BHEL shall give the contractor reasonable help/ facility for carrying out the works.

D.5.3 In the executions of the works, no persons other than the Contractor or his duly appointed representative, Sub- contractor and workmen shall be allowed to do work on the site except by the special permission in writing by BHEL.

D.6.0 **CONTRACTOR'S SITE OFFICE ESTABLISHMENT:**

The contractor shall establish site office at the site and keep posted an authorised representative for the purpose of contract. Any written order or instruction of BHEL or his duly authorised representative shall be communicated to the contractor at the site office and the same shall deemed to have been communicated to the contractor at his legal address.

D.7.0 **CO-OPERATION WITH OTHER CONTRACTORS:**

D.7.1 The contractor shall co-operate with all other contractors or tradesmen of the owner/BHEL who may be performing other works on behalf of them and the workmen who may be employed by the owner/BHEL doing work in the vicinity of the works under the contract. The contractor shall also arrange to perform his work as to minimise to the maximum extent possible interference with the work of other contractors and his workmen. Any injury or damage that may be sustained to the employees of the other contractors, BHEL and the owner due to the contractor's work shall promptly be made good at contractors own expenses. The owner/ BHEL shall determine the resolution of any difference or conflict that may arise between the contractor and other contractor's or between the contractor and workmen of the owner and BHEL in regard to their work. If the works of the contractor is delayed because of any acts or omission of another contractor, the contractor shall have no claim against the owner/ BHEL on that account other than an extension of time for completing his works.

D.7.2 BHEL shall be notified promptly by the contractor of any defects in the other contractor's works that could affect to the contractor's works. The owner/BHEL shall determine the corrective measures if any, required to rectify this situation which shall be binding on the contractor.

D.8.0 **DISCIPLINE OF WORKMEN:**

D.8.1 The contractor shall adhere to the disciplinary procedure set by the owner in respect of his employees & workman at site. The owner/BHEL shall be at liberty to object to the presence of any representatives or employee of the contractor at the site, if in the opinion of the owner/ BHEL such employee has misconducted himself or be incompetent or negligent or otherwise undesirable and then the contractor shall remove such a person objected to and provide in his place a competent replacement.

D.9.0 **CONTRACTOR'S FIELD OPERATION:**

D.9.1 The contractor shall keep informed in advance regarding his field activity plans & schedule for carrying out such part of the works. Any review of such plan or schedule or method of work by the BHEL shall not relieve the contractor of any of his responsibilities towards the field activities and its schedule. Such reviews shall also not be considered as an assumption of any risk or liability by the owner/BHEL or consultant or any of his representatives and no claim of the contractor will be entertained because of the failure or inefficiency of any such plan or schedule or method or work reviewed. The contractor shall be solely responsible for the safety adequacy and efficiency of plant and equipments and his erection methods.

D.9.2 The contractor shall be completely responsible for the conditions of the work-site including the safety of all persons employed by him or his sub-contractor and all the properties under his custody during the performance of the work. This requirements shall apply continuously till the completion of contract and shall not be limited to normal working hours.

D.10.0 **PHOTOGRAPH AND PROGRESS REPORT:**

D.10.1 The Contractor shall furnish to BHEL photographs of the progress of work / work done at site. Photographs shall be taken as & when indicated by BHEL representative. Photograph shall be adequate in size & number to indicate various stages of erection. Each photograph shall contain the date, the name of the Contractor and the title of the Photograph. The cost of photographs is to be born by the Contractor.

D.10.2 The above Photographs along with the soft copy (on floppy/CD) shall accompany the monthly progress report detailing out the progress achieved on all erection activities as compared to the schedules. The report shall also indicate the reasons for the variance between the scheduled and actual progress and action proposed for corrective measures wherever necessary.

D.11.0 **MANPOWER REPORT:**

D.11.1 The Contractor shall submit to BHEL from the first working day of every month, a Manpower report of the previous month detailing the number of persons scheduled to have been employed and actually employed skill-wise and the areas of employment of such labour.

D.12.0 **PROTECTION OF WORK:**

The Contractor shall have total responsibility for protecting his works till it is finally taken over by the owner. No claim will be entertained by the BHEL for damage or loss to the Contractor's works & the contractor shall be responsible for the complete restoration of the damaged work to its original condition to comply with the specification & drawings. Should any such damage to the Contractor's works occur because of other party not under him directly, & if disagreement or

conflict or dispute develops between the contractor & the other party or parties concerns works the same will be resolved as per the provisions of the clause D.7.0 above entitled cooperation with other contractors. The contractor shall not cause any delay in the repair of such damaged works because of any delay in the resolution of such dispute. The contractor shall proceed to repair the work immediately & no cause thereof will be assigned pending resolution of such dispute.

D.13.0 **EMPLOYMENT OF LABOUR:**

D.13.1 The Contractor will be expected to employ on the work only his regular skilled employees with experience of his particular work. No female labour shall be employed after darkness. No person below the age of eighteen years shall be employed.

D.13.2 All travelling expenses including provision of all necessary transport to and fro for Site, lodging allowance and other payments to be Contractor's employees shall be the sole responsibility of the contractor.

D.13.3 The hours of work on the Site shall be decided by the owner/BHEL and the Contractor shall adhere to it. Working hours will normally be eight (8) hours per day Monday through Saturday or depending upon the situation/ requirement.

D.13.4 Contractor's employees shall wear identification badges while on the work at site.

D.13.5 In the case of owner/BHEL become liable to pay any wages or dues to the labour or to any Government agency under any of the provisions of the Minimum Wages Act, Workmen Compensation Act, Contractor Labour Regulation Abolition Act or any other law due to act or omission of the Contractor, BHEL may make such payment and recover the same from the Contractor's bills or from any amount which is already under process of payment to the Contractor.

D.14.0 **FACILITIES TO BE PROVIDED BY OWNER:**

D.14.1 Space: The Contractor shall advice BHEL within Fifteen (15) days from the date of acceptance of the Letter of Intent about his exact requirement of space for his office, storage area. The above requirements shall be reviewed by the Owner/BHEL & space will be allotted to the Contractor for construction of his temporary structures like office and storage sheds.

D.14.2 Construction water and power (Electricity) (Refer Clause C.14.0).

D.15.0 **FACILITIES TO BE PROVIDED BY THE CONTRACTOR:**

D.15.1 **CONSTRUCTION EQUIPMENTS, TOOLS, TACKLES AND SCAFFOLDINGS:**

The Contractor shall provide all the construction equipments, tools, tackles and scaffoldings required for pre-assembly, erection, testing and commissioning of the equipments covered under the contract. He shall submit a list of all such materials to the BHEL before the commencement of work at Site. These tools and tackles shall not be removed from site without the written permission of the owner/BHEL.

D.15.2 **COMMUNICATION:**

The Contractor will make his own arrangement for all his communication needs such as telephone, fax etc., at his site office and his residential accommodation.

D.15.3 **FIRST AID:**

The Contractor shall provide necessary first aid facilities for all the employees, representatives and workmen working at the Site. Enough number of contractor's personnel shall be trained in administering first aid.

D.15.4 **CLEANLINESS:**

D.15.4.1 The Contractor shall be responsible for keeping the entire area allotted to him clean and free from rubbish, debris, etc. during the period of contract. The Contractor shall employ enough number of special personnel to thoroughly clean his work-area at least once in a day. All such rubbish and scrap material shall be stacked or disposed in a place to be identified by the owner/BHEL. Materials and stores shall be so arranged to permit easy cleaning of the area. In areas where equipment might drip oil and cause damage to the floor surface, a suitable protective cover of the flame resistant, oil proof shield shall be provided to protect the floor from such damage.

D.15.4.2 Similarly the labour colony, the office & the residential areas of the Contractor's employees and workmen shall be kept clean & neat to the entire satisfaction of the Owner/BHEL. Proper sanitation arrangements shall be provided by the contractor in the workmen areas, office and residential areas of the contractor.

D.16.0 **LINES AND GRADES:**

All the works shall be performed to the lines, grades and elevations indicated on the drawings. The Contractor shall be responsible to locate the layout of the works. Basic horizontal and vertical control points as required will be established & marked by the Owner/BHEL at Site at suitable points.

These points shall be used as datum for the works under the contractor. The contractor shall inform the Engineer well in advance of the time and places at which he wishes to do work in the area allotted to him, so that suitable datum points may be established and checked by Owner/BHEL to enable the contractor to proceed with his works. Any work done without being properly located may be removed and/or dismantled by the Owner/BHEL at Contractor's expenses.

D.17.0 **FIRE PROTECTION:**

D.17.1 The work procedures that are to be used during erection shall be those which minimise fire hazards to the extent practicable. Combustible materials, combustible waste and rubbish shall be collected and removed from the site at least once each day. Fuels, oils and volatile or flammable materials shall be stored away from the construction and equipments and material storage and areas in safe containers. Untreated canvas paper, plastic or other flammable materials shall not at all be used at site for any other purpose unless otherwise specified, if any such materials are received with the equipment at the Site, the same shall be removed and replaced with acceptable materials before moving in to the construction area or storage.

D.17.2 Similarly corrugated paper fabricated cartons etc., will not be permitted in the construction area either for storage or for handling of materials. All such materials used shall be of water proof and flame resistance type. All other materials such as working drawings, plants etc. which are combustible but are essential for the works to be executed shall be protected against combustion resulting from welding sparks, cutting flames and other similar fire sources.

D.17.3 All the contractors supervisory personnel and sufficient number of workers shall be trained for fire-fighting and assigned specific fire protection duties. Enough of such trained personnel must be available at the Site during the entire period of the Contract.

D.17.4 The contractor shall provide enough fire protection equipment of the types and number for the ware-houses, office, temporary structures, labour colony area etc., access to such fire protection equipment shall be easy and kept all times.

D.18.0 **SECURITY:**

The Contractor shall have total responsibility for all equipments & materials in his custody stored, loose, semi assembled and/or erected by him at site. The contractor shall make suitable security arrangements including employment of security personnel to ensure the protection of all materials, equipments and works from theft, fire, pilferage & other damages and losses. All materials belonging to the Contractors shall enter and leave the project site only with the written permission of the Owner/BHEL in the prescribed manner.

D.19.0 **CONTRACTOR'S AREA LIMITS:**

The Owner will make out the boundary limits of access roads, parking spaces, storage and construction areas for the contractor and the contractor shall not trespass the areas not so marked out for him. The contractor shall be responsible to ensure that none of his personnel move out the areas marked out for his operations. In case of such a need for the contractor's personnel to work in the areas not marked out for him, the same shall done only with written permission of the Owner/BHEL.

D.20.0 **CONTRACTOR'S COOPERATION WITH THE OWNER/ BHEL:**

In cases where the performances of the erection work by the contractor affects the operation of the system facilities of the Owner/BHEL such erection work of the contractor shall be scheduled to be performed only in the manner stipulated by the Owner/BHEL and the same shall be acceptable at all times to the contractor. The Owner/BHEL may impose such restriction on the facilities provided to the contractor such as electricity, water etc., as he may think fit in the interest of the Owner/BHEL and the contractor shall strictly adhere to such restrictions and cooperate with the Owner/BHEL. It will be responsibility of the contractor to provide all necessary temporary instrumentation and other measuring devices required during start up and operation of the equipment system which are erected by him. The contractor shall also be responsible for flushing and initial filling of all the oil and lubricant required for the equipment furnished and erected by him, so as to make such equipments ready for operation. The contractor shall be responsible for supplying such flushing oil & other lubricants unless otherwise specified elsewhere in these documents and specifications.

D.21.0 **PRE-COMMISSIONING TRIALS AND INITIAL OPERATIONS:**

The pre-commissioning trials and initial operations of the equipments furnished and erected by the contractor shall be the responsibility of the contractor as detailed in relevant clauses. The contractor shall provide in addition, test instruments calibrating devices etc. and the labour required for the successful performance of these trials. If it is anticipated that the above test may prolong for a long time, the Contractor's workmen required for the above test shall always be present at site during such trials.

D.22.0 **MATERIAL HANDLING AND STORAGE:**

D.22.1 All the equipments furnished under this contract arriving at site shall be promptly received, unloaded, transported and stored in the storage spaces by the contractor.

D.22.2 Contractor shall be responsible for examining all the shipments immediately on receipt at site and notify BHEL immediately if any damage, shortage, discrepancy. Filling of material verification reports on receipt of materials shall be carried out by the Contractor as per the instructions of Engineer. For any shortages or damages in transit, handling and/or in storage and erection of the equipments at site shall be intimated to BHEL/ equipment supplier promptly to enable them lodge claim with the underwriters. Any financial and/or time loss happened due to contractor's negligence in this regard shall be to the account of the contractor. Any demmurrage, wharfage and any other charges claimed by the Transporter or Railways due to any reason attributable to the contractor such as delay in taking delivery in time shall also be to the account of the contractor.

D.22.3 The Contractor shall maintain an accurate and exhaustive record detailing out the list of all equipments received and keep such record open for the inspection of the Owner/BHEL at any time.

BHEL is an ISO Company and the contractor shall extend all help in maintaining records of receipts, issue and stock in line with Material Management System issued by BHEL. Also, he shall assist in periodic inspection of equipment/materials in stores as per this system.

The Contactor shall carryout all field activities related with ETC work as per Field Quality Plans (FQPs) provided by Engineer to ensure Quality of work at site as well as meet the contractual obligation to BHEL/Owner.

D.22.4 All equipments shall be handled very carefully to prevent any damage or loss. No bare wire ropes, slings etc. shall be used for unloading and/or handling of the equipments without the specified written permission of BHEL. The equipment stores shall be properly protected to prevent damage either to the equipment or to the floor where they are stored. The equipment from the store shall be moved to the actual location at the appropriate time so as to avoid damage of such equipment at site.

D.22.5 All electrical panels, control gears, motors and such other devices shall be properly dried by heating before they are installed and energised. Motor bearings, slip rings, commutators and other exposed parts shall be protected against moisture ingress and corrosion during storage and periodically inspected. Heavy rotation parts if any, in assembled conditions shall be periodically rotated to prevent corrosion due to prolonged storage.

D.22.6 All the electrical equipment, such as motors, transformers etc. shall be tested for insulation resistance at least once in three months from the date of receipt till the date of commissioning and record for such measured insulation values maintained by the contractor. Such records shall be open for inspection by the Owner/BHEL.

D.22.7 The contractor shall ensure that all the packing materials and protection devices used for the various equipments during transit and storage are removed before the equipments are installed.

D.22.8 The consumable and other supplies likely to deteriorate due to storage must be thoroughly protected and stored in a suitable manner to prevent damage or deterioration in quality by storage.

D.22.9 All the materials stored in the open or dusty location must be covered with suitable weather proof & flame proof covering materials wherever applicable.

D.22.10 If the materials belonging to the contractor are stored in areas other than these earmarked for him, the Owner/BHEL will have the right to get it removed to the area earmarked for the contractor at the contractor's cost.

D.22.12 **STORAGE INSTRUCTION FOR GAS FILLED EQUIPMENTS:**

D.22.12.1 All transformers despatched to site are fitted with Nitrogen cylinder in the tank to maintain positive pressure. It will be the responsibility of the contractor to maintain the pressure and replace the empty Nitrogen cylinder with Nitrogen filled cylinder of required purity at his own cost whenever such cylinders are become empty. Contractor should also maintain the periodic record of the pressure of Nitrogen in the transformer in a register for this purpose.

D.22.12.2 For all other gas filled equipments, like CTs, VTs, CVTs etc. the contractor should also maintain the gas pressure & if it falls below the required value, contractor should refill the leaked gas of required purity at his own cost.

D.23.0 **CONSTRUCTION AND ARRANGEMENTS:**

D.23.1 The field activities of the contractors working at site, will be coordinated by BHEL and BHEL decision shall be final in resolving any dispute or conflicts between the contractor and other contractor's and tradesmen of the BHEL regarding scheduling and coordination of work. Such decisions shall not be cause for extra compensation for time to the contractor.

D.23.2 The Owner/Consultant shall hold weekly meetings of all the contractors working at the site at a time and a place so designated. The contractor along with BHEL shall attend such meetings and take notes of discussions during the meeting and the decisions of the Owner/BHEL/Consultant shall be strictly adhered to in performing his works. In addition to the above weekly meetings, the Owner/Consultant/BHEL may call for other meetings either with individual contractors or with selected number of contractors and in such a case the contractor, if called will also attend such meetings with BHEL.

D.23.3 Time is the essence of the contract & the contractor shall be responsible for performance of his work in accordance with the specified construction schedule. If at any time the contractor is falling behind the schedule, he shall take necessary action to make good for such delay by increasing his work force or by working overtime or otherwise accelerate the progress of the work to comply with the schedule and shall communicate such actions in writing to the BHEL satisfying them that his action will compensate for the delay. The contractor shall not be allowed any extra compensation for such action.

D.23.4 BHEL shall however not be responsible for provision of additional labour and/or materials or supply or any other service to the contractor except for the coordination work between various contractors as set out earlier.

D.24.0 **FIELD QUALITY PLANS AND RECORDS:**

The contractor shall maintain at his Site Office upto date copies of all drawings, specifications, FQPs and other contract documents and any other supplementary data complete with all the latest information thereto. The contractor shall also maintain in addition the continuous record of all changes to the above contract documents, drawings, specifications, supplementary data etc. effected at the field and on completion of his total assignment under the contract, shall incorporate all such changes on the drawings and other engineering data to indicate as installed/build conditions of the equipments furnished and erected under the contract.

Such "AS BUILT DRAWINGS" and "ENGINEERING DATA" shall be submitted to BHEL in required number of copies.

D.25.0 **CONTRACTOR'S MATERIALS BROUGHT ON TO SITE:**

D.25.1 The contractor shall bring to site all equipments, components, parts, materials, including construction equipment, tools & tackles for the purpose of the works under intimation to the owner/BHEL. All such goods shall, from the time of there being brought to site but may be used for the purpose of the works only and shall not on any account be removed or taken away by the contractor without the written permission of the BHEL.

D.25.2 After the completion of the works the contractor shall remove from the site under the direction of the BHEL the material such as construction equipment, erection tools and tackles, scaffolding etc. with the written permission of BHEL. If the contractor fails to remove such materials within fifteen (15) days of issue of a notice by the BHEL to do so, then BHEL shall have the liberty to dispose/remove such materials and expanses incurred by BHEL in this regard will be recovered from the Contractor.

D.26.0 **PROTECTION OF PROPERTY AND CONTRACTOR'S LIABILITY:**

D.26.1 The contractor shall be responsible for any damage resulting from his operation. He shall also be responsible for protection of all persons including members of public and employees of the Owner/BHEL and the employees of other contractors and subcontractors building, other plants and equipments and utilities either above or below the ground.

D.26.2 The contractor will ensure provisions of necessary safety equipments such as barriers, sign-boards, warning lights and alarm etc. to provide adequate protection to persons and property. The contractor shall be responsible to give reasonable notice to Owner/BHEL of public or private property and utilities when such property and utilities are likely to get damaged or injured during the performance of his work shall make all necessary arrangements with such owners related to removal and or replacement or protection of such property and utilities.

D.27.0 **PAINTING:**

All exposed metal parts of the equipment including pipings, structures, railings etc. wherever applicable shall be first painted with at least one coat of suitable primer after thoroughly cleaning all such parts off dirt and rust scales, greases, oil and other foreign materials by wire brushing, scraping or/and blasting and the same being inspected and approved by the Engineer for painting. After wards the above parts shall be finished with two coats of enamel paint. The quality of the finish paint shall be as per the standards of ISI equivalent and to be of the colour as approved by the Owner/BHEL.

D.28.0 **PROTECTION OF MONUMENTS AND REFERENCE POINTS:**

The contractor shall ensure that at points such as relic, antiquity, coins, fossils etc. which he may come across during the course of performance of his works either during excavation or elsewhere are properly protected & handed over to the owner under intimation to BHEL. Similarly the contractor shall ensure that the bench marks reference points etc. which are marked out either with the help of owner or by BHEL shall not be disturbed in any way during the performance of his works. If any work is to be performed which may disturb such references, the same shall be only after these are transferred to other suitable locations under the direction of BHEL. The contractor shall provide all necessary materials and assistant for such relocation of reference points etc.

D.29.0 **WORK AND SAFETY REGULATIONS:**

D.29.1 The contractor shall ensure the safety of all the workmen, materials, and equipment either belonging to him or to others working at site.

D.29.2 The contractor will notify the BHEL office of his intention to bring on to site any equipment or any container with liquid or gases, fuel or other substances which may create hazards. BHEL shall have the right to prescribe the conditions under which such equipment or container may be handled and used during the performance of the works and the contractor shall strictly adhere to such instructions. BHEL shall have strictly the right to inspect any construction plant and to forbid its use, if in his opinion it is unsafe. No claim due to such prohibition shall be entertained by BHEL.

D.29.3 Where it is necessary to provide and/or store petroleum products or petroleum mixtures & explosive, the contractor shall be responsible for carrying out such provision and/or storage in accordance with the rules and regulations laid down in Petroleum Act,1934. Explosively Act,1948 and petroleum and carbide of calcium manual published by the Chief Inspector Of Explosive of India. All such storage shall have prior approval of BHEL in case any approval are necessary from the Chief Inspector of Explosive of any statutory authorities, the contractor shall be responsible for obtaining the same.

D.29.4 The contractor shall be responsible for the safe storage of his & his sub-contractor's radio-active source if any.

D.30.0 **ELECTRICAL SAFETY REGULATIONS:**

D.30.1 In no circumstances will the contractor interfere with fuses and Electrical Equipment belonging to BHEL/Owner or to the other contractors.

D.30.2 Before the contractor connects any electrical appliances to any plug or sockets belonging to the other contractor or Owner, he shall:

(a) Satisfy the Owner/BHEL that the appliances are in good working conditions.
(b) Inform the Owner/BHEL of the maximum current, relating, voltage etc. of the appliances.
(c) Obtain permission of the Owner detailing the sockets to which the appliances may be connected.

D.30.3 The BHEL will not grant permission to the contractor until he satisfies that:

(a) The appliance is in good conditions and fitted with suitable plug.
(b) The appliance is fitted with a suitable cable having proper earthing provisions.

D.30.4 No cable in use will be disturbed by the contractor without prior permission. No weight of any description will be imposed on any such cable and no ladder or similar equipment will rest against or attached to it.

D.30.5 No work shall be carried out on any live equipment. The equipment must be made safe by the BHEL/Owner and a permit to work issued before any work is carried out.

D.30.6 The contractor shall employ the necessary number of qualified full time electrician to maintain his temporary electrical installation.

D.31.0 **CONSUMABLES:**

The contractor shall make arrangements for an adequate inventory at site of necessary consumable prior to erection so that the requirements of the same will not come in the way of timely completion of the works under the contract.

D.32.0 **MILD STEEL AND ALUMINIUM WELDING & OTHER SPECIAL PROCESSES :**

D.32.1 Only an approved and qualified welder shall be employed by the contractor. The welder will be subjected to pre-qualification test by Owner/BHEL.

D.32.2 The Contractor shall ensure that personnel employed for doing other special processes like tube/pipe bending etc. are having proper experience and are qualified for doing such work.

D.32.3 Erection of Aluminium tubular bus bar shall include cutting, bending, aluminium welding with sleeves (sleeves supplied by BHEL), Radiographic testing and D.P test of 100% welded joints, fixing corona end bells etc to complete.

D.32.4 For MS welding, red lead paint shall be applied followed by aluminium paint and bitumen after welding. For GS welding , two coats of cold galvanising anti-corrosive paint shall be applied after welding. In case any special process is indicated in customer's specification, then the same shall be applicable.

D.32.5 10% welded joints in earthing shall be tested for Dye penetration test.

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SECTION – E

SCOPE OF WORK AND COMPLETION SCHEDULE

SECTION - E

SCOPE OF WORK AND COMPLETION SCHEDULE

E.1.0 **SCOPE OF WORK :**

The scope of work of the successful tenderer shall comprise but not limited to the following. The Tenderer shall read this scope of work in conjunction with all terms and conditions (Section -A,B,C & D) contained else where in this document. The quoted rates for various equipments/activities are deemed to include all the below mentioned activities and nothing extra is payable on account of these.

E.1.1 **For Contractor supplied materials:** It shall be prime responsibility of contractor to ensure safe storage of material supplied by him. The contractor may construct open/ covered store to ensure proper storage of the materials as per site requirement. Contractor will be permitted to dismantle and take back the stores after completion of the work. No additional payment shall be made/deducted on account of stores constructed by contractor for storing these materials.

For BHEL supplied materials: Contractor shall construct open/ covered store only if the same is mentioned in the Bill of Quantities.

If due to any reason the material can not be unloaded in designated store/open yard and it is unloaded at some nearby place on instructions of site Engineer then this material has to be shifted by subcontractor to designated store/open yard when it is ready without any additional claim. Any multiple handling of material within project premises is not payable by BHEL

Some items may get delivered at stores of other BHEL unit on account of convenience of despatch within the plant area. These material will be collected/shifted by subcontractor to switchyard store at no extra cost.

E.1.2.1 Inspection / verification of equipment / materials received for any shortage / damage after opening the packing cases and intimating the same to BHEL/ Owner and underwriters within the time period specified by BHEL and to strictly follow the procedures specified. Storage of equipment indoor / open stores in line with the instructions of the manufacturer / BHEL.

Conservation / maintenance / upkeep of the equipment in the store.

Temporary lighting in stores & construction area wherever required.

Safety / Security of equipments / materials.

E.1.2.2 **Watch and ward of Erected Equipment/Material** - Soon as the erection of switchyards are taken up, the watch and ward for the erected items will also be arranged by the subcontractor till the switchyards are taken by BHEL/customer

E.1.3 Erection, levelling and fixing of GI Structures of towers, beams including all the equipment support structures on their respective foundations in line with drawings to be furnished by BHEL. Final adjustment of foundation levels by chipping and dressing, checking location, elevation, etc., and checking position of foundations / anchor bolts and grouting/under pinning of anchor bolts and base plates wherever necessary for certain aux. equipment and accessories of main equipment. Materials such as M.S. packing shims of required thickness for levelling and alignment and civil material for final grouting with 1:1 cement mortar with approved make anti-shrinkage compound and finishing shall be arranged by contractor. *The grouting/underpinning of all tower and equipment foundation bolts as per specifications is in the scope of Contractor ie Bidder.*

Fixing and assembly including minor modification, where required, of all cable trench materials like cable tray racks, cable trays, coupler plates, 'T' and 'L' bends etc in line with drawings to be furnished by BHEL. The work shall also covers laying of all cables including glanding and termination for all the equipments covered under BOQ . At various crossing and wherever necessary the cables to pass through pipes laid underground in line with drawing to be furnished by BHEL. Pipes will be supplied by BHEL for cabling from trench to equipment and laying of the same including excavation and backfilling and making and finishing of holes in trench walls will be carried out by the contractor.

E.1.4 Transportation of equipment/material from stores to erection site, erection of equipment materials in line with the drawings/instructions to be furnished by BHEL including filtration of oil wherever required, testing and commissioning and handing over to owner/customer.

E.1.5 Earthing (if called for in BOQ) : laying of earth mat and risers including excavation, bending, cutting, welding, cleaning and painting of joints, backfilling and earth compaction etc. as per BHEL drawings/specifications.

Cutting, pointing and driving of MS rod electrode, installation of pipe electrode and construction of chambers as per drawings.

Earth connections from risers to equipment, structures etc. through GI flat including bending, cutting, welding, cleaning and painting of welded joints as per BHEL's drawings/specifications.

Welding electrode should be of reputed make company ISI certified, and as per BHEL's specifications.

E.1.6 Providing for all consumables : It shall be noted by the tenderer that BHEL shall supply only the equipments/materials listed in schedule of equipments as free issue items. Any other sundry items required for completion of the job shall be procured by the contractor.

All Equipment fixing hardware shall be arranged by BHEL.

All cable glands shall be arranged by BHEL. However cable accessories like ferrules, lugs and markers, cable dressing and tying material etc. shall be in the scope of the contractor. The lugs shall be of reputed make company and as advised by BHEL site Incharge.

E.1.7 Maintenance of switchyard and associated equipment till handing over to the owner, any other activity necessary for completion of the job but not specifically mentioned in this specification.

E.1.8 Unloading, shifting, storing, verification, preservation during storage and handing over of spare items/maintenance equipment to Customer/Owner.

E.1.9 Reconciliation and shifting of all the balance excess material and scrap material to BHEL store or handover in customer store, as the case may be.

This excess material may include erection spares for various items of BOQ such as ACSR/AAC conductor, Al tube, Cable trench materials, Cables etc. Excess erection spare (except main equipment) supplied by purchaser upto 10% of the erected quantity shall be absorbed by the contractor & shall not be payable. Only as erected quantity of the various items of BOQ shall be payable as per the unit rates. However, any erection spares (excluding main equipment) handled in excess of 10% of the erected quantity shall be payable @ 10% of the unit rate (to account for only unloading, storage and watch & ward. However, any additional quantity of main equipment, handled but not erected, shall be paid @ 10% of the item rate.

E.2.0 **ERECTION, TESTING & COMMISSIONING REQUIREMENTS :**

E.2.1 All the switchyard equipment shall be erected, installed, tested and commissioned by the contractor to the satisfaction of BHEL/Owner adhering to the latest national standard and codes. Some of the Reference standards are given below which are normally applicable for Switchyard work. ETC activity of all other equipment to be done as per relevant standards.

a) IS : 10118-1982 Code of practice for selection, installation and maintenance of switchgear & control gear.

b) IS : 10028-1985 Code of practice for installation and maintenance of transformer.

c) IS : 732-1963 Code of practice for electrical wiring.

d) IS : 3043-1963 Code of practice for earthing.

e) IS : 2309-1989 Code of practice for the protection of building and allied structure against lightning.

f) IS : 1646-1982 Code of practice for fire safety of building (General) Electrical installations.

E.2.2 All electrical equipment and installations hall also conform to the latest Indian Electricity rules as regards safety, earthing and other essential provisions specified therein for insulation and operation of electric plants.

E.2.3 Earthing system, earth connections, testing of earthing system and connection, lightning protection system, electrical clearance and safety shall be strictly followed as per the national specifications which will be given to the successful bidder.

E.2.4 The schedule of equipment indicates the quantity of the equipment and these will be procured by BHEL and are to be erected by the contractor. The contractor has to erect, test all equipment for system commissioning and putting the same into operation. The trial run of individual equipment and final commissioning upto the handing over of the system to the customer of BHEL is the responsibility of the contractor.

Contractor will have to provide necessary support i.e.. suitable manpower, common tools, conventional testing instruments as per Annexure 'N' and other assistance as required by BHEL wherever expert services of any equipment are arranged by BHEL viz.. SF6 circuit breakers.

E.2.5 All equipments, material and accessories provided by the contractor shall conform to the requirements of the relevant Indian standard or International standard.

E.3.0 **METHOD OF WORKMANSHIP & QUALITY OF WORK**:

E.3.1 Workmanship will be in accordance with the best engineering practices to ensure satisfactory performances and service life.

E.3.2 All works shall be installed in a first class manner with technical skill in the trade involved to achieve quality of work of high standard. BHEL site supervisor's comments regarding quality of work should be taken care by the contractor.

E.3.3 The erection work shall be supervised by the competent supervisor holding supervisory license by the state or central Government or statutory licensing authority, as the case may be.

E.3.4 The installation shall be carried out in such a manner not to obstruct access to the other equipment installed or likely to be installed in the vicinity.

E.3.5 The complete erection shall be performed in accordance with the modern practices for similar substation equipments.

E.4.0 **EQUIPMENT, MATERIAL & SERVICES TO BE FURNISHED**

E.4.1 The contractor shall employ sufficient labours, skilled, unskilled, supervisory and administrative personnel for timely and effective execution of the contract.

E.4.2 The contractor shall arrange as per Annexure - Q erection tools and tackles, mobile crane, all transport vehicles, measuring & testing equipments necessary for timely and effectively execution of the contract. All measuring & testing instruments shall be pre-calibrated through a certifying agency before use. The certificate of calibration shall be submitted to Engineer for records. In case Contractor is unable to provide the calibrated measuring and test instruments then 'ENGINEER' according to his own wisdom / judgement can recommend a deduction of maximum limit up to 5% from the Contractor's bill. But this in no way relieves the Contractor from arranging the test & measuring instruments / equipment as required for completion of work without affecting the quality of work and meeting any Contractual obligation whatsoever.

E.4.3 All equipment including individual component fittings and accessories shall be properly stored at site so as to obviate any deterioration of electrical properties and mechanical damages.

E.4.4 All equipment shall be thoroughly cleaned of packing materials, scales rust, oil grease etc. prior to commencement of the installation work.

E.4.5 All equipment shall be checked physically for the completeness of all components and devices before taking up installation.

E.4.6 The contractor shall repair all minor defects in equipment, free of charge, if required prior to installation in consultation with equipment manufacturer of BHEL, so that manufacturer's guarantee is not affected in any way. In case of any major damage to the equipments, the same shall be rectified or replaced by the manufacturer's representatives with the approval of BHEL / Owner.

E.4.7 All equipments and accessories shall be installed strictly in accordance with the manufacturer's instructions / drawings. Equipment supplied in sections or in dismantled conditions shall be re-assembled at site with all associated accessories as per manufacturer's instructions.

E.4.8 If the services of BHEL engineers, suppliers, and / or of any equipment manufacturers are required by the contractor at any stage of work, it will made available on chargeable basis at existing rates prevailing at that time.

E.4.9 All consumable items required to carry out welding, brazing, soldering etc. for the erection and commissioning is included in the offer of contractor and shortages in hardware (due to careless / negligent handling at site) to be made up free of cost by the contractor. The quality of such replenishment shall be at par with main supply and to be acceptable to BHEL / Owner.

E.4.10 The successful contractor should note that after execution of work they will send marked up drawings "as erected" drawings to Project Manager at site for preparation of firm "AS BUILT" drawings. "AS BUILT" drawings will bear the signature of Project Manager of BHEL and Contractor's representative.

E.4.11 **OIL FILTRATION (IN CASE OF TRANSFORMERS COVERED IN BOQ):**

An extra high vacuum oil filtration plant with a minimum of thousand GPH capacity shall be employed by the contractor for oil filtration.

An empty oil tank of minimum of 12000 ltrs. capacity also shall be arranged by the contractor to prepare the oil before pushing it into the transformer.

E.5.0 **TESTING AND COMMISSIONING OF EQUIPMENT:**

E.5.1 The testing of all electrical equipment as well as the system as a whole shall be carried out to ensure that the equipment and its components are in satisfactory condition and will successfully perform its functional operation. All required tests shall be carried out by the contractor using his own instruments, testing equipments as well as qualified testing personnel. The tests on power transformer (if covered in BOQ) shall include winding resistance, tan-delta, PPM of moisture, acidity in oil. For SF-6 Circuit Breaker (if covered in BOQ) closing and tripping timing test shall also be carried out in addition to other routine tests.

E.5.2 At site all equipments shall be energised only after certification by the personnel performing the test that the equipment is ready for energising and with the concurrence of BHEL / Owner.

E.6.0 **PREPARATION FOR COMMISSIONING:**

E.6.1 After completion of the installation at site and for the preparation of system commissioning the contractor shall carry out checking and testing of all equipment and installation in accordance with the agreed standards, codes of practices of Indian Standards Institutions and specific instruction furnished by the particular equipments suppliers as well as the Owner.

E.6.2 Required checking to be made on all equipment and installation at site. This shall include but not limited to the following:

a) Physical inspection for removal of any foreign bodies external defects such as damaged insulators, loose connecting bolts, loose foundation bolts etc.

b) Check for grease insulating / lubricating oil leakage and its proper level / quantity.

c) Check for free movement of mechanism of the circuit breaker / isolator and rotating parts of other rotating machine and devices.

d) Check for tightness of all the cables, busbars as well as earth connection in the main earthing net work.

e) Check for clearance of live busbar and conductors from the metal enclosures.

f) Continuity check in case of power and control cables.

g) Checking of all mechanical and electrical interlocks, including tripping of breakers using manual operation of relay.

h) Checking of alarm and annunciation circuits by manual actuation of relevant relays like buchholz relay in case of transformer.

i) Check and calibrate devices requiring field adjustments / calibration like adjustment of relay setting etc.

j) Check proper connection to earth-mat work of all non current carrying parts of equipments & installation.

E.6.3 All the measuring and testing instruments will be arranged by the contractor and while submitting his quotation he shall furnish list of testing equipments which are readily available with him and also which can be procured by him from outside agency for the purpose of testing and commissioning.

E.7.0 **MINOR CIVIL WORK:**

E.7.1 Minor civil works including secondary grouting/under pinning of structure i.e. filling the gap between structure and foundation after levelling, alignment shall be done by the contractor at no extra cost. This shall also include necessary materials required for doing the work.

E.7.2 Minor civil works of final / secondary grouting of structures, towers equipment has to be arranged by the contractor and the rate for the same should be included in respective erection. Final / secondary grouting means filling the gap between the structure and foundation after levelling, alignment etc.

E.7.3 Minor civil work shall also include fixing of foundation bolts for radiator / cooling oil pump etc. Foundation bolts for such work shall however be arranged by BHEL.

E.8.0 **PRICE SCHEDULE**

E.8.1 The prices to be quoted FIRM and should be valid till the work is completed to the satisfaction of BHEL / Owner and handed over the system to Owner.

E.8.2 The quantities given in schedule of equipment are estimated ones and may vary up to ± 30% on the total value of the contract. Quantity of individual item may vary up-to any extent.

E.9.0 **START OF WORK AND COMPLETION SCHEDULE**

E.9.1 The contractor shall mobilise at site within one week from the date of LOI.

E.9.2 The entire work under this tender is required to be completed as indicated in Letter of Intent.

E.9.3 Detailed Bar Chart (activity schedule) should be submitted by the bidder in Annexure 'M' showing as to how the work is proposed to be executed in order to meet the completion schedule. This shall be filled in by the bidder after mobilisation at site and to be given to ENGINEER-IN-CHARGE at site.

E.9.4 The contractor is required to commence the work within the time as indicated in Letter of Intent failing which the contract is liable to be cancelled and EMD/SD shall be forfeited.

E.10.0 **SCHEDULE OF EQUIPMENT:**

The estimated quantities in the Schedule of Equipment given in Annexure-1 is tentative to give idea of work and to enable tenderer to quote unit rates. The actual quantities required to be erected shall be based on relevant drawings and latest revisions.

ANNEXURE TO CONDITIONS OF CONTRACT FOR ETC WORKS

The following terms and conditions shall form a part of the tender document. If any discrepancies found between below mentioned clauses and clauses in the Conditions of Contract for Erection Works, DOC. NO. – TB-ETC-GCC, REV.-02, dated 20th JUNE, 2005, the clauses mentioned in this annexure shall prevail.

A. Condition of Contract for Erection works (DOC. NO. – TB-ETC-GCC, REV.-02, 20th June, 2005):

A. 1.0: GENERAL INSTRUCTION

1.1 **All pages of the tender documents shall be duly signed, stamped and submitted along with the offer in token of complete acceptance thereof.** The information furnished shall be complete by itself. The tenderer is required to furnish all the details and other documents as required in the following pages.

1.2. Tenderers are advised to study all the tender documents carefully. Any submission of tender by the tenderer shall be deemed to have been done after careful study and examination of the tender documents and with the full understanding of the implications thereof. Should the tenderers have any doubt about the meaning of any portion of the Tender Specification or find discrepancies or omissions in the drawings or the tender documents issued are incomplete or shall require clarification on any of the technical aspect, the scope of work etc., tenderer shall at once, contact the authority inviting the tender well in time (so as not to affect last date of submission) for clarification before the submission of the tender. Tenderer's request for clarifications shall be with reference to Sections and Clause numbers given in the tender documents. The specifications and terms and conditions shall be deemed to have been accepted by the tenderer in his offer. Non-compliance with any of the requirements and instructions of the tender enquiry may result in the rejection of the tender.

A.2.0 PROCEDURE FOR SUBMISSION OF SEALED TENDERS

A.2.1 Bidders may please refer Cl no. 2 to Cl no. 4 of the Notice inviting tender.

A.2.2 The tenders received after the specified time of their submission shall be treated as 'Late Tenders' and shall not be considered under any circumstances.

A.2.3 Tenders shall be opened by the officers concerned of BHEL at the time, date and venue as specified in the tender enquiry. Tenderer or their authorized representative may witness the bid opening.

A.2.4 The tenderer shall closely pursue all the clauses, specifications and drawings indicated in the Tender Documents before quoting. Should the tenderer have any doubt about the meaning of any portion of the Tender Specifications or find discrepancies/omission in the drawings or the tender documents issued are incomplete or shall require clarification on any of the technical aspect, scope of work etc. he shall at once contact the authority inviting the tender for clarification before the submission of the tender.

A.2.5 Before submission of offer, the tenderers are advised to inspect the work & the environments and be well acquainted with the actual working and other prevalent conditions, facilities available, sourcing of material and labour, means of transport and access to site, accommodation, etc. No claim will be entertained later on the grounds of lack of knowledge on any of these conditions/ resources.

A.2.6 Tenderer must fill up all the schedules and furnish all the required information as per the instructions given in various sections of the tender specification. Each and every page of the Tender Specification must be SIGNED AND SUBMITTED ALONG WITH THE OFFER by the Tenderer in token of complete acceptance thereof the information furnished shall be complete by itself.

A.2.7 The tenderer shall quote the rates in English Language and international numerals. Total price offered should be entered in figures as well as in words. For the purpose of the tender, the metric system of units shall be used.

A.2.8 T**he tenderer shall quote a percentage above/ below/At Par the rates shown in the "Bill of Quantities Cum Price Schedule (Annexure-I)" of subject tender.**

A.2.9 **The quoted percentage will apply to the individual items of "Annexure-I i.e Bill of Quantity Cum Price Schedule" uniformly.**

A.2.10 All entries in the tender shall either be typed or be written legibly in ink. Erasing and overwriting are not permitted and may render such tender liable for rejection. All cancellations and insertions shall be duly attested by the tenderer.

A.2.11 The tenderer must provide the registered e-mail of their registered office along with the addresses and authorised phone/mobile nos.

A.3.0 ADJUSTMENT PRICE DISCREPANCY (IES): - Not Applicable being e procurement.

A.4.0 EVALUATION OF TECHNICAL BIDS

4.1 Technical Bids submitted by the tenderer will be opened first and evaluated for fulfilling the Pre-Qualification criteria and other conditions in NIT/Tender documents, based on documentary evidences submitted along with the offer.

4.2 In case the same qualifying experience is claimed by more than one bidder due to subletting of work by main contractor to subcontractor (s) then following conditions shall be applicable.

a) For labour + consumable contract without material and T&P:
Benefit of work experience shall be given to the subcontractor who has actually executed job and not to the contractor offloaded down the line.

b) For contract with complete scope i.e. with materials, T&P, labour and consumable:

i) Benefit of work experience shall be given to the subcontractor who has actually executed job and not to the contractor offloaded down the line.

ii) If the contractor offloads the labour and/or T&P portion only, benefit of work experience shall be given to the main contractor and not to the subcontractor who has executed only as labour supply contractor

The bidder's qualification shall be subject to submission of documentary proof. BHEL reserves the right to ask for further proofs including submission of TDS certificates/ for the said job

4.3 In case the qualifying experience is claimed by private organizations based on Work Order and completion certificates from another private organization, BHEL reserves the right to ask for further proofs including submission of TDS certificates/ form 26AS /bills for the said job.

4.4 Credentials of all the bidders participating in open tender will be scrutinized thoroughly by the nominated committee w.r.t. the pre-qualifying requirement for the tender.

4.5 Details of qualifying work(s) executed by the bidder will be forwarded to the principle employer for verification of the work with respect to completion, commencement & completion date, scope and value of the work executed. Performance feedback of the bidder will also be sought from the principle employer.

4.6 BHEL may conduct onsite verification of at least one of the qualifying works to verify completion of the work and evaluate capability and performance of the bidder.

4.7 The bidder representative may be called for the discussion with the committee. His originals may be verified by the committee. In addition to above their organization chart and detailed list of manpower, tools & plants and technical capability may be discussed and ascertained by the committee.

5.0 **EVALUATION OF PRICE BIDS**

5.1 Price Bids of unqualified bidders shall not be opened.

5.2 The offers will be evaluated on the basis of total price basis (refer "BILL OF QUANTITY AND PRICE SCHEDULE) as shown in the price bid.

5.3 Reasons for rejection of the bid shall be intimated in due course after issue of LOI/LOA to successful bidder and receipt of unconditional acceptance of LOI /LOA from the successful bidder

5.4 In case of electronic Reverse Auction, the unqualified bidders shall not be allowed to participate in reverse auction.

A.6.0 DOCUMENTS TO BE ENCLOSED:

Full information shall be given by the tenderer in respect of the following.

6.1 Tenders shall be signed by persons duly authorized/empowered to do so. An attested copy of the Power of Attorney to be submitted in all cases except where the sole proprietor is the signatory to the tender documents

6.2 *PERMANENT ACCOUNT NUMBER:*

Certified copies of Permanent Account Numbers as allotted by Income Tax Department for the Company / Firm / Individual Partners, etc. shall be furnished along with tender.

6.3 AUDITED *BALANCE SHEET AND INCOME TAX RETURN*:

Copy of Audited Balance sheets and income tax return for last three financial years (financial years as specified in PQR)

6.4 *SOLVENCY CERTIFICATE:*

If asked in NIT, bidder should submit solvency certificate (not older than 12 months from date of tender notification) issued by any scheduled bank.

6.5 *DOCUMENT RELATED TO INCORPORATION OF BUSINESS ENTITY:*

6.5.1 *IN CASE OF INDIVIDUALTENDERER:*
His/her full name, address and place & nature of business.

6.5.2 *IN CASE OF PARTNERSHIP FIRMS:*
The names of all the partners with address. A copy of the partnership deed/instrument of partnership duly certified by the Notary shall be enclosed.

6.5.3 *IN CASE OF COMPANIES:*
Date & place of registration including date of commencement certificate in case of Public Companies and the nature of business carried on by the company. Certified copies of Memorandum and Articles of Association are also to be furnished.

6.6 Offer forwarding letter over the letterhead

6.7 *Declaration sheets (As per Prescribed format) over the letter head*

6.8 *No Deviation certificates (As per Prescribed format) over the letterhead*

6.9 GST Registration certificate

All the data required to be enclosed with the tender need to be furnished neatly typed, signed & stamped in the given formats only (in the form of separate sheets) failing which the tender may be considered as incomplete and is liable for rejection. Documentary proof wherever necessary also need to be enclosed.

A.7.0 VALIDITY OF OFFER

The rates in the Tender shall be kept valid for acceptance for a minimum period of **Four Months** from latest due date of offer submission (including extension(s), if any). In case BHEL (Bharat Heavy Electricals Limited) calls for negotiations, such negotiations shall not amount to cancellation or withdrawal of the original offer which shall be binding on the tenderer.

A.8.0 REJECTION OF TENDER & OTHER CONDITIONS:

8.1 The decision of acceptance of tender will rest with BHEL which does not bind itself to accept the lowest tender or any tender and reserves to itself full rights for the following without assigning any reasons whatsoever:

(a) To reject any or all of the tenders.

(b) To split up the work amongst two or more Tenderer as per NIT

(c) To award the work in part as per NIT

(d) In either of the contingencies stated in (b) and (c) above to modify the time for completion suitably.

8.2 Conditional tenders, unsolicited tenders, containing abnormally low/ unworkable rates & amounts, tenders which are incomplete or not in the form specified or defective or have been materially altered or not in accordance with the tender conditions, specifications etc. are liable to be rejected.

8.3. Tenders are liable to be rejected in case of unsatisfactory performance of the tenderer with BHEL, or tenderer under suspension (hold / banning / delisted) by any unit / region / division of BHEL or tenderers who do not comply with the latest guidelines of Ministry / Commissions of Govt. of India. BHEL reserves the right to reject a bidder in case it is observed that they are overloaded and may not be in a position to execute this job as per the required schedule in line with 'NIT'. The decision of BHEL will be final in this regard.

8.4 In case of any adverse information is received concerning performance, capability or conduct of the tenderer after issue of tender enquiry or opening of tender or award of work, BHEL reserves the right to reject the offer at any stage as deemed fit.

8.5 Offers with inadequate Tools & Plants, Manpower Deployment Plan, and Method Statement are liable for rejection.

8.6 If a tenderer who is a proprietor expires after the submission of his tender or after the acceptance of his tender, BHEL may at its discretion, cancel such tender. If a partner of a firm expires after the submission of the tender or after the acceptance of the tender, BHEL may cancel such tender at its discretion unless the firm retains its character.

8.7 BHEL will not be bound by any Power of Attorney granted by the tenderer or by changes in the composition of the firm made subsequent to the execution of the contract. BHEL may, however, recognise such Power of Attorney and changes after obtaining proper legal advice, the cost of which will be chargeable to the contractor concerned.

8.8 If the tenderer deliberately gives wrong information in his tender, BHEL reserves the right to reject such tender at any stage or to cancel the contract, if awarded, and forfeit the Earnest Money/Security Deposit/any other moneys due.

8.9 Canvassing in any form in connection with the tender is strictly prohibited and the tenders submitted by the tenderer who resorts to canvassing are liable to be rejected.

8.10 In case the Proprietor, Partner or Director of the Company / Firm submitting the Tender, has any relative or relation employed in BHEL, the authority inviting tender shall be informed to the fact as per specified format along with the offer, failing this, BHEL may, at its sole discretion reject the tender or cancel the contract and forfeit the Earnest Money/ Security Deposit.

8.11 The successful tenderer should not sub-contract the part or complete work detailed in the tender specifications without written permission of BHEL's Site In charge/ Sector Head. For this the contractor shall submit request application to site in charge supported by credentials (financial and technical) and resource mobilisation schedule of such sub-contractor. Such request is to be considered in consultation with end user/ultimate customer (if applicable) and subject to satisfactory credentials, fund flow arrangement between them, HSE and other contractual and statutory obligations. The tenderer is solely responsible to BHEL for the work awarded to him.

8.12 The Tender submitted by a tenderer shall become the property of BHEL who shall be under no obligation to return the same to the bidder. However unopened price bids and late tenders shall be returned to the bidders.

8.13 unsolicited discount received after the due date and time of Bid Submission shall not be considered for evaluation. However, if the party who has submitted the unsolicited discount/rebate becomes the L-I party, then the awarded price i.e contract value shall be

worked out after considering the discount so offered.

8.14 BHEL shall not be liable for any expenses incurred by the bidder in the preparation of the tender irrespective of whether the tender is accepted or not.

A.9.0 NO DEVIATIONS ARE ACCEPTABLE: -

Offers with deviations are likely to be rejected. However, if the bidder insists on any technical or commercial deviations from the specifications and / or tender conditions, **the price implication, if any, of withdrawing the deviations must be submitted along with the price bid in a separate sealed envelope** super-scribed "**PRICE IMPLICATION FOR WITHDRAWAL OF DEVIATIONS**". No price implication for withdrawal of deviation shall be accepted at a later date, after opening of technical bid.

A.10.0 Consortium**/** JV bidding is not allowed under this NIT.

B. EARNEST MONEY DEPOSIT

Every tender must be accompanied by the prescribed amount of Earnest Money Deposit (EMD) mentioned in NIT.

1. Mode of EMD deposit:

Every tender must be accompanied by the prescribed amount of Earnest Money Deposit (EMD) mentioned in NIT.

Mode of EMD deposit:

EMD can be submitted in any one of the following modes:

i) Cash deposit as permissible under the extant Income Tax Act (before tender opening),

ii) Electronic Fund Transfer credited in BHEL account (before tender opening). Details of BHEL account mentioned in tender document.

iii) Banker's cheque/Pay order/Demand Draft, in favour of 'BHEL' and payable at New Delhi (Along with offer)

iv) Fixed Deposit Receipt (FDR) issued by schedule Banks/Public Finance Institutions as defined in the companies ACT (FDR should be in the name of the contractor, a/c BHEL)

v) Insurance Surety Bonds

No other form of EMD remittance shall be acceptable to BHEL.

Note: The Submission of EMD is compulsory for subject tender. In case requisite Amount of EMD not submitted by the bidder along with offer or before technical bid opening, the offer shall not be considered for evaluation and the offer shall be rejected.

2. **Forfeiture of EMD**

EMD by the bidder will be forfeited as per NIT conditions, if

i) After opening the tender and within the offer validity period, the bidder revokes his tender or makes any modification in his tender which is not acceptable to BHEL.

ii) The contractor fails to deposit the required Security deposit or commence the work within the period as per LOI/contract.

3. EMD by the tenderer shall be withheld in case any action on the tenderer is envisaged under the provision of extant "Guidelines on Suspension of business dealing with Supplier/contractors" and forfeited/ released based on the action as determined under these guidelines.

4. In the case of unsuccessful bidders, the Earnest Money will be refunded to them within a reasonable time after award of work.

5. EMD shall not carry any interest.

6. EMD of successful bidder shall be retained as part of Security Deposit.

7. Bidders may please note that "One Time EMD" provision stands deleted. Hence, bidders who have deposited Rs. 2 Lakh as 'One Time EMD' with BHEL are also required to submit the requisite amount of EMD.

8. **No MSE benefits shall be given to MSEs bidder for WORKS CONTRACT. Please refer clause no. O (facilities provided to MSEs) for detail.**

C. SECURITY DEPOSIT

Security Deposit means the security provided by the Contractor towards fulfilment of any obligations in terms of the provision of the contract.

1. Upon acceptance of Tender, the successful Tenderer should deposit the required amount of Security Deposit for satisfactory completion of work. **The total amount of Security Deposit will be 5% of the Contract Value. EMD of the successful tenderer shall be converted and adjusted towards the required amount of Security Deposit.**

2. Mode of Security deposit:
The security Deposit should be furnished **before start of the work** by the contractor.

"Bidders agrees to submit performance security required for execution of the contract within the time period mentioned. In case of delay in submission of Performance security, enhanced performance security which would include interest (Repo rate + 4%) for the delayed period, shall be submitted by the bidder.

Further, if performance security is not submitted till such time the first bill becomes due, the amount of performance security due shall be recovered as per terms defined in NIT / Contract, from the bills along with due interest".

The balance amount to make up the required Security Deposit of 5% of the contract Value may be furnished in any of the following forms:

i) Cash (as permissible under the extant Income Tax Act)

ii) Local cheques of scheduled banks (subject to realization) / Pay Order / Demand Draft / Electronic Fund Transfer, in favour of BHEL.

iii) Bank Guarantee from Scheduled Banks / Public Financial Institutions as defined in the Companies Act. The Bank Guarantee format for Security Deposit shall be in the prescribed formats enclosed with general conditions of contract.

iv) Fixed Deposit Receipt issued by Scheduled Banks / Public Financial Institutions as defined in the Companies Act. The FDR should be in the name of the contractor, A/C BHEL and duly discharged on the back.

v) Securities available from Indian Post Offices such as National Savings Certificates, Kisan Vikas Patras etc. (Certificates should be held in the name of Contractor furnishing the security and duly endorsed/hypothecated/pledged, as applicable, in favour of BHEL and duly discharged on the back).

vi) Insurance Surety Bonds.

(NOTE: BHEL will not be liable or responsible in any manner for the collection of interest or renewal of the documents or in any other matter connected therewith)

3. **Submission of Security Deposit:**

i) At least 50 % of the required Security Deposit, including the EMD, shall be submitted before start of work. Balance of the Security Deposit can be submitted by way of deduction of 10% of the gross amount progressively from each running bills of the contractor till the total amount of the required Security Deposit is collected.

ii) In case of delay in submission of performance security, enhanced performance security which would include interest (Repo rate + 4%) for the delayed period, shall be submitted by the bidder.

iii) If the value of work done at any time exceeds the contract value, the amount of Security Deposit shall be correspondingly enhanced and the additional Security Deposit shall be immediately deposited by the Contractor or it shall be recovered from payment/s due to the Contractor.

iv) The recoveries made from running bills (cash deduction towards balance SD amount) can be released against submission of equivalent Bank Guarantee in acceptable form, but only once, before completion of work, at the discretion of BHEL.

4. The BG shall be submitted only through the Banker. Along with the BG, the Bank shall also furnish a letter of confirmation (in the prescribed formats enclosed with general conditions of contract).

5. The validity of the Bank Guarantee furnished towards Security Deposit shall be up to three months more than the period of completion of work as stipulated in the LOI and the same will be kept valid by proper renewal till the completion of the work.

6. BHEL reserves the right of forfeiture of Security Deposit in addition to other claims and penalties in the event of the contractor's failure to fulfil any of the contractual obligations or in the event of termination of contract as per terms and conditions of the contract. BHEL reserves the right to set off the Security Deposit, against any claims of any other contracts with BHEL.

7. **Conditions for acceptance of bank guarantees**

Contractors are advice to obtain Bank Guarantee preferably from any of the following BHEL consortium banks

Sl. No.	Name of Bank	Sl. No.	Name of Bank
1	State Bank of India	11	Punjab National Bank
2	Canara Bank	12	Union Bank of India
3	IDBI Bank Limited	13	Yes Bank Limited
4	ICICI Bank Limited	14	RBL Bank Ltd.
5	HDFC Bank Limited	15	Standard Chartered Bank
6	Axis Bank	16	Indian Overseas Bank
7	IndusInd Bank Limited	17	Kotak Mahindra Bank Limited
8	Bank of Baroda	18	Federal Bank Limited
9	Exim Bank	19	Hongkong and Shanghai Banking Corporation Ltd
10	Indian Bank		

Bank Guarantees from Banks outside BHEL's consortium shall be as below:

The Bank Guarantees of all Public sector banks can be accepted (in addition to consortium banks)

The Bank Guarantees of Co-operative banks shall not be accepted.

Bank Guarantees of other than consortium bank and public sector bank can be accepted subject to an overall exposure limit (at New Delhi) of Rs. 10 crores for banks with net worth of more than Rs. 500 crores as on last balance sheet date and Rs 5 crores for banks with net worth between Rs. 350 to Rs 500 crores (A certificate and copy of latest Balance Sheet to be given by the Bank at the time of submission of Bank Guarantees).

In case of private sector banks, a clause to be incorporated in the text of Bank Guarantee that it can be enforceable by being presented at any branch of the bank.

In case of foreign vendors, the bank guarantees issued by foreign banks may be confirmed by our consortium bank in India.

In case of Bank Guarantees given by Non-Consortium banks (Private sector or Public sector), the Bank Guarantees are to be enforceable in New Delhi or the town/ city in which the sector office is located.

8. RETURN OF SECURITY DEPOSIT:

If the contractor duly performs and completes the work in all respects to the entire satisfaction of BHEL and presents an absolute "No demand certificate", returns properties belonging to BHEL, taken, borrowed or hired by him for carrying out the said works, and furnishes performance bond BG in the prescribed proforma, Security Deposit will be released to the contractor after deducting all costs, expenses and other amounts that are to be paid to BHEL under this contract or other contracts entered into with the contractor.

It may be noted that in no case the Security Deposit shall be refunded/released prior to passing of final bill.

D. Bank Account Details for submission of EMD/ Security Deposit through electronic fund transfer mode.

NAME OF THE COMPANY	**BHARAT HEAVY ELECTRICALS LTD**
ADDRESS OF THE COMPANY	**TRANSMISSION BUSINESS GROUP,** **PLOT NO. *25*, SECTOR- 16A, NOIDA – 201301 (U.P.)**
NAME OF BANK	**STATE BANK OF INDIA**
NAME OF BANK BRANCH	**CAG-II NEW DELHI (17313)**
CITY	**NEW DELHI**
ACCOUNT NUMBER	**00000030206227732**
ACCOUNT TYPE	**CASH CREDIT**
IFSC CODE	**SBIN0017313**

E. <u>Payment terms:</u> Clause No. C.2.0 stands deleted. Now this clause shall be read as below.

(**Description of work in this section is made for payment purpose only and the scope is not limited to the activities mentioned below. Please refer technical documents for complete scope of work)**

1. No Mobilization Advance shall be paid.

2. **<u>For BOQ items – 1-16 (Complete scope of work)</u>**

2.1. 10% of the contract item price on the monthly progressive bills on pro rata basis for receipt, material including arranging crane for unloading, maintaining proper records of receipt & storage in Field Quality Plans (FQPs) and as certified by BHEL Engineer.

2.2. 60% of the contract item price on the monthly progressive bills on pro rata basis after arranging necessary calibrated tools/tackles required for erection, submitting calibration reports, qualification/experience certificates of welder/Electrician/other staff, levelling, alignment, tightening and completion of erection including maintaining proper records of installation in FQPs and as certified by BHEL, Engineer.

2.3. 10% of the contract item price on the monthly progressive bills on pro rata basis on arranging calibrated testing equipment, submission of calibration reports, testing of equipment including maintaining proper records of testing in FQPs and as certified by BHEL, Engineer. BOQ items, which are not required to be tested as per FQP, shall be qualified for release of payment on prorate basis after completion of testing of all equipment's of corresponding bay (As per SLD/ layout).

2.4. 10% of the contract item price after completion of satisfactory commissioning and submission of complete records of erection/testing/commissioning /charging protocol as per FQPs for the corresponding bay.

2.5. Last 10% of the contract item price after all test reports as per contract are jointly witnessed and signed by BHEL/customer, "As Built" changes are incorporated in relevant drawings, material reconciliation and substation is handed over to the Owner / Customer. If the contract is for more than one sub-station, then the same will be released after successful handing over of each sub-station. If for any reason, the handing over is delayed for reasons beyond the control of the contractor, in such case this payment will be released against commissioning certificate issued by the BHEL / customer and against submission of final bill of individual substation.

3. **For BOQ item: - 17-20 (Watch & Ward and cutting, drilling & Modification work)**

3.1. 100% of the contract item price on the monthly progressive bills on pro rata basis towards watch & ward against submission of invoice and on certification of engineer in-charge of BHEL.

F. **Overall Quantity variation**-

The individual quantity can vary to any extent or may be deleted for which no compensation will be payable to the contractor and **the rates will remain firm**. Also, the rate of each item remains firm as long as the variation in the total value of work executed under the contract including extra items if any remains within plus/minus 30 percent of the contract value. In case the actual value of executed work including extra work on completion of work becomes less than 70% of the basic/original contract value than the following method shall be adopted.

The actual executed value shall be raised by 7 % (For arriving at the final payment against work executed) subject to the condition that total value of work executed plus increase by 7% as above shall be limited to 70% of the basic/original contract value. The rate quoted shall be firm irrespective of any upward variation in the contract price.

G. **OVER RUN COMPENSATION:**

Not applicable

H. **Clause No. C.30.0 "INCOME TAX/SALES TAX/WORKS TAX/VAT" stands deleted. Now this clause shall be read as below.**

1. All taxes (except GST), duties, charges, royalties, cess and any other levies by Central/ State/local authorities for the execution of the contract shall be borne by the contractor and shall not be payable extra. Any increase of the same at any stage during execution of the contract shall be borne by the contractor. Quoted price of the same shall be inclusive of all such requirements.
2. Contractors have to make their own arrangement at their cost for completing the formalities, if required with relevant taxation authorities, for bringing their material, plant and machinery at site for the execution of the contract. Road permits / way bill, if required shall be arranged by the contractor.
3. The Contractor is responsible to furnish documentary evidence towards GST Registration of the State wherein the site is located or any other documents as per GST Act which may be required from time to time. BHEL will not be held to be responsible for any non-compliance of the Contractor in respect of GST laws as framed from time to time.
4. Goods and Service Tax (GST) will be reimbursed to the Contractor subject to the following conditions: -
   I. Submission of valid GST Compliant Tax Invoice as per the GST Invoice Rules.
   II. The Invoice raised by the Contractor should indicate the BHEL GST Registration Number.)
   III. Contractor declaring such invoice in GSTR-1 and the same should be available to BHEL in the form GSTR -2A/ 2B electronically through GST portal
   IV. Confirmation of payment of GST thereon by contractor on GST portal.
5. The GST amount shall get reflected within prescribed time limit in the GSTN for BHEL to avail the input credit. If the GST Credit is reversed/ denied/ delayed to BHEL due to non-receipt/delayed receipt of Services and/or tax invoice or due to expiry of timeline prescribed in GST law or due to any other factor for availing such Input Tax Credit (ITC) or for any other reason arising out of the act directly attributable to the Contractor, GST amount shall be recoverable from Contractor from any dues payable to the Contractor along with any interest levied/ leviable on BHEL.
6. Statutory variation, if any, on account of GST will be payable by BHEL at actuals on submission of documentary evidence.

7. TDS under Income Tax Act/ GST Act shall be deducted as per applicable rates unless Exemption certificate, if applicable, from the appropriate Authority is furnished to BHEL along with the Invoice.

8. New Taxes & duties (Introduced after tender opening date):

If any new tax or duty is levied by the Central/State Government/Municipality/Local Authority and becomes directly applicable on items specified in the Bill of Quantities, full reimbursement shall be made subject to submission of documentation as per statute.

I. BOCW (TAXES, DUTIES & LEVIES):

BUILDING & OTHER CONSTRUCTION WORKERS (REGULATION OF EMPLOYMENT AND CONDITIONS OF SERVICE) ACT, 1996 (BOCW Act) AND RULES OF 1998 READ WITH BUILDING & OTHER CONSTRUCTION WORKERS CESS Act, 1996 & CESS RULES, 1998.

1. In case any portion of work involves execution through building or construction workers, then compliance to the above titled Acts shall be ensured by the contractor and contractor shall obtain license and deposit the cess under the Act. In the circumstances it may be ensured as under: -

1.1. It shall be the sole responsibility of the contractor in the capacity of employer to forthwith (within a period of 15 days from the award of work) apply for a licence to the Competent Authority under the BOCW Act and obtain proper certificate thereof by specifying the scope of its work. It shall also be responsibility of the contractor to furnish a copy of such certificate of licence / permission to BHEL within a period of one month from the date of award of contract.

1.2. It shall be the sole responsibility of the contractor as employer to ensure compliance of all the statutory obligations under these act and rules including that of payment / deposit of 1% cess on gross payment made for value of work involving building or construction workers engaged by the contractor within a period of one month from the receipt of payment.

1.3. It shall be the responsibility of the sub-contractor to furnish the receipts / challans towards deposit of the cess together with the number, name and other details of beneficiaries (building workers) engaged by the sub-contractor during the preceding month.

1.4. It shall be the absolute responsibility of the sub-contractor to make payment of all statutory payments & compensations to its workers including that is provided under the Workmen's Compensation Act, 1923.

1.5. The contractor shall, however ensure before deposit of any BOCW cess, that customer is not depositing the same in order to avoid excess deposit of cess.

1.6. The contractor shall bear cost of BOCW cess either by way of deposit or through recovery by BHEL in case the same is deposited by the customer.

1.7. In case of failure in above mentioned compliances, BOCW Cess @ 1% as well as applicable penalty as specified in BOCW Act/Rules shall be deducted from the contractor

J. DELAY AND EXTENSION OF TIME:

1. If, in the opinion of the Engineer, the work is delayed :

(i) by reason of abnormally bad weather, or

(ii) by reason of serious loss or damage by fire, or

(iii) by reason of civil commotion, local combination of workmen, strike or lockout, affecting any of the trades employed on the work, or

(iv) by delay on the part of the agency or tradesman engaged by the BHEL in executing work not forming part of the contract, or

(v) By reason of any other cause which in the absolute discretion of the Engineer is beyond the contractor's control, then in any such case, the Engineer (or higher authority) may make fair and reasonable extension in the completion dates of the individual items of work of the contract as whole. Such extension which will be communicated to the contractor by the Engineer in writing shall be final and binding on the contractor. No other claim in this respect for compensation, idle labour or otherwise howsoever is admissible. Upon the happening of any such event causing delay the contractor shall immediately give notice thereof in writing to the Engineer but shall nevertheless use constantly his best endeavour to prevent or make good the delay and shall do all that may reasonably be required to the satisfaction of the Engineer to proceed with the work.

2. In case of delay in completion of work BHEL reserve the right to grant time extension under the following options depending upon the performance of the vendor:

a) Time extension without levy of LD in case it is found that delay is not attributable to the vendor

b) Time extension with deduction of applicable LD in line with Liquidity Damage clause if the delay is solely attributable to the vendor.

c) In case facts of delay is not settled, BHEL reserve the right to grant provisional time extension for delay in completion of total work or part thereof and running/ interim payments to the vendor will be released without deduction of LD subject to submission of additional Bank guarantee equivalent to maximum LD amount valid till completion of work under their scope and grant of final time extension.

During provisional time extension period ORC/ PVC shall not be payable to the contractor. The Final Delay analysis shall be prepared on completion of the work. In case of delay is not attributable to contractor as per final delay analysis the ORC/ PVC shall be released along with the final bill without any interest charges attributable to BHEL.

In case of delay attributable to contractor, LD shall be deducted for that period in line with clause "Compensation/ LD/ Penalty for delay in execution" of conditions of contract and balance ORC/ PVC (if any) shall be released along with the final bill without any interest charges attributable to BHEL.

K. <u>LD / PENALTY FOR DELAY IN EXECUTION:</u>

The Clause No. C.5.0 "LD / Penalty for delay in execution" of Conditions of contract for ETC works stands deleted. Now the modified clause shall be read as below:

In case the contractor fails to complete the project within the time specified in the tender specification or any extension thereof subject to force majeure condition, the contractor shall be liable to pay by way of LD/Penalty a sum equal to the half percent of the contract price, per calendar week or part thereof by which the commissioning of the project is delayed, subject to ceiling of 10 % of the contract price. Once the maximum limit of delay is reached (i.e. 20 week of delay) BHEL may consider termination of the contract and forfeit the Security deposit without prejudice to the other remedies under the contract.

Amended/ revised contract value (excluding Extra Works, Supplementary /Additional Items) shall be considered for calculating LD/ penalty.

L. RIGHTS OF <u>BHEL</u>: - The Clause No. B.7.0 "RIGHTS of BHEL" of Conditions of contract for ETC works stands deleted. Now the modified clause shall be read as below: -

BHEL reserves the following rights in respect of this contract during the original contract period or its extensions if any, as per the provisions of the contract, without entitling the contractor for any Compensation

1. To withdraw any portion of work and/or to restrict/alter quantum of work as indicated in the contract during the progress of work and get it done through other agencies to suit BHEL's commitment to its customer or in case BHEL decides to advance the date of completion due to other emergent reasons/ BHEL's obligation to its customer.
   In case of inadequate manpower deployed by the contractor, BHEL reserves the right to deploy additional manpower through any other agency for expediting activities in the interest of the project. Supplied manpower shall be put on job by the contractor and payments and other statutory compliances related to manpower shall be the contractor's responsibility. In case of contractor's failure to fulfil his obligations in respect of such manpower, BHEL reserves the right to take necessary action as per contract conditions.

2. Breach of Contract, Remedies and Termination

2.1. The following shall amount to breach of contract:

I. Non-supply of material/ non-completion of work by the Supplier/Vendor within scheduled delivery/ completion period as per contract or as extended from time to time.

II. The Supplier/Vendor fails to perform as per the activity schedule and there are sufficient reasons even before expiry of the delivery/ completion period to justify that supplies shall be inordinately delayed beyond contractual delivery/ completion period.

III. The Supplier/Vendor delivers equipment/ material not of the contracted quality.

IV. The Supplier/Vendor fails to replace the defective equipment/ material/ component as per guarantee clause.

V. Withdrawal from or abandonment of the work by the Supplier/Vendor before completion as per contract.

VI. Assignment, transfer, subletting of Contract by the Supplier/Vendor without BHEL's written permission resulting in termination of Contract or part thereof by BHEL.

VII. Non-compliance to any contractual condition or any other default attributable to Supplier/Vendor.

VIII. Any other reason(s) attributable to Vendor towards failure of performance of contract.
In case of breach of contract, BHEL shall have the right to terminate the Purchase Order/ Contract either in whole or in part thereof without any compensation to the Supplier/Vendor.

IX. Any of the declarations furnished by the contractor at the time of bidding and/ or entering into the contract for supply are found untruthful and such declarations were of a nature that could have resulted in non-award of contract to the contractor or could expose BHEL and/ or Owner to adverse consequences, financial or otherwise.

X. Supplier/Vendor is convicted of any offence involving corrupt business practices, antinational activities or any such offence that compromises the business ethics of BHEL, in violation of the Integrity Pact entered into with BHEL has the potential to harm the overall business of BHEL/ Owner.

Note-Once BHEL considers that a breach of contract has occurred on the part of Supplier/Vendor, BHEL shall notify the Supplier/Vendor by way of notice in this regard. Contractor shall be given an opportunity to rectify the reasons causing the breach of contract within a period of 14 days.

In case the contractor fails to remedy the breach, as mentioned in the notice, to the satisfaction of BHEL, BHEL shall have the right to take recourse to any of the remedial actions available to it under the relevant provisions of contract.

LD against delay in executed work in case of Termination of Contract:

LD against delay in executed work shall be calculated in line with relevant LD clause of GCC, for the delay attributable to contractor. For limiting the maximum value of LD, contract value shall be taken as Executed Value of work till termination of contract.

Method for calculation of "LD against delay in executed work in case of termination of contract" is given below.

i) Let the time period from scheduled date of start of work till termination of contract excluding the period of Hold (if any) not attributable to contractor = T1
ii) Let the value of executed work till the time of termination of contract= X
iii) Let the Total Executable Value of work for which inputs/fronts were made available to contractor and were planned for execution till termination of contract = Y
iv) Delay in executed work attributable to contractor i.e. T2=[1-(X/Y)] x T1
v) LD shall be calculated in line with LD clause of the Contract for the delay attributable to contractor taking "X" as Contract Value and "T2" as period of delay attributable to contractor.

2.2 **Remedies in case of Breach of Contract is established:**

i) Wherein the period as stipulated in the notice issued under clause "BREACH OF CONTRACT, REMEDIES AND TERMINATION" of GCC has expired and Contractor has failed to remedy the breach, BHEL will have the right to terminate the contract on the ground of "Breach of Contract" without any further notice to contractor.

ii) Upon termination of contract, BHEL shall be entitled to recover an amount equivalent to 10% of the Contract Value for the damages on account of breach of contract committed by the Contractor. This amount shall be recovered by way of encashing the security instruments like performance bank guarantee etc available with BHEL against the said contract. In case the value of the security instruments available is less than 10% of the contract value, the balance amount shall be recovered from other financial remedies (i.e. available bills of the contractor, retention amount, from the money due to the Contractor etc. with BHEL) or the other legal remedies shall be pursued.

iii) wherever the value of security instruments like performance bank guarantee available with BHEL against the said contract is 10% of the contract value or more, such security instruments to the extent of 10% contract value will be encashed. In case no security instruments are available or the value of the security instruments available is less than 10% of the contract value, the 10% of the contract value or the balance amount, as the case may be, will be recovered in all or any of the following manners:

iv) In case the amount recovered under sub clause (a) above is not sufficient to fulfil the amount recoverable then; a demand notice to deposit the balance amount within 30 days shall be issued to Contractor.

v) If Contractor fails to deposit the balance amount within the period as prescribed in demand notice, following action shall be taken for recovery of the balance amount:

a) from dues available in the form of Bills payable to defaulted Contractor against the same contract.
b) If it is not possible to recover the dues available from the same contract or dues are insufficient to meet the recoverable amount, balance amount shall be recovered from

any money(s) payable to Contractor under any contract with other Units of BHEL including recovery from security deposits or any other deposit available in the form of security instruments of any kind against Security deposit or EMD.

c) In-case recoveries are not possible with any of the above available options, Legal action shall be initiated for recovery against defaulted Contractor.

vi) It is an agreed term of contract that this amount shall be a genuine pre-estimate of damages that BHEL would incur in completion of balance contractual obligation of the contract through any other agency and BHEL will not be required to furnish any other evidence to the Contractor for the purpose of estimation of damages.

vii) In addition to the above, imposition of liquidated damages, debarment, termination, de-scoping, short-closure, etc., shall be applied as per provisions of the contract.

Note:

1) The defaulting contractor shall not be eligible for participation in any of the future enquiries floated by BHEL to complete the balance work. The defaulting contractor shall mean and include:

(a) In case defaulted contractor is the Sole Proprietorship Firm, any Sole Proprietorship Firm owned by same Sole Proprietor.

(b) In case defaulted contractor is The Partnership Firm, any firm comprising of same partners/ some of the same partners (but not including any new partner); or sole proprietorship firm owned by any partner(s) as a sole proprietor.

2.3. In case Contractor fails to deploy the resources as per requirement informed by BHEL in writing to expedite the work, BHEL can deploy own/hired/otherwise arranged resources and recover the expenses incurred from the dues payable to contractor. Recoveries shall be actual expenses incurred plus 5% overheads or as defined in TCC.

2.4. To terminate the contract or to restrict the quantum of work and pay for the portion of work executed in case BHEL's contract with their customer are terminated for any reason, whatsoever.

2.5. Whenever any Claim or Claims for payment of any sum of money(s) arises under this or any other contract against the contractor, BHEL shall be entitled to withhold and also have a lien to retain such sum of money(s) in whole or in part from any money(s) payable to contractor and/or security deposits furnished or deducted in cash from the bills of contractor, (if any) under this contract. In the event of the securities or the amounts payable to Contractor, being insufficient to cover BHEL claims, then BHEL shall be entitled to withhold and have a lien to the extent of such claims from any sum or sums found payable or which at any time thereafter may become payable to the contractor under this or any other contract with BHEL.

a) Claim or Claims for payment of any sum of money(s) arising from the Contractor under this or any other contract against the contractor, shall mean, the sum of money(s) actually incurred by BHEL in fulfilling the contractual responsibilities of contractor under the contract, to which he has failed to fulfil plus applicable overheads (@ 5%) along with interest as applicable under the Contract on total amount (i.e. money actually incurred plus overheads)

b) It is an agreed term of the contract that, the sum or sums of money so withheld or retained under the lien by BHEL will be kept withheld or retained as such by BHEL till the claims arising out of this or any other contract are finally adjudicated wither through Arbitration or a Court of competent jurisdiction as the case may be in accordance with the terms of contract. Intimation given by the BHEL Engineer regarding withholding of such money(s) shall be considered as sufficient and relevant date for all purposes. No Interest shall be payable on such sum(s) of money which becomes due or as the case may be adjudged to be due from BHEL to Contractor, whether under contract or otherwise.

c) Where the contractor is a partnership firm, BHEL shall be entitled to withhold and also have a lien to retain towards such claims in whole or in part, from any other money(s) payable to any partner, whether in his individual capacity or otherwise.

d) If any money(s) shall, as a result of any claim or application made under the relevant provisions of any Labour Welfare Act and/ or Rules, including but not limited to Contract Labour Regulation & Abolition Act, Minimum Wages Act, Payment of Gratuity Act, BOCW (RE&CS) Act, Provident Fund Act, Employee State Insurance Act, be directed to be paid by the BHEL, such money shall be deemed to be moneys payable to the BHEL by the Contractor.

e) Where the Contractor fails to repay to BHEL such moneys along with applicable overheads (@ 5%) and interest, as aforesaid within seven days of being demanded, BHEL shall be entitled to recover the same from Contractor's bills/ Security Deposit or any other money(s) payable to Contractor under this Contract or any other Contract with BHEL.

2.6. While every endeavor will be made by BHEL to this end, yet BHEL cannot guarantee uninterrupted work due to conditions beyond its control. The Contractor will not be normally entitled for any compensation/extra payment on this account unless otherwise specified elsewhere in the contract.

2.7. BHEL may permit or direct contractor to demobilize and remobilize at a future date as intimated by BHEL in case of following situations for reasons other than Force majeure conditions and not attributable to contractor:

i) suspension of work(s) at a Project either by BHEL or Customer,

or

ii) where work comes to a complete halt or reaches a stage wherein worthwhile works cannot be executed and there is no possibility of commencement of work for a period of not less than three months

In such cases, charges towards demobilization and remobilization shall be as decided by BHEL after successful remobilization by contractor at site, and decision of BHEL shall be final and binding on the contractor. After remobilization, all conditions as per contract shall become applicable. In case Contractor does not remobilize with adequate resources or does not start the work within the period as intimated, then BHEL reserves the right to terminate the contract and effect remedies under Clause **"Remedies in case of Breach of Contract"** In case of any conflict, BHEL decision in this regard shall be final and binding on the contractor.

2.8. In the unforeseen event of inordinate delay in receipt of materials, drawings, fronts etc. due to which inordinate discontinuity of work is anticipated, BHEL on its own or contractor's request at its discretion may consider to short close the contract in any of the following cases:

a) The balance works (including but not limited to Trial Operation, PG Test etc.) are minor vis a vis the scope of work envisaged as per the contract.
b) There has been no significant work in past 6 months OR no significant work is expected in next 6 months (example in Hydro projects or in projects where work has stopped due to reasons beyond the control of BHEL).
c) The balance works cannot be done within a reasonable period of time as they are dependent on unit shut down or on other facilities of customer or any other such reasons not attributable to the contractor.

At the point of requesting for short closure, contractor shall establish that he has completed all works possible of completion and he is not able to proceed with the balance works due to constraints beyond his control. In such a case, the estimated value of the unexecuted portion of work (or estimated value of services to be provided for carrying out milestone/stage payments like Trial Operation/PG Test etc.) as decided by BHEL, shall however be reduced from the final contract value.

Note: The Contractor shall not be eligible for any compensation on account of Quantity Variation arising out of short-closure of contract as per clause above.

M. <u>FORCE MAJEURE:</u>

Clause No. B.13.0 (FORCE MAJEURE) of Conditions of Contract for ETC Works has been modified as below:

M.1. "Force Majeure" shall mean circumstance which is:

a) beyond control of either of the parties to contract,
b) either of the parties could not reasonably have provided against the event before entering into the contract,
c) having arisen, either of the parties could not reasonably have avoided or overcome, and
d) is not substantially attributable to either of the parties
And
Prevents the performance of the contract,

Such circumstances include but shall not be limited to:

i) War, hostilities , invasion, act of foreign enemies.
ii) Rebellion, terrorism, revolution, insurrection, military or usurped power, or civil war.
iii) Riot, commotion or disorder by persons other than the contractor's personnel and other employees of the contractor and sub-contractors.
iv) Strike or lockout not solely involving the contractor's personnel and other employees of the contractor and sub-contractors.
v) Encountering munitions of war, explosive materials, ionizing radiation or contamination by radio-activity, except as may be attributable to the contractor's use of such munitions, explosives, radiation or radio- activity.
vi) Natural catastrophes such as earthquake, tsunami, volcanic activity, hurricane or typhoon, flood, fire, cyclones etc.
vii) Epidemic, pandemic etc.

M.2. The following events are explicitly excluded from Force Majeure and are solely the responsibilities of the non-performing party: a) any strike, work-to-rule action, go-slow or similar labour difficulty (b) late delivery of equipment or material (unless caused by Force Majeure event) and (c) economic hardship.

M.3. If either party is prevented, hindered or delayed from or in performing any of its obligations under the Contract by an event of Force Majeure, then it shall notify the other in writing of the occurrence of such event and the circumstances thereof within 15 (fifteen) days after the occurrence of such event.

M.4. The party who has given such notice shall be excused from the performance or punctual performance of its obligations under the Contract for so long as the relevant event of Force Majeure continues and to the extent that such party's performance is prevented, hindered or delayed. The Time for Completion shall be extended by a period of time equal to period of delay caused due to such Force Majeure event.

M.5. Delay or non-performance by either party hereto caused by the occurrence of any event of Force Majeure shall not

a) Constitute a default or breach of the Contract.

Give rise to any claim for damages or additional cost expense occasioned thereby, if and to the extent that such delay or non-performance is caused by the occurrence of an event of Force Majeure

M.6. BHEL at its discretion may consider short closure of contract after 1 year of imposition of Force Majeure in line with extant guidelines. In any case, Supplier/Vendor cannot consider deemed short-closure after 1 year of imposition of Force Majeure.

N. SETTLEMENT OF DISPUTE

Clause No. B.15.0 (Arbitration) of Conditions of Contract for ETC Works has been modified as below:

If any dispute or difference of any kind whatsoever shall arise between BHEL and the Supplier/Vendor, arising out of the contract for the performance of the work whether during the progress of contract termination, abandonment or breach of the contract, it shall in the first place referred to Designated Engineer for amicable resolution by the parties. Designated Engineer (to be nominated by BHEL for settlement of disputes arising out of the contract) who within 60 days after being requested shall give written notice of his decision to the contractor. Save as hereinafter provided, such decision in respect of every matter so referred shall forthwith be given effect to by the Supplier/Vendor who shall proceed with the work with all due diligence, whether he or BHEL desires to resolve the dispute as hereinafter provided or not.

If after the Designated Engineer has given written notice of this decision to the party and no intention to pursue the dispute has been communicated to him by the affected party within 30 days from the receipt of such notice, the said decision shall become final and binding on the parties. In the event the Supplier/Vendor being dissatisfied with any such decision or if amicable settlement cannot be reached then all such disputed issues shall be resolved through conciliation in terms of the BHEL Conciliation Scheme 2018 as per Clause “Conciliation” of GCC.

N.1. Conciliation:

Any dispute, difference or controversy of whatever nature howsoever arising under or out of or in relation to this Agreement (including its interpretation) between the Parties, and so notified in writing by either Party to the other Party (the "Dispute") shall, in the first instance, be attempted to be resolved amicably in accordance with the conciliation procedure as per BHEL Conciliation Scheme 2018. The proceedings of Conciliation shall broadly be governed by Part-III of the Arbitration and Conciliation Act 1996 or any statutory modification thereof and as provided in - "Procedure for conduct of conciliation proceedings" (as available in www.bhel.com)).

Note: Ministry of Finance has issued OM reference No. 1/2/24 dated 03.06.2024 regarding "Guidelines for Arbitration and Mediation in Contracts of Domestic Public Procurement. In the said OM it has been recommended that Government departments/

Entities/agencies are to encourage mediation under the Mediation Act. 2023. The said Act has not yet been notified by the Government. Therefore, the clause **"Settlement of Disputes"** shall be modified accordingly as and when the Mediation Act 2023 gets notified.

N.2. ARBITRATION:

N.2.1. Except as provided elsewhere in this Contract, in case Parties are unable to reach amicable settlement (whether by Conciliation to be conducted as provided in Clause **"Conciliation"** herein above or otherwise) in respect of any dispute or difference; arising out of the formation, breach, termination, validity or execution of the Contract; or, the respective rights and liabilities of the Parties; or, in relation to interpretation of any provision of the Contract; or. in any manner touching upon the Contract (hereinafter referred to as the 'Dispute'), then, either Party may, refer the disputes to Arbitral Institution i.e. **"India International Arbitration Centre (IIAC) Delhi"** and such dispute to be adjudicated by Sole Arbitrator appointed in accordance with the Rules of said Arbitral Institution.

N.2.2. A party willing to commence arbitration proceeding shall invoke Arbitration Clause by giving notice to the other party in terms of section 21 of the Arbitration & Conciliation Act, 1996 (hereinafter referred to as the 'Notice') before referring the matter to arbitral institution. The Notice shall be addressed to the **Executive Director, TBG, BHEL, Noida**, executing the Contract and shall contain the particulars of all claims to be referred to arbitration with sufficient detail and shall also indicate the monetary amount of such claim including interest, if any.

N.2.3. After expiry of 30 days from the date of receipt of aforesaid notice, the party invoking the Arbitration shall submit that dispute to the Arbitral Institutions and that dispute shall be adjudicated in accordance with their respective Arbitration Rules. The matter shall be adjudicated by a Sole Arbitrator who shall necessarily be a Retd Judge having considerable experience in commercial matters to be appointed/nominated by the respective institution. The cost/expenses pertaining to the said Arbitration shall also be governed in accordance with the Rules of the respective Arbitral Institution. The decision of the party invoking the Arbitration for reference of dispute to a specific Arbitral institution for adjudication of that dispute shall be final and binding on both the parties and shall not be subject to any change thereafter. The institution once selected at the time of invocation of dispute shall remain unchanged.

N.2.4. The fee and expenses shall be borne by the parties as per the Arbitral Institutional rules.

N.2.5. The Arbitration proceedings shall be in English language and the seat and venue of Arbitration shall be **Delhi.**

N.2.6. Subject to the above, the provisions of Arbitration & Conciliation Act 1996 and any amendment thereof shall be applicable. All matters relating to this Contract and arising out

of invocation of Arbitration clause are subject to the exclusive jurisdiction of the Court(s) situated at **Delhi**.

N.2.7. Notwithstanding any reference to the Designated Engineer or Conciliation or Arbitration herein, a. the parties shall continue to perform their respective obligations under the Contract unless they otherwise agree. Settlement of Dispute clause cannot be invoked by the Contractor, if the Contract has been mutually closed or 'No Demand Certificate' has been furnished by the Contractor or any Settlement Agreement has been signed between the Employer and the Contractor.

N.2.8. The Mechanism of resolution of disputes through arbitration shall be available only in the cases where the value of the dispute is less than Rs. 10 Crores.

N.2.9. In case the disputed amount (Claim, Counter claim including interest is Rs. 10 crores and above, the parties shall be within their rights to take recourse to remedies other than Arbitration, as may be available to them under the applicable laws after prior intimation to the other party. Subject to the aforesaid conditions, provisions of the Arbitration and Conciliation Act, 1996 and any statutory modifications or re-enactment thereof as amended from time to time, shall apply to the arbitration proceedings under this clause.

N.2.10. In case, multiple arbitrations are invoked (whether sub-judice or arbitral award passed) by any party to under this contract, then the cumulative value of claims (including interest claimed or awarded) in all such arbitrations shall be taken in account while arriving at the total claim in dispute for the subject contract for the purpose of clause N.2.9. Disputes having cumulative value of less than 10 crores shall be resolved through arbitration and any additional dispute shall be adjudicated by the court of competent jurisdiction.

In case of Contract with Public Sector Enterprise (PSE) or a Government Department, the following shall be applicable:

In the event of any dispute or difference relating to the interpretation and application of the provisions of commercial contract(s) between Central Public Sector Enterprises (CPSEs)/ Port Trusts inter se and also between CPSEs and Government Departments/Organizations (excluding disputes concerning Railways, Income Tax, Customs & Excise Departments), such dispute or difference shall be taken up by either party for resolution through AMRCD (Administrative Mechanism for Resolution of CPSEs Disputes) as mentioned in DPE OM No. 05/0003/2019-FTS-10937 dated 14-12-2022 as amended from time to time.

O. FACILITIES PROVIDED TO MSEs: -

Vide office memorandum F.No.21(8)/2011-MA dated 09.11.2016, Office of AS&DC, Ministry of MSME has issued clarification regarding definition of Goods and Services under the Public Procurement Policy of MSEs order-2012, In accordance with the Public Procurement Policy for MSEs order-2012 and OM regarding definition of Goods and Services issued by Ministry of MSME, it is clarified that benefits as envisaged in Public Procurement Policy for MSEs Order 2012 are to be provided in respect of the procurements related to the Goods and Services produced and provided by Micro and Small Enterprises (MSEs) only and **no benefits is to be given in Case of Works Contracts.**

P. CLOSING OF CONTRACTS

The Contract shall be considered completed and closed upon completion of contractual obligations and settlement of Final Bill or completion of Guarantee period whichever is later. Upon closing of Contract, BHEL shall issue a performance/ experience certificate as per

standard format, based on specific request of Contractor as per extant BHEL guidelines through the online portal available at https://siddhi.bhel.in only.

Q. SUSPENSION OF BUSINESS DEALINGS

BHEL reserves the right to take action against Contractors who either fail to perform or Tenderers/Contractor who indulge in malpractices, by suspending business dealings with them in line with BHEL guidelines issued from time to time.

The offers of the bidders who are under suspension as also the offers of the bidders, who engage the services of the banned firms / principal / agents, shall be rejected. The list of banned firms is available on BHEL web site www.bhel.com.

If any bidder / supplier / contractor during pre-tendering / tendering / post tendering / award / execution / post-execution stage indulges in any act, including but not limited to, mal-practices, cheating, bribery, fraud or and other misconduct or formation of cartel so as to influence the bidding process or influence the price or tampers the tendering process or acts or omits in any manner which tantamount to an offence punishable under any provision of the Indian Penal Code, 1860 or any other law in force in India, or does anything which is actionable under the Guidelines for Suspension of Business dealings, action may be taken against such bidder / supplier / contractor as per extant guidelines of the company available on www.bhel.com and / or under applicable legal provisions. Guidelines for suspension of business dealings is available in the webpage:

http://www.bhel.com/vender_registration/vender.php.

R. PERFORMANCE MONITORING:

The Contractors performance shall be continuously monitored during execution of work at site.
In case of contractor's performance is found not satisfactory during the execution of work at site, BHEL may take alternate remedial measures and may not consider the contractor for further tenders, if the contractor performance is not improved in spite of opportunities given by BHEL.

S. MEASUREMENT OF WORK AND MODE OF PAYMENT:

a) All payments due to the contractors shall be made by e-mode only, unless otherwise found operationally difficult for reasons to be recorded in writing.

b) For progress running bill payments: - The Contractor shall present detailed measurement sheets in triplicate, duly indicating all relevant details based on technical documents and connected drawings for work done during the month/period under various categories in line with terms of payment as per contract. The basis of arriving at the quantities, weights shall be relevant documents and drawings released by BHEL. These measurement sheets shall be prepared jointly with BHEL Engineers and signed by both the parties.

c) These measurement sheets will be checked by BHEL Engineer and quantities and percentage eligible for payment under various groups shall be decided by BHEL Engineer. The abstract of quantities and percentage so arrived at based on the terms of payment shall be entered in Measurement Book by BHEL Engineers and signed by both the parties.

d) These measurement sheets will be checked by BHEL Engineer and quantities and percentage eligible for payment under various groups shall be decided by BHEL Engineer. The abstract of quantities and percentage so arrived at based on the terms of payment shall be entered in Measurement Book and signed by both the parties.

e) Based on the above quantities, contractor shall prepare the bills, along with statutory documents, in prescribed format and work out the financial value. These will be entered in Measurement Book and signed by both the parties. Payment shall be made by BHEL after effecting the recoveries due from the contractor.

f) All recoveries due from the contractor for the month/period shall be effected in full from the corresponding running bills unless specific approval from the competent authorities is obtained to the contrary.

g) Measurement shall be restricted to that portion of work for which it is required to ascertain the financial liability of BHEL under this contract.

h) The measurement shall be taken jointly by persons duly authorized on the part of BHEL and by the Contractor.

i) The Contractor shall bear the expenditure involved if any, in making the measurements and testing of materials to be used/ used in the work. The contractor shall, without extra charges, provide all the assistance with appliances and other things necessary for measurement.

j) If at any time due to any reason whatsoever, it becomes necessary to re-measure the work done in full or in part, the expenses towards such re measurements shall be borne by the contractor unless such re measurements are warranted solely for reasons not attributable to contractor.

k) Passing of bills covered by such measurements does not amount to acceptance of the completion of the work measured. Any left out work has to be completed, if pointed out at a later date by BHEL.

l) Final measurement bill shall be prepared in the final bill format prescribed for the purpose based on the certificate issued by BHEL Engineer that entire works as stipulated in tender specification has been completed in all respects to the entire satisfaction of BHEL. Contractor shall give unqualified "No Claim" Certificate. All the tools and tackles loaned to him should be returned in satisfactory condition to BHEL. The abstract of final quantities and financial values shall also be entered in the Measurement Books and signed by both parties to the contract. The Final Bill shall be prepared and paid within a reasonable time after completion of work.

T. NO INTEREST PAYABLE TO CONTRACTOR:

Notwithstanding anything to the contrary contained in any other document comprising in the Contract, no interest shall be payable by BHEL to Contractor on any moneys or balances including but not limited to the Security Deposit, EMD, Retention Money, RA Bills or the Final Bill, or any amount withheld and/or appropriated by BHEL etc., which becomes or as the case may be, is adjudged to be due from BHEL to Contractor whether under the Contract or otherwise.

U. PROGRESSIVE PAYMENT/ FINAL PAYMENT:

1. **Running Account Bills (RA Bills)**
   i) These are for interim payments when the contracts are in progress. The bills for such interim payments are to be prepared by Contractor in prescribed formats (RA Bill forms).

ii) Payments shall be made according to the extent of work done as per measurements taken up to the end of the calendar month and in line with the terms of payments described in the Tender documents.

iii) Recoveries on account of electricity, water, statutory deductions etc. are made as per terms of contract.

iv) Full rates for the work done shall be allowed only if the quantum of work has been done as per the specifications stipulated in the contract. If the work is not executed as per the stipulated specifications, BHEL may ask the contractor to redo the work according to the required specifications, without any extra cost.

v) The contractor shall submit his monthly RA bills with all the details required by BHEL on specified date every month covering progress of work in all respects and areas for the previous calendar month.

vi) Mode of payment and measurement of work completed shall be as per relevant clauses of General Conditions of Contract

vii) Release of payment in each running bill including ORC Bills where ever applicable will be as per stages of progressive pro rata payments.

viii) The contractor will be eligible for payment of RA Bills within 30 days of submission of running bill complete in all respects with all documents. It is the responsibility of the contractor to make his own arrangements for making timely payments towards labour wages, statutory payments, outstanding dues etc. and other dues in the meanwhile.

All documents like HR Clearance, Quality and Safety Compliances etc. required for processing the RA Bills should be submitted along with RA Bills.

ix) BHEL shall release payment through Electronic Fund Transfer (EFT)/RTGS. In order to implement this system, Contractor to furnish details pertaining to his Bank Accounts where proceeds will be transferred through BHEL's banker, as per prescribed formats.

x) <u>For MSMEs, at the time of submission of first RA bill, the subcontractor has to declare whether it is registered on RXIL portal and wishes to receive the proceeds through RXIL portal throughout the contract duration.</u>

xi) Note: BHEL may also choose to release payment by other alternative modes as applicable.

xii) **<u>Documents required for RA Bill:</u>**

a) GST Complied Invoice of the work done as per approved BOQ.
b) Jointly signed Measurement sheet, WAM -6 for RA Bill.
c) Material Reconciliation statement
d) Test Report of the material as per FQP
e) Power of Attorney before submission of Bill.
f) Validity of Bank Guarantees as applicable under the contract.
g) HR compliance documents:
    1) Labour Payment Certificate, Wages payment sheet
    2) Proof of PF, ESI, WC contribution submission
    3) Proof of Bonus payment as per Bonus Act if applicable.
h) Any other documents as per customer requirement/statutory requirement.

Note :

BHEL Site in charge has to certify that all the above required documents have been received and verified and documents sl no. a) to d) duly verified are to be sent to Finance along with RA bills.

2. **Final Bill:**

Final Bill' is used for final payment on closing of Running Account for works or for single payment after completion of works. 'Final Bill' shall be submitted as per prescribed format after completion of works as per scope, material reconciliation, removal of temporary structures, return of scrap/surplus material of BHEL. BHEL shall settle the final bills after deducting all liabilities of Contractor to BHEL.

2.1. **Documents required for Final Bill:**

a) GST Complied Invoice of the work done as per approved BOQ.
b) Jointly signed Measurement sheet, WAM -7, WAM-10 format (if Applicable).
c) Valid Bank Guarantees as applicable under the contract.
d) Labour Payment Certificate (if applicable)
e) 'No claim' certificate from the contractor.
f) Deviation statement showing the Executed quantities and quantities as per the contract.
g) Submission of Test reports as per FQP (if applicable)
h) Material Reconciliation statement duly approved by BHEL
i) HR compliance documents:
    i) Labour Payment Certificate, Wages payment sheet
    ii) Proof of PF, ESI, WC contribution submission
    iii) Proof of Bonus payment as per Bonus Act if applicable.
j) Submission of As Built Drawings (if applicable)
k) Compliance report from BHEL/Customer for completion of punch points
l) Final Delay Analysis.
m) Any other documents as per customer requirement/statutory requirement.

Note :
BHEL Site incharge has to certify that all the above required documents have been received and verified and document sl no. a) to f) duly verified are to be sent to Finance alongwith Completion certificate.

V. LIMITATION ON LIABILITY:

Notwithstanding anything to the contrary in this Contract or LOA or any other mutually agreed document between the parties, the maximum liability, for damages, of the contractor, its servants or agents, shall under no circumstances exceed an amount equal to the Price of the Contract or the Work Order. The Contractor shall not in any case be liable for loss of profit or special, punitive, exemplary, indirect or consequential losses whatsoever. This shall not be applicable on the recoveries made by Customer from BHEL on account of Contractor, any other type of recoveries for workmanship, material, T&P etc. due from the contractor.

W. All other terms and conditions of GCC shall remain unchanged.

INDEMNITY BOND

(To be typed and submitted in the Letter Head of the Company/Firm of Bidder)

This Indemnity Bond executed by <_____name of company> having their Registered Office at <_____> in favour of M/s Bharat Heavy Electricals Limited, a Company incorporated under the Companies Act, 1956, having its Registered Office at BHEL House, Siri Fort, Asiad, New Delhi - 110049 through its unit - TBG, 5th Floor, BHEL Sadan, Plot No. 25, Sector-16A, Noida-201301 (UP). (Hereinafter referred to as the Company)

And whereas the Company has entered into a Contract with M/s_____, the executants of this Deed (hereinafter referred to as the Contractor) as its contractor in respect of the work of "_____".

AND WHEREAS under the provisions of GCC further stipulates that the Contractor shall indemnify the Company against all claims of whatever nature arising during the course of execution of Contract including defects liability period of <_____Months > i.e till <_____>

Now this deed witness that in case the Company is made liable by any Authority including Court to pay any claim or compensation etc. in respect of all labourers or other matters at any stage under or relating to the Contract with the Contractor , the Contractor hereby covenants and agrees with the Company that they shall indemnify and reimburse the Company to the extent of such payments and for any fee, including litigation charges, lawyers' fees, etc, penalty or damages claimed against the Company by reason of the Contractor falling to comply with Central/States Laws, Rules etc, or his failure to comply with Contract (including all expenses and charges incurred by the Company).

The Contractor further indemnifies the Company for the amount which the Company may be liable to pay by way of penalty for not making deductions from the Bills of the Contractor towards such amount and depositing the same in the Government Treasury.

The Contractor further agree that the Company shall be entitled to withhold and adjust the Security Deposit and/or withhold and adjust payment of Bills of Contractor pertaining to this Contract against any payment which the Company has made or is required to make for which the Contractor is liable under the Contract and that such amount can be withheld, adjusted by the Company till satisfactory and final settlement of all pending matters and the Contractor hereby gives his consent for the same.

The Contractor further agrees that the terms of indemnity shall survive the termination or completion of this contract.

The contractor further agrees that the liability of the contractor shall be extended on actual basis notwithstanding the limitations of liability clause, in respect of :

1. breach of terms of contract by the contractor
2. breach of laws by the contractor
3. breach of Intellectual property rights by the contractor
4. breach of confidentiality by the contractor

Nothing contained in this deed, shall be construed as absolving or limiting the liability of the Contractor under said Contract between the Company and the Contractor. That this Indemnity Bond is irrevocable and the condition of the bond is that the Contractor shall duly and punctually comply with the terms and the conditions of this deed and contractual provisions to the satisfaction of the Company.

In witness where of M/s _____ these presents on the day, month and year first, above written at _____ by the hand of its signatory Mr._____.

Signed for and on behalf of
M/s _____

Witness:

1.

2.

PROFORMA OF BANK GUARANTEE (in lieu of SECURITY DEPOSIT)

In consideration of Bharat Heavy Electricals Limited (hereinafter referred to as the 'Employer' which expression shall unless repugnant to the context or meaning thereof, include its successors and permitted assigns) incorporated under the Companies Act, 1956 and having its registered office at BHEL House, Siri Fort, New Delhi-110049 through its Unit at BHEL, Transmission Business Group, Noida (name of the Unit) having agreed to exempt _____(Name of the Vendor / Contractor / Supplier) with its registered office at_____[1] (hereinafter called the said "Contractor" which term includes supplier), from demand under the terms and conditions of the Contract reference No._____ dated _____ [2] valued at Rs……[3](Rupees ……) (hereinafter called the said Contract), of Security Deposit for the due fulfilment by the said Contractor of the terms and conditions contained in the said Contract, on production of a Bank Guarantee for Rs……[4] (Rupees…….....only),

We _____(indicate the name and address of the Bank) having its Head Office at _____(address of the head Office) (hereinafter referred to as the Bank), at the request of _____ [Contractor(s)], being the Guarantor under this Guarantee, do hereby irrevocably and unconditionally undertake to forthwith and immediately pay to the Employer, an amount not exceeding Rs._____without any demur, immediately on demand from the Employer and without any reservation, protest, and recourse and without the Employer needing to prove or demonstrate reasons for its such demand

Any such demand made on the bank, shall be conclusive as regards the amount due and payable by the Bank under this guarantee. However, our liability under this guarantee shall be restricted to an amount not exceeding Rs._____.

We undertake to pay to the Employer any money so demanded notwithstanding any dispute or disputes raised by the Contractor(s) in any suit or proceeding pending before any Court or Tribunal or Arbitrator or any other authority, our liability under this present being absolute and unequivocal.

The payment so made by us under this guarantee shall be a valid discharge of our liability for payment hereunder and the Contractor(s) shall have no claim against us for making such payment.

We, further agree that the guarantee herein contained shall remain in full force and effect during the period that would be taken for the performance of the said Contract and that it shall continue to be enforceable till all the dues of the Employer under or by virtue of the said Contract have been fully paid and its claims satisfied & the Employer certifies that the terms and conditions of the said Contract have been fully and properly carried out by the said contractor(s) or acceptance of the final bill or discharge of this guarantee by the Employer, whichever is earlier. This guarantee shall initially remain in force up to and including_____[5] and shall be extended from time to time for such period as may be desired by the Employer. Unless a demand or claim under this guarantee is made on us in writing on or before the _____[6], (3 months more than the present date of validity of Bank Guarantee) we shall be discharged from all the liability under this guarantee thereafter.

We, _____ (indicate the name of the Bank) further agree with the Employer that the Employer shall have the fullest liberty without our consent and without affecting in any manner

our obligations hereunder to vary any of the terms and conditions of the said Contract or to extend time of performance by the said contractor(s) from time to time or to postpone for any time or from time to time any of the powers exercisable by the Employer against the said contractor(s) and to forbear or enforce any of the terms and conditions relating to the said Contract and we shall not be relieved from our liability by any reason of any such variation or extension being granted to the said contractor(s) or for any forbearance, act or omission on the part of the Employer or any indulgence by the Employer to the said contractor(s) or by any such matter or thing whatsoever which under the law relating to sureties would but for this provision have effect of so relieving us.

The Bank also agrees that the Employer at its option shall be entitled to enforce this Guarantee against the Bank as a principal debtor, in the first instance without proceeding against the Contractor and notwithstanding any security or other guarantee that the Employer may have in relation to the Contractor's liabilities.

This Guarantee shall not be determined or affected by liquidation or winding up, dissolution or change of constitution or insolvency of the Contractor but shall in all respects and for all purposes be binding and operative until payment of all money payable to the Employer in terms thereof. This guarantee will not be discharged due to the change in the constitution of the Bank or the Contractor(s).

We,……. BANK lastly undertake not to revoke this guarantee during its currency except with the previous consent of the Employer in writing.

Notwithstanding anything to the contrary contained hereinabove:

a) The liability of the Bank under this Guarantee shall not exceed…… [4]

b) This Guarantee shall be valid up to ……[5]

c) Unless the Bank is served a written claim or demand on or before _____[6] all rights under this guarantee shall be forfeited and the Bank shall be relieved and discharged from all liabilities under this guarantee irrespective of whether or not the original bank guarantee is returned to the Bank.

We, _____ Bank, have power to issue this Guarantee under law and the undersigned as a duly authorized person has full powers to sign this Guarantee on behalf of the Bank.

Date _____ Day of _____

for___(indicate the name of the Bank)__

(Signature of Authorised signatory)

[1] ADDRESS OF THE VENDOR /CONTRACTOR / SUPPLIER .

[2] DETAILS ABOUTTHE NOTICE OF AWARD/CONTRACTREFERENCE

[3] CONTRACT VALUE

[4] BG AMOUNTIN FIGURES AND WORDS

[5] VALIDITY DATE (At least 3 months more than completion period)

[6] DATE OF EXPIRY OF CLAIM PERIOD (At least 3 months more than the present date of validity of BG)

Notes:

1 The expiry of claim period shall be at least 3 months more than the validity date. It may be ensured that the same is in line with the agreement/ contract entered with the Vendor.

2 The BG should be on Non-Judicial Stamp paper/e-stamp paper of appropriate value as per Stamp Act prevailing in the State(s) where the BG is submitted or is to be acted upon or the rate prevailing in the State where the BG was executed, whichever is higher. The Stamp Paper/e-stamp paper shall be purchased in the name of Vendor/Contractor/Supplier /Bank issuing the guarantee.

3 In Case of Bank Guarantees submitted by Foreign Vendors:

a. From Nationalized/Public Sector / Private Sector/ Foreign Banks (BG issued by Branches in India) can be accepted subject to the condition that the Bank Guarantee should be enforceable in the town/city or at nearest branch where the Unit is located i.e. Demand can be presented at the Branch located in the town/city or at nearest branch where the Unit is located.

b. From Foreign Banks (wherein Foreign Vendors intend to provide BG from local branch of the Vendor country's Bank)

b.1 In such cases, in the Tender Enquiry/ Contract itself, it may be clearly specified that Bank Guarantee issued by **any of the Consortium Banks only** will be accepted by BHEL. As such, Foreign Vendor needs to make necessary arrangements for issuance of Counter- Guarantee by Foreign Bank in favour of the Indian Bank's (BHEL's Consortium Bank) branch in India. It is advisable that all charges for issuance of Bank Guarantee/ counter- Guarantee should be borne by the Foreign Vendor. The tender stipulation should clearly specify these requirements.

b.2 In case, Foreign Vendors intend to provide BG from Overseas Branch of our Consortium Bank (e.g. if a BG is to be issued by SBI Frankfurt), the same is acceptable. However, the procedure at sl.no. b.1 will required to be followed.

Form WAM 6

BHARAT HEAVY ELECTRICALS LIMITED
DIVISION.....
Running Account Bill
(Para 4.3.1 of Works Accounts Manual)

Departmental Bill No.

Name of the Contractor — Date:

Name of the Work: — Division: — Sub-Division:

Sanctioned Estimate: — Date of written order to commence the Work: — Period of work covered in this bill:

Code No.: — Date of commencement of work:

Contract Agreement No.: — Dated: — Due date of completion as per agreement

Date of approval of Competent Authority for time extension as applicable (copy to be enclosed).

I. ACCOUNT OF WORK EXECUTED

Adhoc payment for work not previously measured **			Item No. of work	Description of work	Quantity as per agreement	Quantity executed upto date	Rate	Unit	Payment on the basis of actual measurement upto date	Quantity executed since last RA bill	Payment on the basis of actual measurement since last running account bill	Remarks
Total as per last running account bill	Since last running account bill	Total upto date										
1	2	3	4	5	6	7	8	9	10	11	12	13

** 1. Whenever payment is made on adhoc basis without actual measurements the amount in whole rupees should be entered in columns 1 to 3 only and not in columns 7 to 12

2. Whenever there is an entry in column 12 on the basis of actual measurement, the whole of the amount previously paid without detailed measurement should be adjusted by a minus entry in column 2 equivalent to the amount shown in column 1, so that the total upto date in column 3 may become nil.

Total value of work done upto date (A) -------

Deduct value of work shown on the last Running Account Bill (B) -------

Net value of work done since last Running Account Bill (C) -------

Rupees (in words) ..... Only

Note :
Wherever adhoc payments to contractors against running bills are made in accordance with the extant Works Policy, the amount so paid shall be adjusted.

II. MEMORANDUM OF PAYMENTS

			I	II
1.	Total value of work actually measured as per Account No. I, Column 10	(A)	----------	----------
2.	Total upto date adhoc payment for work covered by approximate or plan measurements as per Account I, Col. 3	(B)	----------	----------
4.	Total upto date payments [(A)+(B)]	(C)	----------	----------
5.	Total amount of payments already made as per entry (D) of last Running Account Bill No. ..... dated ..... forwarded to the Accounts Department on	(D)		----------
6.	Balance [(C) - (D)]			----------
7.	Payments now to be made:		----------	
	a) by cash / cheque		----------	
	b) by deduction for value of materials supplied by BHEL vide Annexure A attached		----------	
	c) by deduction for hire of tools and plant vide Annexure B attached		----------	
	d) by deduction for other charges vide Annexure C attached		----------	
	e) by deduction on account of security deposit		----------	
	f) by deduction on account of Income Tax			----------

Note :	Amounts relating to items 4 to 6 above should be entered in column II and those relating to item 7 in column I. The amount shown against item 6 and the total of item 7 should agree with each other.

III. CERTIFICATE OF THE ENGINEER IN CHARGE

1	The measurements on which the entries in column 7 to 12 of Part I of this Bill (Account of work executed) are based were made by ---------- and are reorded at pages - ---------- of Measurement Book No. ---------- (Name and Designation)
2	Certified that the methods of measurement are correct and the work has been carried out in accordance with the terms and conditions, schedules, specifications and drawings etc. forming part of the contract agreement, subject to deviations included in the deviation statement (Annexure D)
3	Certified that in addition to and quite apart from the quantities of work actually executed as shown in column 10 of Part I, some work has actually been done in connection with several items and the value of the such work is, in no case, less than the adhoc payments as per column 3 of Part I, made or proposed to be made, for the convenience of the contractor in anticipation of, and subject to the results of, detailed measurement which will be made as soon as possible.
4	Certified that measurements by Engineer-incharge and test check of prescribed percentage of measurements by the concerned superior authorities has been carried out.
5	Certified that there are no pending recoveries from the contractor on account of chargeable items (e.g T&P, consumables, material, etc.) issued either by BHEL or by the customer and other recoveries like power, water, quarter, tax liability towards declaration forms etc.
6	Certified that with regard to the free issues, regular reconciliation is being done, completed upto ---------- and there are no recoveries pending from the contractor on account of such issues in excess of requirement for execution of work as per contract.
7	Certified that there is no pending recovery for damaged material issued free of cost.
8	Certified that the contractor has fulfilled all the requirements as per contract with reference to statutory obligations (PF, ESI, Minimum Wages, BOCW, Insurance etc.), support services such as service manpower, computer system , T&P etc

Signature of Contractor

Date:

Signature of Engineer in Charge

Designation:

Date:

IV. CERTIFICATE OF THE SENIOR ENGINEER

1	Certified that the measurements have been check measured to the prescribed extent by .... at site and also by the undersigned and the relevant entries have been initialed in the Measurement Book. (vide pages .....) (Name and Designation)
2	Certified that all the measurements recorded in the measurement book have been correctly billed for
3	Certified that all recoverable amounts in respect of materials tools and plant etc. and other charges have been correctly made vide annexures A to C attached.

Certified for payment * of Rs. ..... (Rupees ..... only)

*** Here specify the net amount payable.**

Date: **Signature of Senior Engineer**

V. ENTRIES TO BE MADE IN THE FINANCE DEPARTMENT

Code No.:

Accounts Bill No. ---------- dated ----------

Entered in Journal Book vide entry No. ---------- dated ----------

Passed for ---------- Rs.----------

Less Deductions ---------- Rs.----------

Net amount payable ---------- Rs.----------

(Rupees ---------- only)

Payable to Shri / M/s ---------- by cheque / cash

Entered in Contractors ledger No. ---------- Page ----------

	ALLOCATION	
Estimate No :	Debit	Credit
	(Gross amount)	(Deductions)
Name of Work :		
Account code head		
Total		

Assistant
Date:

Accountant
Date:

Finance Executive
Date:

Form WAM 6 (Contd.)

ANNEXURE A

Statement showing details of materials issued to the contractor Shri / M/S..... in respect of Contract Agreement / Work Order No.....Dated..... and covered by the agreement

Sl.No.	Stores Issue Voucher No. and date	Issue voucher No. and date allotted by stores to the SIV	Description of material issued issued to the contractor	Quantity issued		Quantity actually incorporated in the work	Balance quantity with contractor		If recoverable from the contractor				
				Free	Chargeable		Free	Chargeabl	Rate at which recoverable	Amount recoverable	Amount recovered upto previous bill	Balance now recovered	Remarks
1	2	3	4	5	6	7	8	9	10	11	12	13	14
							Total						

Certified that …….. (balance quantity of free issue material as per Col. 8 above) is physically available with the Contractor.

Signature of Contractor
Date:

Signature of Engineer in Charge
Date:

Signature of Senior Engineer
Date:

ANNEXURE B

Statement showing tools and plant issued to the contractor Shri/M/s..... in respect of Contract Agreement No.....Dated.....

Sl. No.	Description of Tools and Plant Issued	Period for which issued	Rate at which recovery is to be made	Amount recoverable	Amount recovered upto previous bill	Balance Recovered now	Remarks
1	2	3	4	5	6	7	8
			TOTAL				

Signature of Contractor
Date :

Signature of Engineer in Charge
Date :

Signature of Senior Engineer
Date:

Form WAM 6 (Contd.)

ANNEXURE C

Statement showing details of other recoveries to be made from the contractor Shri/M/s----------in respect of contract Agreement No. .....Dated .....

S. No.	Particulars	Unit	Quantity	Rate	Amount recoverable	Amount recovered up to previous bill	Amount now recovered	Remarks
1	2	3	4	5	6	7	8	9
1	Water charges							
2	Electricity charges							
3	Seignorage charges							
4	Medical charges							
5	Cost of empty gunny bags and empty containers not returned							
6								
7								
8								
	TOTAL							

Signature of Contractor
Date :

Signature of Engineer in Charge
Date :

Signature of Senior Engineer
Date:

ANNEXURE D
DEVIATION STATEMENT

Name of the Contractor:

Contract Agreement No

Name of Work:

Date:

S. No.	Description of Item	Unit	Quantity as per agreement	Quantity as executed	Quantity further anticipated	Total quantity anticipated on completion	Rate as per agreement	Rate as executed	Amount as per agreement	Amount as executed	Amount further anticipated	Total Amount anticipated on completion	Difference		Reason for deviation with authority, if any
													Excess	Savings	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Signature of Engineer in Charge
Date :

Signature of Senior Engineer
Date :

Form WAM 7

BHARAT HEAVY ELECTRICALS LIMITED
DIVISION.....
.....And Final Bill
(Para 4.3.2 of Works Accounts Manual)

Departmental Bill No:
Date:
Name of the Contractor: Division: Sub-Division:
Name of the Work: Date of Written order to commence the work:

Sanctioned Estimate: Date of commencement of the Work:
Contract Agreement/ Work Order No: Dated: Due date of completion as per Agreement:
Date of actual completion of the work:

I. ACCOUNT OF WORK EXECUTED

Adhoc payment for work not previously measured **			Item no. of the agreement / work order	Description of work	Quantity as per agreement	Quantity executed upto date	Rate	Unit	Payment on the basis of actual measurement upto date	Quantity since last running account bill	Payment on t he basis of actual measurement since last running account bill	Remarks
Total as per last running account bill	Since last running account bill	Total upto date										
1	2	3	4	5	6	7	8	9	10	11	12	13

** Whenever there is an entry in column 12 on the basis of actual measurement, the whole of the amount previously paid without detailed measurement should be adjusted by a minus entry in column 2 equivalent to the amount shown in column 1, so that the total upto date in column 3 may become nil.

Total value of work done upto date	(A)	-------
Deduct value of work shown on the last Running Account Bill	(B)	-------
Net value of work done since last Running Account Bill	(C)	-------

Rupees (in words) ..... Only

Form WAM 7 (Contd.)

II. MEMORANDUM OF PAYMENTS

1	Total value of work actually measured as per Account No. I column 10		(A)	----------
2	Deduct amount of payments already made as per last running account bill No. ..... dated		(B)	----------
3	Payment now to be made [(A) - (B)]		(C)	----------
4	Deduct amounts recoverable from the contractor on account of :			
	a) Materials supplied by BHEL vide Annexure A attached	----------		
	b) Hire of tools and plant vide Annexure B attached	----------		
	c) Other charges vide Annexure C attached	----------		
	d) Income Tax	----------		
	Total Deductions			----------
5	Balance			----------
6	Refunds of Security Deposit			----------
7	Net amount to be paid to the contractor			----------

Net value Rupees (in words) ..... Only

I/ We hereby certify that I/We have performed the work as per the terms and conditions of Contract Agreement/Work Order No.....Dated.....for which payment is claimed as above and that I/We have no further claim under this agreement/work order.

Signature of the Contractor

Date:

III CERTIFICATE OF THE ENGINEER IN CHARGE

1. The measurements on which the entries in columns 7 to 11 of Part I of this bill (Account of work executed) are based were made by.....
.....are recorded at pages.....of measurement book No..... (Name and Designation)
2. A statement showing the quantities of stores issued to the contractor (whether free or on recovery basis) and their disposal is attached.

Date:

Signature of Engineer incharge

Designation:

Form WAM 7 (Contd.)

IV CERTIFICATE OF THE SENIOR ENGINEER

1. Certified that I have personally inspected the work and that the work has been physically completed on the due date in accordance with the terms and conditions, schedules, specifications and drawings etc., forming part of the contract agreement, subject to the deviations noted in Deviation Statement (Annexure D).
2. Certified that the measurements have been check measured to the prescribed extent by..... ..... and by the undersigned at site and the relevant entries have been initiated in the measurement book (vide pages.....) (Name and Designation)
3. Certified that the methods of measurement are correct.
4. Certified that the measurements have been technically checked with reference to contract drawings, deviations etc.
5. Certified that the measurements recorded in the measurement book have been correctly billed for at the contract rates or approved rates.
6. Certified that all recoverable amounts in respect of stores, tools and plant, water, electricity charges etc. have been correctly made vide Annexures A to C and that there are no other demands outstanding against the contractor on this contract.
7. Certified that the issues of all stores as per statement attached (whether charged to the contractor or direct to the work) have been technically checked and represent fair and reasonable issues for the items of work executed vide Annexure E.
8. Certified that all statutory requirements including PF, ESI, Minimum wages, Insurance, GST, BOCW, etc. are complied with by the Contractor. This should be duly backed by the relevant documents.

Certified for payment of * Rs.....(Rupees.....only).

***Here specify the net amount payable**

Signature of Senior Engineer

Date

IV ENTRIES TO BE MADE IN THE FINANCE DEPARTMENT

Account code head	Debit (Gross Amount)	Credit (Deductions)
TOTAL		

Passed for.....Rs.....
Less Deductions.....Rs.....
Net Amount Payable.....Rs.....
(Rupees.....only)

Assistant

Date:

Accountant

Date:

Finance Executive

Date:

Form WAM 7 (Contd.)

ANNEXURE A
Part I

Statement showing details of materials issued to the contractor Shri / M/S.....in respect of Contract Agreement / Work Order No.....Dated..... and covered by the agreement.

Sl.No.	Stores Issue Voucher No. and date	Issue voucher No. and date allotted by stores to the SIV	Description of material issued issued to the contractor	Quantity issued	Quantity actually incorporated in the work	Whether recoverable from the contractor or supplied free	If recoverable from t he Contractor				
							Rate at which recoverable	Amount recoverable	Amount recovered upto previous bill	Balance now recovered	Remarks
1	2	3	4	5	6	7	8	9	10	11	12
						Total					

Signature of Contractor
Date:

Signature of Engineer in Charge
Date:

Signature of Senior Engineer
Date:

ANNEXURE A
Part II

Statement showing details of materials issued to the contractor Shri / M/S..... in respect of Contract Agreement / Work Order No.....Dated..... and not covered by the agreement

Sl.No	Stores Issue Voucher No.and Date	Issue Voucher No. and date allotted by stores to the SIV	Description of material issued to the contractor	Quantity issued	Quantity actually incorporated in the work	Issue Rate	Amount recoverable	Amount recovered upto previous bill	Balance now recovered	Remarks
1	2	3	4	5	6	7	8	9	10	11

TOTAL
Add Departmental Charges
Add GST (Wherever applicable)
GRAND TOTAL

Signature of Contractor
Date:

Signature of Engineer-in-Charge
Date:

Signature of Senior Engineer
Date:

Note: Cost of materials recovered in this bill should be shown against item 4 (a) of the memorandum of payments. The amounts of taxes and departmental charges recovered in this bill should be incorporated in Annexure C.

Form WAM 7 (Contd.)

ANNEXURE B

Statement showing tools and plant issued to the contractor Shri /M/S.....in respect of contract Agreement / Work Order No.....Dated.....

Sl.No.	Description of Tools and Plant Issued	Period for which issued	Rate at which recovery is to be made	Amount recoverable	Amount recovered upto previous bill	Balance now recovered	Remarks
1	2	3	4	5	6	7	8
			TOTAL				

Signature of Contractor
Date

Signature of Engineer-in-Charge
Date

Signature of Senior Engineer
Date

ANNEXURE C

Statement showing details of other recoveries to be made from the contractor Shri/M/s..... In respect of Contract Agreement / Work Order No.....Dated.....

Sl.No.	Particulars	Unit	Quantity	Rate	Amount recoverable	Amount recovered upto previous bill	Amount now recovered	Remarks
1	2	3	4	5	6	7	8	9
1	Water charges							
2	Electricity charges							
3	Medical charges							
4	Cost of empty gunny bags and empty containers not returned							
5								
6								
7								
			TOTAL					

Signature of Contractor
Date

Signature of Engineer in Charge
Date

Signature of Senior Engineer
Date

Form WAM 7 (Contd.)

ANNEXURE D

DEVIATION STATEMENT

Name of the Contractor: Contract Agreement/Work Order No.

Name of the Work: Date:

SL. No.	Description of Item	Unit	Quantity as per agreement	Quantity as executed	Rate as per agreement	Rate as executed	Amount as per agreement	Amount as executed	Difference		Reason for the deviation with authority, if any
									Excess	Savings	
1	2	3	4	5	6	7	8	9	10	11	12

Signature of Engineer in Charge Signature of Senior Engineer

Date: Date:

ANNEXURE E

Statement showing the consumption of materials issued to the contractor Shri/M/s…… in respect of Contract Agreement / Work Order No……Dated……

Name of the Work:

ON RECOVERY BASIS

SL. No.	Description of material	Unit	Quantity actually issued	Quantity actually incorporated in the work	Balance	Particulars of disposal of balance	Quantity to be issued as per approved data for work actually done	Variation in consumption (difference between colum 5 & 8)		Rate chargeable for excess/short consumption, if any	Amount Recoverable for excess/short consumption, including materials not returned, if any	Remarks
								More	Less			
1	Cement											
2	Bricks											
3	Wood											
4	Asbestos Sheet											
5	Iron Material											
6												
7												

Signature of Contractor Signature of Engineer in Charge Signature of Senior Engineer

Date: Date: Date:

Note

1. The quantities shown in columns 4 and 5 above should tally with those shown in columns 5 & 6 respectively of Annexure A (Part I and II)
2. Data statement of theoretical consumption should be attached in support of quantity specified in column 8.

Form WAM 7 (Contd.)

ANNEXURE F

Statement showing details of materials issued to the contractor Shri/M/s..... in respect of Contract Agreement / Work Order No.....dated.....

Name of the Work:

FREE OF COST

Sl.No	Stores Issue Voucher No.	Description of material	Unit	Quantity issued	Quantity required as per data	Quantity consumed in the work	Balance (if any)	Nature of disposal for the balance	Rate chargeable for material not returned	Amount recoverable for material not returned	Remarks
1	2	3	4	5	6	7	8	9	10	11	12

Signature of Contractor
Date:

Signature of Engineer in Charge
Date:

Signature of Senior Engineer
Date:

ANNEXURE G

QUESTIONNAIRE TO BE ANSWERED BY THE ENGINEER IN CHARGE AND SENIOR ENGINEER

(Correct particulars and answers to be recorded)

1. Name of the Work:
2. Name of the Contractor:
3. Date of commencement of the Work:
4. Contract agreement /Work Order No. and date:
5. Reference to the supplementary Agreement No. if any:
6. Whether administrative approval and technical sanction has been accorded by the competent authority? If so, cite reference?
7. Whether sanction of the competent authority and financial concurrence of the Finance Department for award of the work has been accorded? If so, cite reference.
8. Whether the work has been completed in time? If not whether penalty has been levied or sanction of the competent authority for extension of time granted and communicated to the Finance Department with reasons for grant of extension? (Due and actual date of completion of the work and reference to letter No. and date granting the extension of time should be given).
9. (a) Whether the rates allowed in the bill have been checked with the contract agreement?

   (b) Whether the rates for extra/supplemental items have been approved by the competent authority and the sanction communicated to the Finance Department together with rate analysis? If so, cite reference
10. Whether deviations have been approved by the competent authority? If yes, give reference to the approval; if not, give reasons.
11. Whether the rates of recovery of stores issued to the contractor which are not provided for in the contract agreement have been settled in consultation with Finance?
12. Whether discrepancies pointed out by the Finance department in the stores statement have been reconciled and accepted by the Finance Department?
13. Whether materials issued to the contractor in excess of the theoretical requirements have been returned to the Stores department and the No. and date of such returned stores vouchers have been shown in Stores statement? If not, whether the cost of such excess materials has been recovered at the prescribed rate? Whether consumption statements in respect of materials chargeable to the work have been attached to the bill?
14. Whether consumption of materials shown has been technically checked by Senior Engineer?
15. Whether materials issued and used in the work is not less than that required for consumption in work according to our specifications? If consumption is less, whether necessary recovery has been made in the bill?
16. Whether measurements have been checked by the Engineer and Senior Engineer to the extent required and certificates of check recorded in the measurement books?
17. Whether contractor has signed the bill and the measurement books without reservations? If not, whether reasons have been intimated to the Finance Department?
18. Whether arithmetical calculations have been checked and certificate recorded in the measurement books by a person other than the one who calculated initially?
19. Whether any work was done at the risk and cost of the contractor and whether such cost has been recovered from him? Give particulars.
20. Whether all advance payments on running accounts have been recovered?
21. Whether all the recoveries due for services given to the contractor like rent of accommodation, water charges, electricity charges have been recovered and whether payments made by the company on behalf of the contractor have been adjusted?
22. Whether the files containing abstracts from measurement books/standard measurement books have been completed/updated?
23. Whether hire charges for tools & plant have been recovered and the statement of hire charges with full details attached?
24. Whether the certificate of workmanship and completion of work according to specifications, drawings etc. is recorded by Engineer Incharge/Senior Engineer and whether recoveries have been made for defective works, if any?
25. Whether all corrections in the bill/measurement books etc. have been neatly made and attested and there are no overwriting?
26. Whether final measurements have been taken as soon as possible after completion of the work and the certificate of completion issued? If not, whether reasons for delay have been recorded and communicated to finance department?
27. In respect of quantities reduced in the final bill as compared to the running payment, whether adequate reasons have been recorded and communicated to finance department?
28. Whether the expenditure has been classified correctly according to heads of account recorded in the sanctioned estimate?
29. Whether the work has been completed within the estimated cost? If not, what is the percentage of excess over the sanctioned estimate/ administrative approval? In case the excess is beyond the competency of the Senior Engineer, what action has been taken for obtaining the approval of the authority competent to sanction the excess?
30. (a) If the contractor has furnished bank guarantee in lieu of cash security deposit towards proper execution of works and guarantee against defects during the maintenance period, whether the period of currency of the bank guarantee covers the entire maintenance period?

    (b) If not whether security deposit has been proposed to be recovered from the final bill?
31. Whether all the previous audit objections raised on running account bills have been settled? If so, cite references.

Signature of Engineer in Charge
Date:

Signature of Senior Engineer
Date:

ANNEXURE TO MODEL CONCILIATION CLAUSE FOR CONDUCT OF CONCILIATION UNDER THE BHEL CONCILIATION SCHEME, 2018

BRIEF PROCEDURE FOR CONDUCT OF CONCILIATION PROCEEDINGS

1. The proceedings of Conciliation shall broadly be governed by Part-III of the Arbitration and Conciliation Act 1996 or any statutory modification thereof and as provided herein:

2. The party desirous of resorting to Conciliation shall send an invitation/notice in writing to the other party to conciliate specifying all points of Disputes with details of the amount claimed. The party concerned shall not raise any new issue thereafter. Parties shall also not claim any interest on claims/counter-claims from the date of notice invoking Conciliation till the conclusion of the Conciliation proceedings.

3. The party receiving the invitation/notice for Conciliation shall within 30 days of receipt of the notice of Conciliation intimate its consent for Conciliation along with its counter-claims, if any.

4. The Conciliation in a matter involving claim or counter-claim (whichever is higher) up to Rs 5 crores shall be carried out by sole Conciliator nominated by BHEL while in a matter involving claim or counter-claim (whichever is higher) of more than Rs 5 crores Conciliation shall be carried out by 3 Conciliators nominated by BHEL.

5. The Parties shall be represented by only their duly authorized in-house executives/officers and neither Party shall be represented by a Lawyer.

6. The first meeting of the IEC shall be convened by the IEC by sending appropriate communication/notice to both the parties as soon as possible but not later than 30 days from the date of his/their appointment. The hearings in the Conciliation proceeding shall ordinarily be concluded within two (2) months and, in exceptional cases where parties have expressed willingness to settle the matter or there exists possibility of settlement in the matter, the proceedings may be extended by the IEC by a maximum of further 2 months with the consent of the Parties subject to cogent reasons being recorded in writing.

7. The IEC shall thereafter formulate recommendations for settlement of the Disputes supported by reasons at the earliest but in any case within

15 days from the date of conclusion of the last hearing. The recommendations so formulated along with the reasons shall be furnished by the IEC to both the Parties at the earliest but in any case within 1 month from the date of conclusion of the last hearing.

8. Response/modifications/suggestions of the Parties on the recommendations of the IEC are to be submitted to the IEC within time limit stipulated by the IEC but not more than 15 days from the date of receipt of the recommendations from the IEC.

9. In the event, upon consideration, further review of the recommendations is considered necessary, whether by BHEL or by the other Party, then, the matter can be remitted back to the IEC with request to reconsider the same in light of the issues projected by either/both the Parties and to submit its recommendations thereon within the following 15 days from the date of remitting of the case by either of the Parties.

10. Upon the recommendations by the Parties, with or without modifications, as considered necessary, the IEC shall be called upon to draw up the Draft Settlement Agreement in terms of the recommendations.

11. When a consensus can be arrived at between the parties only in regard to any one or some of the issues referred for Conciliation the draft Settlement Agreement shall be accordingly formulated in regard to the said Issue(s), and the said Settlement Agreement, if signed, by the parties, shall be valid only for the said issues. As regards the balance issues not settled, the parties may seek to resolve them further as per terms and conditions provided in the contract.

12. In case no settlement can be reached between the parties, the IEC shall by a written declaration, pronounce that the Conciliation between the parties has failed and is accordingly terminated.

13. Unless the Conciliation proceedings are terminated in terms of para 22 (b), (c) & (d) herein below, the IEC shall forward his/its recommendations as to possible terms of settlement within one (1) month from the date of last hearing. The date of first hearing of Conciliation shall be the starting date for calculating the period of 2 months.

14. In case of 3 members IEC, 2 members of IEC present will constitute a valid quorum for IEC and meeting can take place to proceed in the matter after seeking consent from the member who is not available. If necessary, videoconferencing may be arranged for facilitating participation of the members. However, the IEC recommendations will be signed by all members. Where there is more than one (1) Conciliator, as a general rule they shall act jointly. In the event of differences between the Members of IEC, the decision/recommendations of the majority of the Members of IEC shall prevail and be construed as the recommendation of the IEC.

15. The Draft Settlement Agreement prepared by the IEC in terms of the consensus arrived at during the Conciliation proceedings between the Parties shall be given by the IEC to both the parties for putting up for approval of their respective Competent Authority.

16. Before submitting the draft settlement agreement to BHEL's Competent Authority viz. the Board Level Committee on Alternative Dispute Resolution (BLCADR) for approval, concurrence of the other party's Competent Authority to the draft settlement agreement shall be obtained by the other party and informed to BHEL within 15 days of receipt of the final draft settlement agreement by it. Upon approval by the Competent Authority, the Settlement Agreement would thereafter be signed by the authorized representatives of both the Parties and authenticated by the members of the IEC.

17. In case the Draft Settlement Agreement is rejected by the Competent Authority of BHEL or the other Party, the Conciliation proceedings would stand terminated.

18. A Settlement Agreement shall contain a statement to the effect that each of the person(s) signing thereto (i) is fully authorized by the respective Party(ies) he/she represents, (ii) has fully understood the contents of the same and (iii) is signing on the same out of complete freewill and consent, without any pressure, undue influence.

19. The Settlement Agreement shall thereafter have the same legal status and effect as an arbitration award on agreed terms on the substance of the dispute rendered by an arbitral tribunal passed under section 30 of the Arbitration and Conciliation Act, 1996.

20. Acceptance of the Draft Settlement Agreement/recommendations of the Conciliator and/or signing of the Settlement Agreement by BHEL shall

however, be subject to withdrawal/closure of any arbitral and/or judicial proceedings initiated by the concerned Party in regard to such settled issues.

21. Unless otherwise provided for in the agreement, contract or the Memorandum of Understanding, as the case may be, in the event of likelihood of prolonged absence of the Conciliator or any member of IEC, for any reason/incapacity, the Competent Authority/Head of Unit/Division/Region/Business Group of BHEL may substitute the Conciliator or such member at any stage of the proceedings. Upon appointment of the substitute Conciliator(s), such reconstituted IEC may, with the consent of the Parties, proceed with further Conciliation into the matter either de-novo or from the stage already reached by the previous IEC before the substitution.

22. The proceedings of Conciliation under this Scheme may be terminated as follows:
    a. On the date of signing of the Settlement agreement by the Parties; or,
    b. By a written declaration of the IEC, after consultation with the parties, to the effect that further efforts at conciliation are no longer justified, on the date of the declaration; or,
    c. By a written declaration of the Parties addressed to the IEC to the effect that the Conciliation proceedings are terminated, on the date of the declaration; or,
    d. By a written declaration of a Party to the other Party and the IEC, if appointed, to the effect that the Conciliation proceedings are terminated, on the date of the declaration.
    e. On rejection of the Draft Settlement Agreement by the Competent Authority of BHEL or the other Party.

23. The Conciliator(s) shall be entitled to following fees and facilities:

Sl No	**Particulars**	**Amount**
1	Sitting fees	Each Member shall be paid a Lump Sum fee of Rs 75,000/- for the whole case payable in terms of paragraph No. 27 herein below.
2	Towards drafting of settlement agreement	In cases involving claim and/or counter-claim of up to Rs 5crores. Rs 50,000/- (Sole Conciliator)

Sl No	Particulars	Amount
		In cases involving claim and/or counter-claim of exceeding Rs 5 crores but less than Rs 10 crores. Rs 75,000 (per Conciliator) In cases involving claim and/or counter-claim of more than Rs 10 crores. Rs 1,00,000/- (per Conciliator) Note: The aforesaid fees for the drafting of the Settlement Agreement shall be paid on Signing of the Settlement Agreement after approval of the Competent Authority or Rejection of the proposed Settlement Agreement by the Competent Authority of BHEL.
3	Secretarial expenses	Rs 10,000/- (one time) for the whole case for Conciliation by a Sole Member IEC. Where Conciliation is by multi member Conciliators –Rs 30,000/- (one time)- to be paid to the IEC
4	Travel and transportation and stay at outstation i) Retired Senior Officials of other Public Sector Undertakings (pay scale wise equivalent to or more than E-8 level of BHEL)	As per entitlement of the equivalent officer (pay scale wise) in BHEL.
	Others	As per the extant entitlement of whole time Functional Directors in BHEL.

Sl No	Particulars	Amount
		Ordinarily, the IEC Member(s) would be entitled to travel by air Economy Class.
5	Venue for meeting	Unless otherwise agreed in the agreement, contract or the Memorandum of Understanding, as the case may be, the venue/seat of proceedings shall be the location of the concerned Unit / Division / Region / Business Group of BHEL. Without prejudice to the seat/venue of the Conciliation being at the location of concerned BHEL Unit / Division / Region / Business Group, the IEC after consulting the Parties may decide to hold the proceedings at any other place/venue to facilitate the proceedings. Unless, Parties agree to conduct Conciliation at BHEL premises, the venue is to be arranged by either Party alternately.

24. The parties will bear their own costs including cost of presenting their cases/evidence/witness(es)/expert(s)on their behalf. The parties agree to rely upon documentary evidence in support of their claims and not to bring any oral evidence in IEC proceedings.

25. If any witness(es) or expert(s) is/are, with the consent of the parties, called upon to appear at the instance of the IEC in connection with the matter, then, the costs towards such witness(es)/expert(s) shall be determined by the IEC with the consent of the Parties and the cost so determined shall be borne equally by the Parties.

26. The other expenditures/costs in connection with the Conciliation proceedings as well as the IEC's fees and expenses shall be shared by the Parties equally.

27. Out of the lump sum fees of Rs 75,000/- for Sitting Fees, 50% shall be payable after the first meeting of the IEC and the remaining 50% of the Sitting Fees shall be payable only after termination of the conciliation proceedings in terms of para 22 hereinabove.

28. The travelling, transportation and stay at outstation shall be arranged by concerned Unit as per entitlements as per Serial No. 3 of the Table at para 23 above, and in case such arrangements are not made by the BHEL Unit, the same shall be reimbursed to the IEC on actuals limited to their entitlement as per Serial No. 4 of the Table at Para 23 above against supporting documents. The IEC Member(s) shall submit necessary invoice for claiming the fees/reimbursements.

29. The Parties shall keep confidential all matters relating to the conciliation proceedings. Confidentiality shall extend also to the settlement agreement, except where its disclosure is necessary for purposes of its implementation and enforcement or as required by or under a law or as per directions of a Court/Governmental authority/ regulatory body, as the case may be.

30. The Parties shall not rely upon or introduce as evidence in any further arbitral or judicial proceedings, whether or not such proceedings relate to the Disputes that is the subject of the Conciliation proceedings:
    a. Views expressed or suggestions made by the other party in respect of a possible settlement of the Disputes;
    b. admissions made by the other party in the course of the Conciliator proceedings;
    c. proposals made by the Conciliator;
    d. The fact that the other Party had indicated his willingness to accept a proposal for settlement made by the Conciliator.

31. The Parties shall not present the Conciliator(s) as witness in any Alternative Dispute Resolution or Judicial proceedings in respect of a Disputes that is/was the subject of that particular Conciliation proceeding.

32. None of the Conciliators shall act as an arbitrator or as a representative or counsel of a Party in any arbitral or judicial proceeding in respect of a Disputes that is/was the subject of that particular Conciliation proceeding.

33. The Parties shall not initiate, during the Conciliation proceedings, any arbitral or judicial proceedings in respect of a Disputes that is the subject matter of the Conciliation proceedings except that a Party may initiate arbitral or judicial proceedings where, in his opinion, such proceedings are necessary for preserving his rights including for preventing expiry of period of limitation. Unless terminated as per the provisions of this Scheme, the Conciliation proceedings shall continue

notwithstanding the commencement of the arbitral or judicial proceedings and the arbitral or judicial proceedings shall be primarily for the purpose of preserving rights including preventing expiry of period of limitation.

34. The official language of Conciliation proceedings under this Scheme shall be English unless the Parties agree to some other language.

Format 2 to BHEL Conciliation Scheme, 2018

FORMAT FOR SEEKING CONSENT FOR REFERRING THE DISPUTES TO CONCILIATION THROUGH IEC

To,

M/s. (Stakeholder's name)

Sub: Resolution of the Disputes through conciliation by Independent Expert Committee (IEC).

Ref: Contract No/MoU/Agreement/LOI/LOA& date _____.

Sir,

With reference to above referred Contract/MoU/Agreement/LOI/LOA, you have raised certain Disputes/claims. Vide your letter dated____ you have requested BHEL to refer the Disputes/claims to IEC for Conciliation.

We are enclosing herewith Format (3) for giving consent and the terms and conditions of BHEL Conciliation Scheme, 2018 governing conciliation through IEC. You are requested to give your unconditional consent to the said terms and conditions of the Scheme by returning the same duly sealed and signed on each page. On receipt of your consent, matter will be put to the Competent Authority for consideration and decision.

Please note that BHEL has also certain claims against you (if applicable). BHEL reserves its right to agree or not to agree conciliation of the said disputes through BHEL and this letter is being issued without prejudice to BHEL's rights and contentions available under the contract and law.

Yours faithfully,

Representative of BHEL

Format 3 to BHEL Conciliation Scheme, 2018

FORMAT FOR GIVING CONSENT BY CONTRACTOR/VENDOR/CUSTOMER/COLLABORATOR/CONSORTIUM PARTNERSFOR REFERRING THE DISPUTES TO CONCILIATION THROUGH IEC

To,

BHEL

.....

Sub: Resolution of Disputes through Conciliation by Independent Expert Committee (IEC).

Ref: Contract/MoU/Agreement/LOI/LOA No & date____

With reference to above referred contract, our following bills/invoices/claims submitted to BHEL are still unpaid giving rise to Disputes:

SL. no.	Claim Description	Bill submitted to BHEL (no. and date)	Amount of the bill/claim	Amount received from BHEL	Outstanding Amount

Accordingly we request you to kindly refer the Disputes in respect of above claims to IEC for Conciliation.

We hereby agree and give our unconditional consent to the terms and conditions of BHEL Conciliation Scheme, 2018 governing conciliation through IEC. We have signed the same on each page and enclosed it for your consideration.

Yours faithfully,

(Signature with stamp)

Authorized Representative of Contractor
Name, with designation
Date

Format 5 to BHEL Conciliation Scheme, 2018

STATEMENT OF CLAIMS/COUNTER CLAIMS TO BE SUBMITTED TO THE IEC BY BOTH THE PARTIES

1. Chronology of the Disputes

2. Brief of the Contract/MoU/Agreement/LOI/LOA

3. Brief history of the Disputes:

4. Issues:

5. Details of Clam(s)/Counter Claim(s):

Sl. No.	**Description of claim(s)/Counter Claim**	**Amount (in INR)Or currency applicable in the contract**	**Relevant contract clause**

6. Basis/Ground of claim(s)/counter claim(s) (along with relevant clause of contract)

Note– *The Statement of Claims/Counter Claims may ideally be restricted to maximum limit of 20 pages. Relevant documents may be compiled and submitted along with the statement of Claims/Counter Claims. The statement of Claims/Counter Claims is to be submitted to all IEC members and to the other party by post as well as by email.*

BILL OF QUANTITY CUM PRICE SCHEDULE (ANNEXURE-I)

Name of Project: 765/400/220kV AIS Switchyard Bikaner-III (New Substation)

Name of Work: Erection work of Structure and Stringing at 765/400/220 kV AIS Switchyard at POWERGRID, Bikaner-III Project in Bikaner, Rajasthan

Tender Spec. No. : TBSM/BIKANER-III/EREC-STR/TENDER/24-25, DATE: 16.01.2025

SR. NO.	Description of Item	UOM	Quantity	Unit Rate	Amount
1	Galvanised steel Lattice Structures including hardwares for Towers & beams (220KV,400KV & 765KV SWITCHYARD) as per layout	MT	2,000	₹ 5,888.00	₹ 1,17,76,000.00
2	AAC BULL CONDUCTOR complete with Twin/Quad bundle rigid/flexible spacers etc to complete	meter	56,000	₹ 110.00	₹ 61,60,000.00
3	ACSR Bersimis Conductor complete with Twin/Quad bundle rigid/flexible spacers etc to complete	meter	45,000	₹ 85.00	₹ 38,25,000.00
4	Installation of 7/9 SWG GI Stranded Shield wire including tension clamp, PG clamp and clamping on structure for down conductor	meter	14,600	₹ 66.00	₹ 9,63,600.00
5	765kV Double tension insulator string and associated hardware fittings with turn buckle suitable for quad conductor (conductor OD<40mm)	No.	84	₹ 5,369.00	₹ 4,50,996.00
6	765kV Double tension insulator string and associated hardware fittings without turn buckle suitable for quad conductor (conductor OD<40mm)	No.	84	₹ 5,369.00	₹ 4,50,996.00
7	765kV Double tension insulator string and associated hardware fittings with turn buckle suitable for hexa conductor (conductor OD<40mm)	No.	6	₹ 5,369.00	₹ 32,214.00
8	765kV single "V" suspension insulator string and associated hardware fittings with drop clamp suitable for quad conductor (conductor OD<40mm)	No.	6	₹ 5,650.00	₹ 33,900.00
9	765kV single "V" suspension insulator string and associated hardware fittings with Through clamp suitable for quad conductor (conductor OD<40mm)	No.	42	₹ 5,650.00	₹ 2,37,300.00
10	400kV Double tension insulator string and associated hardware fittings with turn buckle suitable for quad conductor (conductor OD<40mm)	No.	150	₹ 4,132.00	₹ 6,19,800.00
11	400kV Double tension insulator string and associated hardware fittings without turn buckle suitable for quad conductor (conductor OD<40mm)	No.	132	₹ 4,132.00	₹ 5,45,424.00
12	400kV single suspension insulator string and associated hardware fittings with drop clamp suitable for quad conductor (conductor OD<40mm)	No.	63	₹ 3,381.00	₹ 2,13,003.00
13	220kV Double tension insulator string and associated hardware fittings with turn buckle suitable for quad conductor (conductor OD<40mm)	No.	93	₹ 3,139.00	₹ 2,91,927.00
14	220kV Double tension insulator string and associated hardware fittings without turn buckle suitable for quad conductor (conductor OD<40mm)	No.	93	₹ 3,139.00	₹ 2,91,927.00
15	220kV Double tension insulator string and associated hardware fittings with turn buckle suitable for single conductor (conductor OD<40mm)	No.	15	₹ 3,139.00	₹ 47,085.00
16	220kV single suspension insulator string and associated hardware fittings with drop clamp suitable for quad conductor (conductor OD<40mm)	No.	41	₹ 2,825.00	₹ 1,15,825.00
17	Cutting and Modification - Structural Plates: Structure Modification - All tools and tackles required for GI structure, any other steel structure modification shall be in the scope of Erection agency. Minor welding and application of protective / zinc rich paint on welded surface is also included in the scope.	KG	1,000	₹ 25.00	₹ 25,000.00
18	Modification of existing Hole Sizes in Structures: All tools and tackles required for GI structure, any other steel structure modification shall be in the scope of Erection agency. Application of protective / zinc rich paint on modified surface is also included in the scope.	Nos	100	₹ 122.00	₹ 12,200.00
19	Drilling of Additional Holes in Structures : Structure Modification -All tools and tackles required for GI structure, any other steel structure modification shall be in the scope of Erection agency. Application of protective / zinc rich paint on modified surface is also included in the scope.	Nos	100	₹ 122.00	₹ 12,200.00
20	Watch and ward of stored / erected material at project site and storage area or any other locations as per instruction of site in charge. (round the clock security by authorized service agency)	Per Post Per Month	12	₹ 74,138.00	₹ 8,89,656.00
	Total Amount (Excluding GST)				**₹ 2,69,94,053.00**

Note: Scope of Erection work includes Unloading from truck/ trailer/ carriers and handling in store, upkeeping, shifting to & fro from store to work location/any location within site boundary, receipt & verification of material, material reconciliation, verification, record keeping, material relocating as per site / storage requirements, safe keeping, Pre-erection assembly, erection/ installation of the material/equipment as per drawings/instruction of site incharge, reconciliation after completion of Erection and handing over surplus material & Spares to BHEL/Customer. The Scope include provision of manpower, all tools & plant, testing kit required for erection work, hydra/crane, man lifter, winch and any other machinery/arrangement to be made for working at height as required for complete installation. IR test for insulator is in Erection agency scope. Preparation and taking approval of joint erection protocol with BHEL/CUSTOMER as per approved feild quality plan.

Validate Print Help

Percentage BoQ

Tender Inviting Authority: BHEL, TBG- SubContracting Department, Sector 16A Noida, UP

Name of Work: ERECTION WORK OF STRUCTURE AND STRINGING AT 765/400/220 KV AIS SWITCHYARD AT POWERGRID, BIKANER-III PROJECT IN BIKANER, RAJASTHAN.

Contract No: TBSM/BIKANER-III/EREC-STR/TENDER/24-25 DATE: 16.01.2025

Name of the Bidder/ Bidding Firm / Company :						

PRICE SCHEDULE

(This BOQ template must not be modified/replaced by the bidder and the same should be uploaded after filling the relevent columns, else the bidder is liable to be rejected for this tender. Bidders are allowed to enter the Bidder Name and Values only)

NUMBER #	TEXT #	NUMBER #	TEXT #	NUMBER	NUMBER #	TEXT #
Sl. No.	Item Description	Quantity	Units	Estimated Rate in Rs. P	TOTAL AMOUNT Without Taxes in Rs. P	TOTAL AMOUNT In Words
1	2	4	5	6	53	55
1	Total amount as per rates in BOQ (as per Annexure-I) for "Erection work of Structure and Stringing at 765/400/220 kV AIS Switchyard at POWERGRID, Bikaner-III Project in Bikaner, Rajasthan". - Excluding GST	1.000	Nos	26994053.00	**26994053.00**	INR Two Crore Sixty Nine Lakh Ninety Four Thousand &Fifty Three Only
Total in Figures					**26994053.00**	INR Two Crore Sixty Nine Lakh Ninety Four Thousand &Fifty Three Only
Quoted Rate in Figures			**Select**		**0.000**	INR Zero Only
Quoted Rate in Words					**INR Zero Only**	

Sl.No.	BOQ_ANNEXURE_1: STANDARD & PROJECT SPECIFIC TECHNICAL NOTES & SCOPE
1	Scope of Erection work includes Unloading from truck/ trailer/ carriers and handling in store, upkeeping, shifting to & fro from store to work location/any location within site boundary, receipt & verification of material, material reconciliation, verification, record keeping, material relocating as per site / storage requirements, safe keeping, Pre-erection assembly, erection/ installation of the material/equipment as per drawings/instruction of site incharge, reconciliation after completion of Erection and handing over surplus material & Spares to BHEL/Customer. The Scope include provision of manpower, all tools & plant, testing kit required for erection work, hydra/crane, man lifter, winch and any other machinery/arrangement to be made for working at height as required for complete installation. IR test for insulator is in Erection agency scope. Preparation and taking approval of joint erection protocol with BHEL/CUSTOMER as per approved feild quality plan.
2	Erection agency Supplied Material (as applicable) - For approved make of supply items, please visit "POWERGRID COMPENDIUM OF VENDORS" at following website address. **www.powergrid.in** Erection agency to offer items from powergrid approved make only (as applicable). Erection agency to supply material of proven design and make, which have already been extensively used and tested. Erection agency to obtain approval from BHEL Engineer incharge / Customer prior to supply. Quantity of supply items are provisional and shall be finalised during contract stage. Qty of supply item may vary upto any extent and and even may get deleted. However overall contract value may vary +/- 30%. Variation will be valid up-to contract stage.
3	All consumables required for sucessful erection of present scope of work is in Erection agencys scope, such as (not limited to) Welding Electrodes, Low hydrogen content welding electrode, Paint, bitumen compound, Zinc riched enamel paint, red oxide and zinc chromate etc. complete in all respect.
4	All pre-commissioning activities for substation equipment shall be carried out in accordance **"Pre- Commissioning procedures for Switchyard Equipments (Doc. No. D-2-01-03-01-04 or latest version)"**
5	The storage instructions of the equipment manufacturer/ Employer shall be strictly adhered to. POWERGRID Field Quality Plan shall be followed alongwith the provision of Technical Specification for storage.
6	All arc welding shall be done with **low hydrogen content electrodes** as per customer/BHEL approved specification/make.
7	All welding done at site for equipment and structures, shall be painted with zinc rich paint immediately to avoid corrosion.
8	Testing istruments (dully calibrated) have to be arranged by Erection agency at it's own cost (List is only provided for information , if any other instrument not mentioned below but required for sucessful completion of Erection work shall be in Erection agency scope). Erection agency to submit valid calibration certificate during commencement of testing works.
a	Contact Resistance Measurement kit (CRM)
b	5kV/1kV Insulation tester

BOQ_ANNEXURE_2

PROJECT SPECIFIC DRAWING & DOCUMENT LIST

Sl. No.	DRAWING / DOCUMENT NUMBER	DRAWING / DOCUMENT TITLE
1	TB-0-424-316-001-REV 07	BIKANER III NEW S/S- ELECTRICAL LAYOUT PLAN & SECTIONAL ELEVATION OF BIKANER (III) S/S
2	TB-0-424-316-003-REV 01	BIKANER III NEW S/S- STRUCTURE LAYOUT PLAN & SECTION
3	TB-0-424-316-004-REV 00	BIKANER III NEW S/S- DSLP LAYOUT
4	TB-0-424-316-008-REV 00, TB-424-316-008-BOQ -REV 00	BIKANER III NEW S/S- ERECTION KEY DIAGRAM LAYOUT PLAN & SECTION & BOQ

Note: Above drawings are given for reference purpose. Latest revision of above drawings will be shared with successful bidder, which is to be followed, during contract execution stage.

BOQ_ANNEXURE_3

STANDARD DRAWING & DOCUMENT LIST

Sl.No	DRAWING / DOCUMENT NUMBER	DRAWING / DOCUMENT TITLE
1	SECTION-PROJECT-REV.00	SECTION-PROJECT. (REV.00): Substation Package SS01 a) Construction of 765/400/220kV Bikaner-III (new) PS b) Extension of 765 kV Neemrana-II S/s c) Extension of 400kV Bikaner-III S/s under Transmission system for evacuation of power from REZ in Rajasthan (7.7 GW) under Phase IV-Part I,
2	C/ENGG/SPEC/GTR (Rev.15)	SECTION-GENERAL TECHNICAL REQUIREMENTS (REV.15)
3	C / ENGG / SPEC / ERC REV. NO: 10	SECTION-SE (SWITCHYARD ERECTION (REV.10))
4	D-2-01-03-01-04	PRE COMMISSIONING PROCEDURE & FORMAT FOR SWITCHYARD ERECTION
5	Annexure-III	Specific Requirement_Rev 07 with Annexures
6	C/ENGG/SPEC/STR (REV 06)	SECTION: STRUCTURE

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM)

DRG. NO. TB-0-424-316-001

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

LOCAL Y
LOCAL X

NOTES:

1. DEAD END TOWER ERECTION AND CUTTING/STRINGING OF LINE CONDUCTOR & SHIELD WIRE ARE NOT IN BHEL SCOPE BUT CONNECTION OF EQUIPMENT TOWARDS LINE SIDE SHALL BE DONE BY BHEL. SUPPLY OF TENSION INSULATOR STRING ON LINE SIDE OF TAME OFF GANTRY IS IN BHEL SCOPE OF WORK INCLUDING TENSION CLAMP FOR EARTHWIRE.
2. SUPPLY, ERECTION, TESTING, COMMISSIONING OF 765kV REACTOR & 400kV TRAFO (765/220/33 kV, 1500 MVA) IS NOT IN BHEL SCOPE, HOWEVER, FORMATION OF HV, LV, TERTIARY, NEUTRAL & AUXILIARY BUSES ALONG WITH SPS & ITS STRUCTURE (EARTHING AND ARRANGEMENT FOR CABLING) IS COVERED IN SCOPE OF WORK AS PER ITS SECTION/PROJECT
3. FIRE RESISTANT WALL BETWEEN 765kV TRANSFORMER UNITS AND 765kV REACTORS UNITS ARE IN BHEL SCOPE.
4. ALL DIMENSIONS ARE IN MM UNLESS OTHERWISE SPECIFIED.
5. LOCATION OF SPS SHOWN IS INDICATIVE ONLY. EXACT LOCATION SHALL BE FINALISED DURING DETAILED ENGINEERING STAGE, BASED ON LINE, TRANSMISSION, FOUNDATION FOR WAVE TRAP SHALL BE CONSTRUCTED FOR ALL THREE PHASES.
6. DETAILS OF BAY, CCE, CVT JUNCTION BOX & SWITCHYARD PANEL ROOM (SPR) LOCATION SHALL BE SHOWN IN CABLE TRENCH LAYOUT DRAWING.
7. FLUSH HEIGHT OF FOUNDATION WILL BE MIN 300MM FROM FINISHED GROUND LEVEL (FGL).
8. LOCATION OF LT TRANSFORMER AND TERTIARY EQUIPMENTS SHALL BE DECIDED IN CONSULTATION WITH POWERGRID
9. LOCATION OF LINE SIDE EQUIPMENT SHOWN HERE IS INDICATIVE. THE LOCATION OF SAME SHALL BE FINALIZED AFTER FINALISATION OF FINAL LINE TOWERS.
10. REFER DETAIL DRAWING FOR 765/400kV TRANSFORMER ARRANGEMENT LAYOUT: TB-0-424-316-006-R2, 765kV REACTOR ARRANGEMENT LAYOUT: TB-0-424-316-005-R2.
11. LA PRESSURE RELIEF VALVE SHALL NOT BE TOWARDS TRANSFORMER/REACTOR EQUIPMENT KEPT AWAY FOR LIGHTNING ARRESTER
12. ADEQUATE CONDUCTOR AND SAFETY UNDER GROUND MESH (EGPS) IS ADDITIONAL TO PRESENT CONTRACT AND CONTRACTUAL AGREEMENT IS NEEDED TO EXECUTE THIS SAME.
13. DEAD END TOWER LOCATION IS INDICATIVE. THE SAME SHALL BE CONFIRMED BY POWERGRID.
14. 765/400/220kV LINE SIDE CONDUCTOR TO BE INFORMED BY POWERGRID.
15. AUX BUILDING SIZE MAY VARY DEPENDING ON ACDB LOAD CALCULATIONS.
16. FOR BETTER VISIBILITY OF DRAWING PLOT BOUNDARY IS SHOWN ONLY UPTO FUTURE SUBSTATION AREA. FOR COMPLETE PLOT BOUNDARY REFER GA DRAWING.
17. ALL THE ROADS SHOWN IN THE LAYOUT ARE OF 3.75M WIDTH.
18. LINE SIDE EQUIPMENT LOCATION TO BE FINALIZED AFTER CONFIRMATION OF DEADEND TOWER LOCATION.
19. LINE CONDUCTOR TO BE INFORMED BY POWERGRID FOR ALL PRESENT SCHEME LINE CONNECTIONS (FOR FINALISING THE CLAMP & CONNECTORS).
20. BAY LOCATION SHALL BE AS PER TRENCH LAYOUT.

REV.	DATE	ALTERED BY / CHECKED BY / APPROVED BY	REMARKS
07	11.12.24		REVISED AS MARKED
06	02.11.24		REVISED AS PER POWERGRID COMMENTS
05	31.07.24		REVISED AS PER POWERGRID COMMENTS
04	22.07.24		REVISED AS PER POWERGRID COMMENTS
03	05.07.24		REVISED AS PER PGCIL COMMENTS
02	14.06.24		REVISED AS PER PGCIL COMMENTS
01	30.05.24		REVISED AS PER PGCIL COMMENTS

NOA NO.: CC/TW-NIS/DOM/A10/23/01956/NOA-1/24-10264/301

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

NAME OF CUSTOMER: POWERGRID CORPORATION OF INDIA LIMITED
NAME OF CLIENT:
NAME OF PROJECT: Establishment of 6x1500 MVA, 765/400 kV & 5x500 MVA 400/220 kV Bikaner-III Pooling Station (including 800kV, 2x125MVAR, reactor at Bikaner-III)

BHARAT HEAVY ELECTRICALS LTD.
TRANSMISSION BUSINESS GROUP

	SIGN / NAME	STAMP / SIGN	DATE
DRAWN			
CHECKED			
APPROVED			

POWERGRID DRAWING NO.: TB0202359-1002359-BHSA80-EL0CT-LAYOUT

SCALE: NTS
DRG. SIZE: A0

DESIGN/TITLE: ELECTRICAL LAYOUT PLAN & SECTIONAL ELEVATION OF BIKANER (III) S/S

SHT. NO./DRAWING NO.: TB-0-424-316-001
REV. NO.: 07
SHEET 1 OF 1 / NEXT SHEET 02

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)

DRG. NO. TB-0-424-316-001

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

SECTION-A (765KV-LINE-TIE-ICT)

SECTION-B (765KV-REACTOR-TIE-ICT)

SECTION-C (765KV-FUTURE LINE-TIE-ICT)

SECTION-D (400KV LINE-TIE-LINE)

SECTION-E (765/400KV ICT BAY-TIE-400KV LINE)

SECTION-F (400KV BAY-TIE-ICT)

SECTION-G (400KV-FUTURE STATCOM-TIE-ICT)

SECTION-H (220KV ICT-TIE-LINE)

SECTION-I (220KV-BUS COUPLER-TIE-LINE)

SECTION-J (220KV-TBC)

SECTION-V (220KV ICT-TIE-TBC-2)

SECTION-K (765KV-400KV INTERCONNECTION)

SECTION-L (765KV BUS CVT SECTION)

SECTION-O(220KV BUS SECTIONALIZER)

SECTION-P

SECTION-U (400KV REACTOR)

SEC-M (400KV BUS CVT SECTION)

SEC-N (220KV BUS CVT SECTION)

SECTION-Q(765KV MAIN BUS)

SECTION-W(220KV TRANSFER BUS)

SECTION-S(220KV MAIN BUS-I/II)

SECTION-T(220KV TRANSFER BUS)

SECTION-R(400KV MAIN BUS)

REV.	DATE	ALTERED BY / CHECKED BY / APPROVED BY
07	11.12.24	SS / SS / BKS
ZONE	REVISED AS MARKED ⚠	

REV.	DATE	ALTERED BY / CHECKED BY / APPROVED BY
06	02.11.24	SS / SS / BKS
ZONE	REVISED AS PER POWERGRID COMMENTS	

REV.	DATE	ALTERED BY / CHECKED BY / APPROVED BY
05	31.07.24	SS / SS / BKS
ZONE	REVISED AS PER POWERGRID COMMENTS	

REV.	DATE	ALTERED BY / CHECKED BY / APPROVED BY
04	22.07.24	SS / SS / BKS
ZONE	REVISED AS PER POWERGRID COMMENTS	

REV.	DATE	ALTERED BY / CHECKED BY / APPROVED BY
03	05.07.24	SS / SS / BKS
ZONE	REVISED AS PER PGCIL COMMENTS	

REV.	DATE	ALTERED BY / CHECKED BY / APPROVED BY
02	14.06.24	SS / SS / BKS
ZONE	REVISED AS PER PGCIL COMMENTS	

REV.	DATE	ALTERED BY / CHECKED BY / APPROVED BY
01	30.05.24	AS / AS / BKS
ZONE	REVISED AS PER PGCIL COMMENTS	

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

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

NAME OF CUSTOMER: BIKANER-III NEEMRANA TRANSMISSION LIMITED
NAME OF CLIENT: POWERGRID CORPORATION OF INDIA LIMITED
NAME OF PROJECT: Establishment of 6x1500 MVA, 765/400 kV & 5x500 MVA 400/220 kV Bikaner-III Pooling Station (including 400kV, 2x125MVAR, reactor at Bikaner-III)

BHARAT HEAVY ELECTRICALS LTD.
TRANSMISSION BUSINESS GROUP

	SIGN / NAME	STAMP / SIGN	DATE
DESIGNED	DT	-DO-	01.04.24
DRAWN	MK	-DO-	01.04.24
CHECKED	RMS	-DO-	02.04.24
APPROVED			

Power: DOT
Area: ER-II
State: BIHAR
SCALE: 1:1
DRG. SIZE: A0
POWERGRID DRAWING NO.: TB0200259-1002259-BNSIIIRO-ELGCT-LAYOUT

DESIGN/TITLE: ELECTRICAL LAYOUT PLAN & SECTIONAL ELEVATION OF BIKANER (III) S/S

DRG./DWG. NO.: TB-0-424-316-001
REV./REV.: 07
SHEET No. 02 / TOTAL SHEET 03

DRG. NO. TB-0-424-316-001

BILL OF QTY. FOR 765kV MAIN EQUIPMENTS:

SL.NO.	DESCRIPTION	RATING	S. C. RATING	SLD QTY. (NO.)	NOA QTY. (NO.)	SYMBOL	SCOPE OF SUPPLY
1	500 MVA, (1-PH) AUTOTRANSFORMER	765/400/33KV	50 KA FOR 1 S.	19	19		POWERGRID
2	110MVAR LINE REACTOR (1-PH) WITH NGR(600 Ohm).	765KV	50 KA FOR 1 S.	6	6		POWERGRID
3	110MVAR BUS REACTOR (1-PH)	765KV	50 KA FOR 1 S.	7	7		POWERGRID
4	SF6 CIRCUIT BREAKER WITH CR, WITH CSD (3-PH)	3150A	50 KA FOR 1 S.	4	4		BHEL
5	SF6 CIRCUIT BREAKER WITH CR,WITHOUT CSD (3-PH)	3150A	50 KA FOR 1 S.	2	2		BHEL
6	SF6 CIRCUIT BREAKER WITHOUT CR,WITH CSD (3-PH)	3150A	50 KA FOR 1 S.	12	12		BHEL
7	SF6 CIRCUIT BREAKER WITHOUT CR,WITH CSD (1-PH) PROVISION	3150A	50 KA FOR 1 S.	1	1		BHEL
8	ISOLATOR WITH ONE E/S (3 PH) VERTICAL KNEE TYPE	3150A	50 KA FOR 1 S.	22	20		BHEL
9	ISOLATOR WITH TWO E/S (3 PH) VERTICAL KNEE TYPE	3150A	50 KA FOR 1 S.	12	14		BHEL
10	ISOLATOR WITH ONE E/S (1 PH) VERTICAL KNEE TYPE	3150A	50 KA FOR 1 S.	32	32		BHEL
11	ISOLATOR WITHOUT E/S (1 PH.) VERTICAL KNEE TYPE	3150A	50 KA FOR 1 S.	58	58		BHEL
12	CURRENT TRANSFORMER (1 PH.) WITH 120% EXTENDED CURRENT RATING.	3000A	50 KA FOR 1 S.	48	48		BHEL
13	CVT (1 PH.)	8800pF	NA	12	12		BHEL
14	SURGE ARRESTER (1 PH.)	624 kV	NA	38	38		BHEL
15	WAVE TRAP (1 PH.) PEDESTAL TYPE.	1mH, 3150A	50 KA FOR 1 S.	04	04		BHEL
16	BUS POST INSULATOR (1 PH.) – 8KN	NA	NA	78△	86		BHEL
17	GUY INSULATOR (1PH)	NA	NA	56	—		BHEL

BILL OF QUANTITY FOR 220kV EQUIPMENTS (BHEL SCOPE)

SCHEDULE OF EQUIPMENT (OUTDOOR)

ITEM CODE	DESCRIPTION	SYMBOL	SLD QTY. (NOS.)	NOA QTY. (NOS.)
1	245KV, 1600A, 50kA/1s CIRCUIT BREAKER (3-Ph)		12	13
2	245KV, 3150A, 50kA/1s CIRCUIT BREAKER (3-Ph)		04	04
3	245KV, 1600A, 50kA/1s HDB ISOLATOR WITH 2E/S (3-Ph)		12	13
4	245KV, 1600A, 50kA/1s HDB ISOLATOR WITH 1E/S (3-Ph)		12	13
5	245KV, 1600A, 50kA/1s HDB TANDEM ISOLATOR WITHOUT E/S (3-Ph)		23	25
6	245KV, 3150A, 50kA/1s HDB ISOLATOR WITH 2E/S (3-Ph)		04	04
7	245KV, 3150A, 50kA/1s HDB ISOLATOR WITH 1E/S (3-Ph)		04	04
8	245KV, 1600A (120%), 50kA/1s CURRENT TRANSFORMER (1-Ph)		36	39
9	245KV, 2500A (120%), 50kA/1s CURRENT TRANSFORMER (1-Ph)		12	12
10	245KV CAPACITIVE VOLTAGE TRANSFORMER (4400 pF) (1-Ph)		27	30
11	216KV SURGE ARRESTER (1-Ph)		30	33
12	220KV, 1600A, 0.5mH, 50kA/1s LINE TRAP (1-Ph)		05	06
12	245KV BUS POST INSULATOR (1-Ph)- 8KN		133△	140

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

SL.NO.	DESCRIPTION	RATING	S. C. RATING	SLD QTY. (NO.)	NOA QTY. (NO.)	SYMBOL
21	125MVAR BUS REACTOR (3-PH)	420 kV	63 KA FOR 1 S.	2	2	
22	SF6 CIRCUIT BREAKER WITHOUT CR WITH CSD (3-PH)	3150A	63 KA FOR 1 S.	15	16	
23	SF6 CIRCUIT BREAKER WITHOUT CR,WITHOUT CSD (3-PH)	3150A	63 KA FOR 1 S.	14	15	
24	ISOLATOR WITH ONE E/S (3 PH) DOUBLE BREAK TYPE	3150A	63 KA FOR 1 S.	69	69	
25	ISOLATOR WITH TWO E/S (3 PH) DOUBLE BREAK TYPE	3150A	63 KA FOR 1 S.	2	2	
26	ISOLATOR WITH ONE E/S (1 PH) DOUBLE BREAK TYPE	3150A	63 KA FOR 1 S.	18	19	
27	ISOLATOR WITHOUT E/S (1 PH) DOUBLE BREAK TYPE	3150A	63 KA FOR 1 S.	17	17	
28	CURRENT TRANSFORMER (1 PH.) WITH 120% EXTENDED CURRENT RATING.	3000A	63 KA FOR 1 S.	87	87	
29	CVT (1 PH.)	4400pF	NA	24	24	
30	LINE TRAP (1 PH.)	0.5mH 3150A	63 KA FOR 1 S.	12	12	
31	SURGE ARRESTER (1 PH.)	336 kV	NA	58	58	
32	BUS POST INSULATOR (1 PH.) – 8KN	420 kV	NA	131	169	
33	GUY INSULATOR (1PH)	420 kV	NA	18	—	

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

SL.NO.	DESCRIPTION	RATING	SLD QTY. (NO.)	NOA QTY. (NO.)	SYMBOL	SCOPE OF SUPPLY
1	SURGE ARRESTER (1 PH.)	132 kV, 10 KA 5 KJ/KV	2	2		POWERGRID
2	CT. (1 PH.) FOR TRANSFORMER NEUTRAL	33KV	6	6		BHEL
x	CT. (1 PH.) FOR REACTOR NEUTRAL	33KV	2	2		BHEL
[illegible]	145kV CIRCUIT BREAKER (1-PH) FOR NGR BY-PASSING ARRANGEMENT	145kV, 1250A,5 KA	2	2		BHEL
[illegible]	145KV BUS POST INSULATOR (1-PH) – 6 KN	145kV, 6 KN	4	4		BHEL

BILL OF QTY. OF BUS POST INSULATORS FOR 765KV SPARE ICT AND REACTOR CONNECTION ARRANGEMENT

SL.NO.	DESCRIPTION	SLD QTY.	NOA QTY.	SYMBOL	SCOPE OF SUPPLY
1	765KV 8KN BUS POST INSULATOR FOR 765KV SPARE ICT CONNECTION ARRAGEMENT	32	06 LOT		BHEL
2	765KV 8KN BUS POST INSULATOR FOR 765KV SPARE REACTOR CONNECTION ARRANGEMENT	21	04 LOT		BHEL
3	400KV 8KN BUS POST INSULATOR FOR 765KV SPARE ICT CONNECTION ARRAGEMENT	31	06 LOT		BHEL
4	145KV 6KN BUS POST INSULATOR FOR 765KV SPARE REACTOR CONNECTION ARRANGEMENT AND REACTOR NEUTRAL FORMATION	47	04 LOT		BHEL
5	52KV 8KN BUS POST INSULATOR FOR 765KV SPARE ICT DELTA CONNECTION ARRANGEMENT AND ICT DELTA FORMATION	794	06 LOT		BHEL
6	36KV 8KN BUS POST INSULATOR FOR 765KV SPARE ICT NEUTRAL CONNECTION ARRANGEMENT AND ICT NEUTRAL FORMATION	138	06 LOT		BHEL

* 765KV CB WITH CSD
# 400KV CB WITH CSD

CLEARANCE TABLE AS PER POWERGRID SPECIFICATION:-

SL.NO.	DESCRIPTION	765kV SYSTEM	400kV SYSTEM	220kV SYSTEM	66kV SYSTEM
1	PHASE TO PHASE FOR CONDUCTOR-CONDUCTOR CONFIGURATION FOR ROD-CONDUCTOR CONFIGURATION	7600mm 9400mm	4000mm 4200mm	2100mm 2100mm	750mm 750mm
2	PHASE TO EARTH FOR CONDUCTOR-CONDUCTOR STRUCTURE FOR ROD-CONDUCTOR CONFIGURATION	4900mm 6400mm	3500mm 3500mm	2100mm 2100mm	630mm 630mm
3	SECTIONAL CLEARANCE	10300mm	6500mm	5000mm	3100mm
4	VERTICAL DISTANCE BETWEEN LOWEST PART OF INSULATOR TO PLINTH	2550mm	2550mm	2550mm	2550mm

CONDUCTOR & STRINGING DETAILS –765kV

SL.NO.	DESCRIPTION	LEVEL FROM PLINTH	SUB-CONDUCTOR	TENSION INSULATOR STRING/PHASE
1.	MAIN BUS-I & II	(AT 22M HEIGHT)	QUAD AAC BULL CONDUCTOR WITH 450MM SUB-CONDUCTOR SPACING	DOUBLE TENSION 210 kN COMPOSITE LONG ROD INSULATOR
2.	JACKBUS	(AT 42M HEIGHT)	QUAD AAC BULL CONDUCTOR WITH 450MM SUB-CONDUCTOR SPACING	DOUBLE TENSION 210 kN COMPOSITE LONG ROD INSULATOR
3.	DROPPERS/JUMPERING	–	QUAD AAC BULL CONDUCTOR WITH 450MM SUB-CONDUCTOR SPACING	SINGLE SUSPENSION 210 kN COMPOSITE LONG ROD INSULATOR
4.	EQUIPMENT INTERCONNECTION	(AT 14M HEIGHT)	6.3" IPS AL. TUBE (130mm OD)/QUAD AAC BULL CONDUCTOR WITH 450MM SPACING	
5.	EARTHWIRE	(AT 48M HEIGHT)	7/3.66mm GI WIRE (10.98mm DIA)	
6.	INTERCONNECTION BETWEEN 765/400kV TRAFO TO 400kV SUB-STATION		QUAD BERSIMIS ACSR CONDUCTOR WITH 450MM SUB-CONDUCTOR SPACING/6.5" IPS AL. TUBE	
7.	EQUIPMENT INTERCONNECTION NEAR [illegible]	(AT 12M HEIGHT)	QUAD BULL BERSIMIS ACSR CONDUCTOR WITH 450MM SUB-CONDUCTOR SPACING/6.3" IPS AL. TUBE	

CONDUCTOR & STRINGING DETAILS –400kV

SL.NO.	DESCRIPTION	LEVEL FROM PLINTH	SUB-CONDUCTOR	TENSION INSULATOR STRING/PHASE
1.	MAIN BUS-I & II	(AT 16M HEIGHT)	QUAD AAC BULL CONDUCTOR WITH 450MM SUB-CONDUCTOR SPACING	DOUBLE TENSION 120 kN COMPOSITE LONG ROD INSULATOR
2.	JACKBUS	(AT 33.5M HEIGHT)	QUAD BERSIMIS ACSR CONDUCTOR WITH 450MM SUB-CONDUCTOR SPACING	DOUBLE TENSION 120 kN COMPOSITE LONG ROD INSULATOR
3.	DROPPERS/JUMPERING	–	QUAD BERSIMIS ACSR CONDUCTOR WITH 450MM SUB-CONDUCTOR SPACING	SINGLE SUSPENSION 120 kN COMPOSITE LONG ROD INSULATOR
4.	EQUIPMENT INTERCONNECTION	(AT 8M HEIGHT)	4.5" IPS AL. TUBE /QUAD ACSR BERSIMIS CONDUCTOR WITH 450MM SPACING	
5.	EARTHWIRE	(AT 28.5M HEIGHT)	7/3.66mm GI WIRE (10.98mm DIA)	
6.	INTERCONNECTION BETWEEN 400/220kV TRAFO TO 220kV SUB-STATION		TWIN BERSIMIS ACSR CONDUCTOR WITH 450MM SUB-CONDUCTOR SPACING	
7.	BUS CVT, CVT & SA IN LINE BAYS	–	TWIN BERSIMIS ACSR CONDUCTOR WITH 450MM SUB-CONDUCTOR SPACING	

CONDUCTOR & STRINGING DETAILS –220kV

SL.NO.	DESCRIPTION	LEVEL FROM PLINTH	SUB-CONDUCTOR	TENSION INSULATOR STRING/PHASE
1.	MAIN BUS-I & II	(AT 11.7M HEIGHT)	QUAD AAC BULL CONDUCTOR WITH 250MM SUB-CONDUCTOR SPACING	DOUBLE TENSION 120 kN COMPOSITE LONG ROD INSULATOR
2.	TRANSFER BUS	(AT 11.7M HEIGHT)	QUAD ACSR BERSIMIS CONDUCTOR WITH 250MM SUB-CONDUCTOR SPACING	DOUBLE TENSION 120 kN COMPOSITE LONG ROD INSULATOR
3.	JACKBUS	(AT 16.2M HEIGHT)	QUAD/TWIN BERSIMIS ACSR CONDUCTOR WITH 250MM SUB-CONDUCTOR SPACING	DOUBLE TENSION 120 kN COMPOSITE LONG ROD INSULATOR
4.	DROPPERS/JUMPERING	–	QUAD/TWIN BERSIMIS ACSR CONDUCTOR WITH 250MM SUB-CONDUCTOR SPACING	SINGLE SUSPENSION 120 kN COMPOSITE LONG ROD INSULATOR
5.	EQUIPMENT INTERCONNECTION	(AT 5.9M HEIGHT)	4.0" IPS AL. TUBE /TWIN ACSR BERSIMIS CONDUCTOR WITH 250MM SPACING	
6.	BUS CVT, CVT & SA IN LINE BAYS	–	TWIN BERSIMIS ACSR CONDUCTOR WITH 250MM SUB-CONDUCTOR SPACING	

NOA NO.: CC/T/W-NS/DOM/A10/23/01956/NOA-1/24-102643/01

REV.	DATE	ALTERED BY / CHECKED / APPROVED	REMARKS
07	11.12.24	SS / SS / SKS	REVISED AS MARKED
06	02.11.24	SS / SS / SKS	REVISED AS PER POWERGRID COMMENTS
05	31.07.24	SS / SS / SKS	REVISED AS PER POWERGRID COMMENTS
04	22.07.24	SS / SS / SKS	REVISED AS PER POWERGRID COMMENTS
03	05.07.24	SS / SS / SKS	REVISED AS PER PGCIL COMMENTS
02	14.06.24	SS / SS / SKS	REVISED AS PER PGCIL COMMENTS
01	30.05.24	SS / AB / SKS	REVISED AS PER PGCIL COMMENTS

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

NAME OF CUSTOMER: BIKANER-III NEEMRANA TRANSMISSION LIMITED
NAME OF CLIENT: POWERGRID CORPORATION OF INDIA LIMITED
NAME OF PROJECT: Establishment of 6x1500 MVA, 765/400 kV & 5x500 MVA 400/220 kV Bikaner-III Pooling Station (including 400kV, 2x125MVAR, reactor at Bikaner-III)

BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION BUSINESS GROUP

	SIGN / NAME	DATE
DESIGNED	[illegible]	-DEC-
DRAWN	[illegible]	-DEC-
CHECKED	[illegible]	-DEC-
APPROVED	[illegible]	-DEC-

SYSTEM / STAGE: POWERGRID DRAWING NO.: TB0025B9-1002B9-B4SA80-E3ACT-LAYOUT

DRG. DESC.: ELECTRICAL LAYOUT PLAN & SECTIONAL ELEVATION OF BIKANER (III) S/S

DRG./DRAWING NO.: TB-0-424-316-001 — DRG./REV.: 07

SHEET No.03 / NEXT SHEET ---

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

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)

DRG. NO. TB-0-424-316-003

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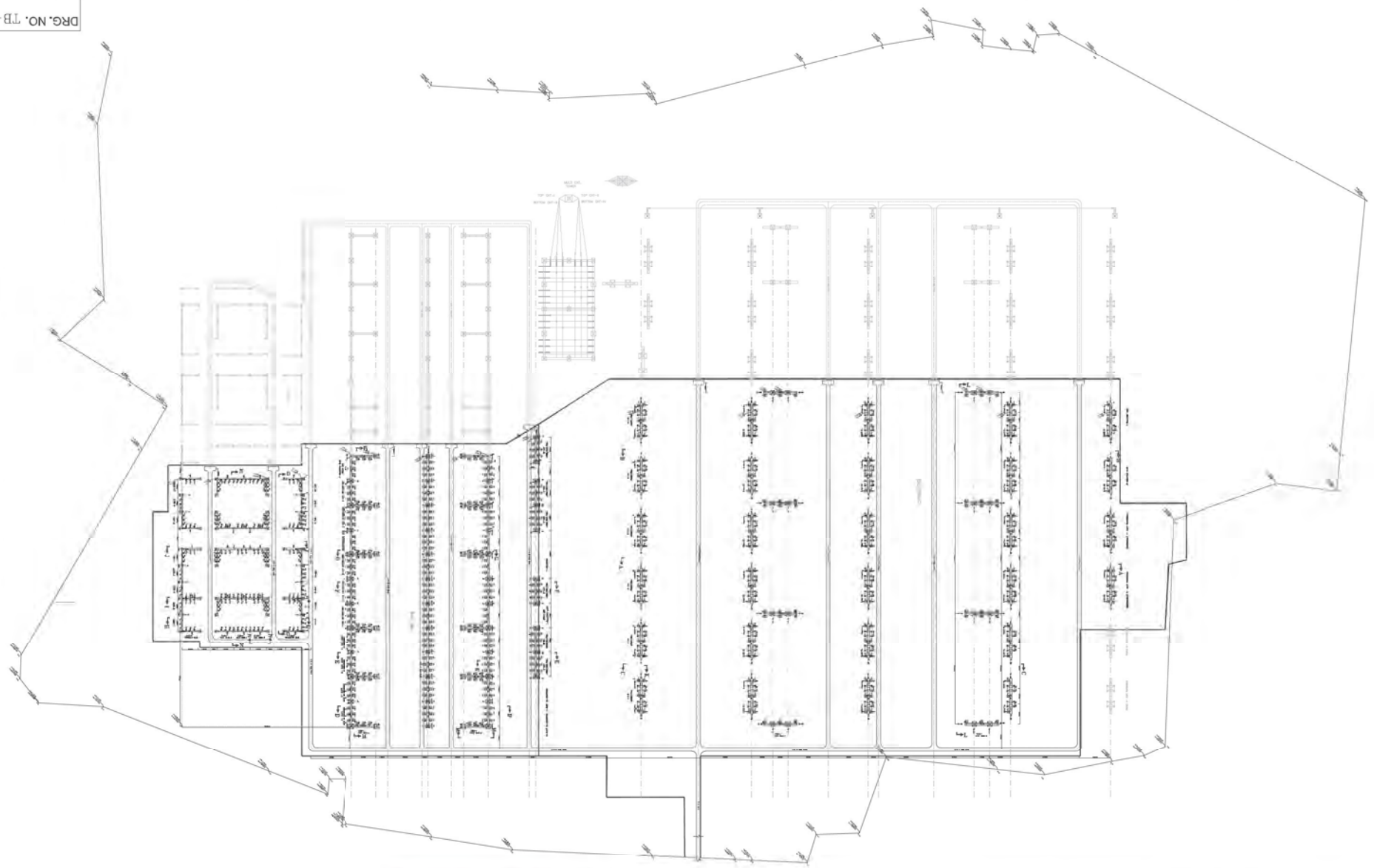
INVENTORY NO | SIGN. AND DATE | REF. DRG. NO. | COMPUTER DRG. PATH NAME :



NOA NO.: CC/TW-NS/DOM/A10/23/01956/NOA-1/24-10/2/3/01

ADDITIONAL INFORMATION W.O.No.	NAME OF CUSTOMER: BIKANER-III NEEMRANA TRANSMISSION LIMITED NAME OF CLIENT: POWERGRID CORPORATION OF INDIA LIMITED NAME OF PROJECT: Establishment of 6x1500 MVA, 765/400 kV & 5x500 MVA 400/220 kV Pooling Station (Including 400kV, 2x125MVAR, reactor at Bikaner-III)
STATUS OF DRAWING: APPROBATION OF PRINTS	BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION BUSINESS GROUP
REV. 01 DATE 12.08.24	ALTERED: SY; CHECKED: SS; APPROVED: SKS
ZONE	REVISED AS PER POWERGRID COMMENTS

	DRN./MAC.	ENGR.
DRAWN	SY	-SGD-
CHECKED	SS	-SGD-
APPROVED	SKS	-SGD-

POWERGRID DRAWING NO.: TB202359-100209-RS3480-STN-LAYOUT

SCALE: NOT TO SCALE

DWG. TITLE: BIKANER III NEW S/S- STRUCTURE LAYOUT PLAN & SECTION

DRAWING NO.: TB-0-424-316-003

TYPE OF SHEET: No. 01

TB202359-10

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)

DRG. NO. TB-0-424-316-003

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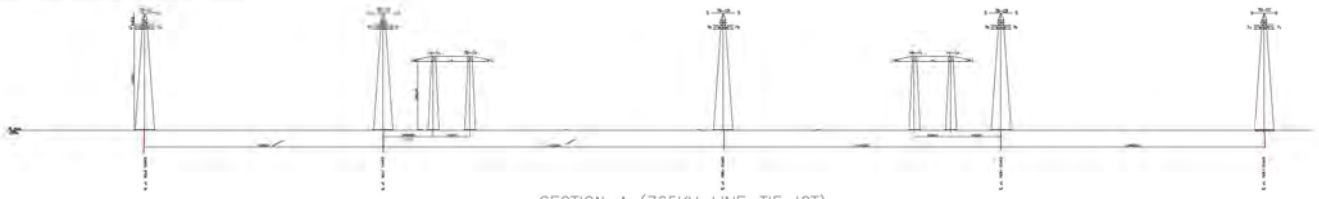
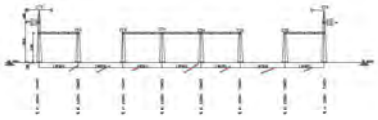
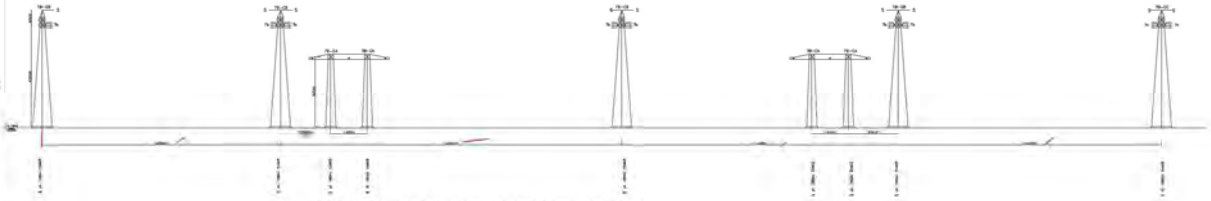
COMPUTER DRG. PATH NAME | REF. DWG. NO. | SIGN. AND DATE | INVENTORY NO



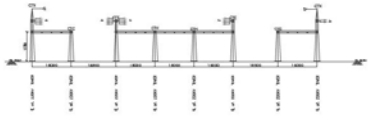
SECTION–A (765KV–LINE–TIE–ICT)



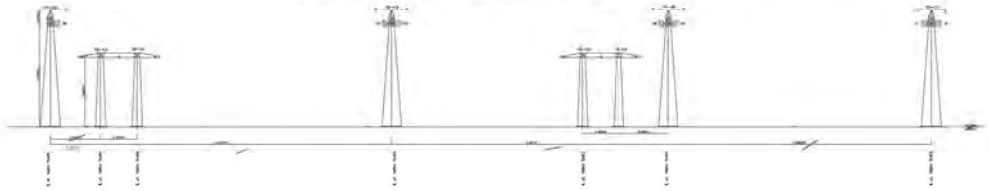
SECTION–H (220KV ICT–TIE–LINE)



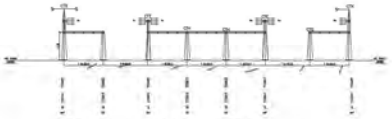
SECTION–B (765KV–REACTOR–TIE–ICT)



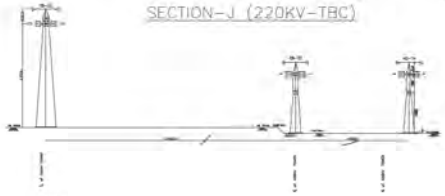
SECTION–I (220KV–BUS COUPLER–TIE–LINE)



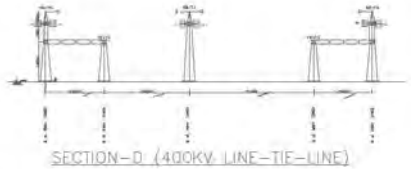
SECTION–C (765KV–FUTURE LINE–TIE–ICT)



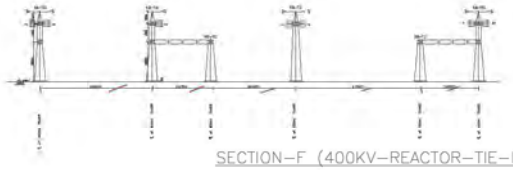
SECTION–J (220KV–TBC)



SECTION–K (765KV–400KV INTERCONNECTION)

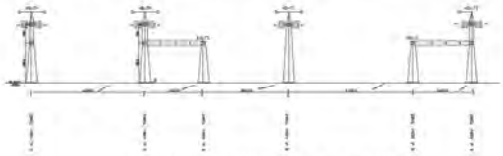


SECTION–D (400KV LINE–TIE–LINE)

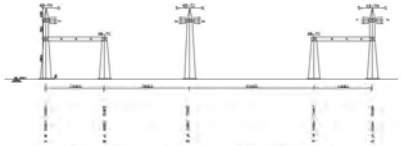


SECTION–F (400KV–REACTOR–TIE–ICT)

SECTION–N(220KV MAIN BUS–I/II)



SECTION–E (400KV ICT–TIE–LINE)



SECTION–G (400KV–FUTURE STATCOM–TIE–ICT)

SECTION–O(220KV TRANSFER BUS)

SECTION–L(765KV MAIN BUS)

SECTION–M(400KV MAIN BUS)

NOA NO.: EC/TW-NS/DOM/A10/23/01956/NOA-1/24-10364/01

ADDITIONAL INFORMATION
W.O.No.

STATUS OF DRAWING
DISTRIBUTION OF PRINTS

REV.	DATE	ALTERED BY CHECKED SS APPROVED SKS
01	12.08.24	
ZONE	REVISED AS PER POWERGRID COMMENTS	

NAME OF CUSTOMER: BIKANER-III NEEMRANA TRANSMISSION LIMITED
NAME OF CLIENT: POWERGRID CORPORATION OF INDIA LIMITED
NAME OF PROJECT: Establishment of 6x1500 MVA, 765/400 kV & 5x500 MVA 400/220 kV Pooling Station (Including 400kV, 2x125MVAR, reactor at Bikaner-III)

BHARAT HEAVY ELECTRICALS LTD.
TRANSMISSION BUSINESS GROUP

	NAME	SIGN
DRAWN	SY	-SGD-
CHECKED	SS	-SGD-
APPROVED	SKS	-SGD-

POWERGRID DRAWING NO.: TB232399-100229-RS3480-STN-LAYOUT

DRAWING NO.: TB-0-424-316-003

TITLE: BIKANER III NEW S/S- STRUCTURE LAYOUT PLAN & SECTION

SHEET No. 02

TB232399-100229-RS3480-STN-LAYOUT

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)

DRG. NO. TB-0-424-316-004

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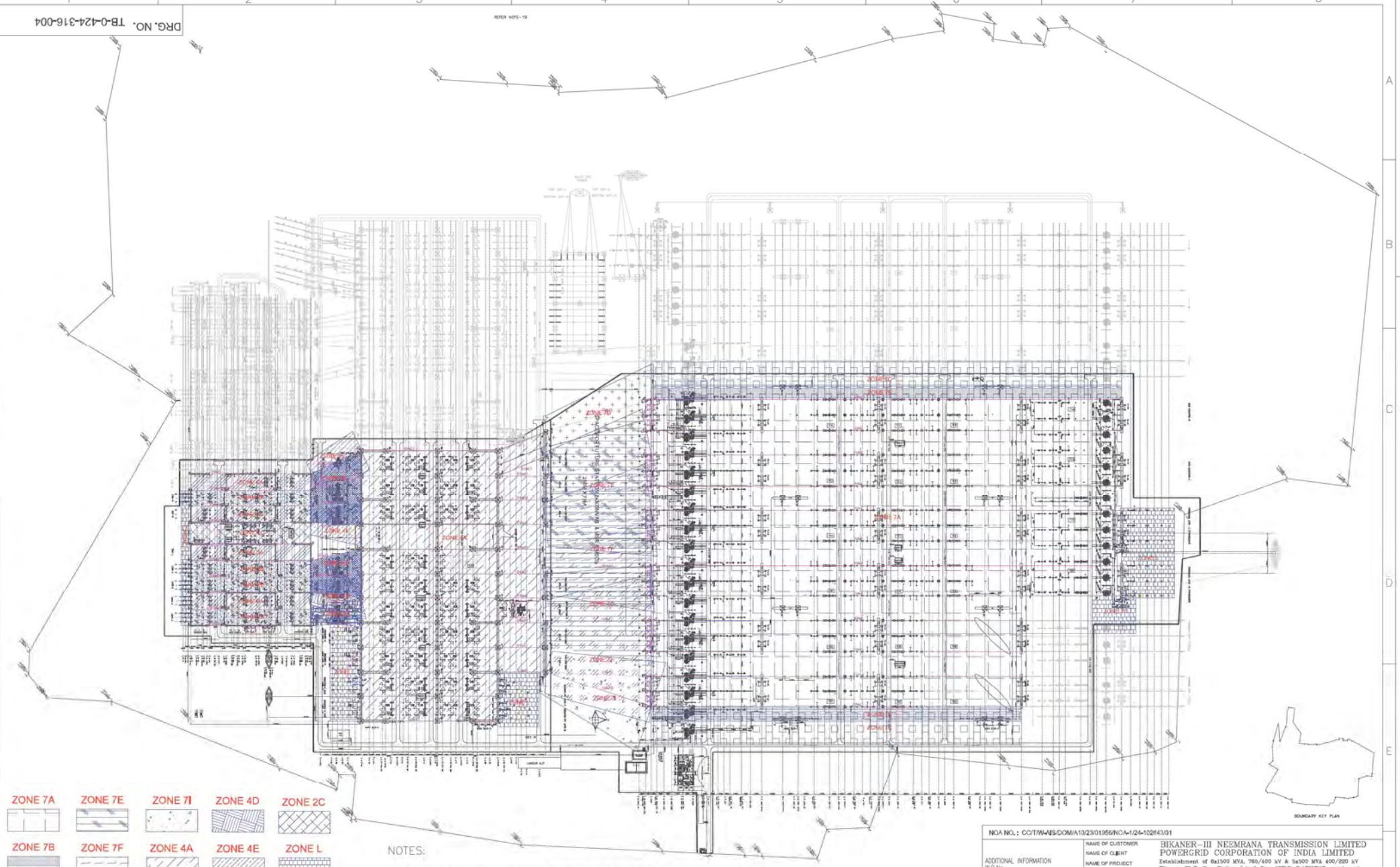
COMPUTER DRG. PATH NAME | REF. DWG. NO. | SIGN. AND DATE | INVENTORY NO.



NOTES:

1. LINE SIDE EQUIPMENT WILL BE PROVISIONED ON SHIELD WIRE (NOT IN PHase) BEYOND LAST TOWER (DEAD END TOWER) TO GIVE TOWER, ZONE 7I, IE
SHOWN INDICATIVELY FOR THIS AREA.
2. DSLP OF CONTROL ROOM BUILDING, AUXILIARY BUILDING & FITTH WILL BE SUBMITTED VIDE SEPARATE DOCUMENT.

ITEM DESCRIPTION	QUANTITY (Meters)
1. SHIELD WIRE=11.99KM	14300

BOUNDARY KEY PLAN

LOA NO.: CC/T/W-NS/DOM/A10/23/01956/NOA-1/24-102643/01

REV.	DATE	ALTERED / CHECKED / APPROVED
ZONE		

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

NAME OF CUSTOMER / NAME OF CLIENT: BIKANER-III NEEMRANA TRANSMISSION LIMITED
POWERGRID CORPORATION OF INDIA LIMITED
NAME OF PROJECT: Establishment of 6x1500 MVA, 765/400 kV & 5x500 MVA 400/220 kV Bikaner-III Pooling Station (including 400kV, 2x125MVAR, reactor at Bikaner-III)

BHEL — BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION BUSINESS GROUP

	DSN / NAME	SIGN / DATE	
	DT	-DEC-	27.06.24
	CHK	-DEC-	27.06.24
	APPD	-DEC-	27.06.24

POWERGRID DRAWING NO.: TB0424-100BBO-MEI400-DSLP-LAYOUT

SCALE: 1:1000 / SCALE

DRG DSIG

शीर्षक/TITLE: BIKANER III NEW S/S- DSLP LAYOUT

ड्रा.सं./DRAWING NO.: TB-0-424-316-004

पृष्ठ/REV.: 00

पृष्ठ सं./SHEET No. 01 अगला पृष्ठ/NEXT SHEET ---

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)

DRG. NO. TB-0-424-316-008

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COMPUTER DRG. PATH NAME :

REF. DRG. NO.

SIGN. AND DATE

INVENTORY NO.

LOCAL Y

LOCAL X

NOA NO. : GC/TW/NS/DOM/A10/23/01966/NOA-1/29.10(NB)/01

ADDITIONAL INFORMATION W.O.No.	NAME OF CUSTOMER: BIKANER-III NEEMRANA TRANSMISSION LIMITED
STATUS OF DRAWING:	NAME OF CLIENT: POWERGRID CORPORATION OF INDIA LIMITED
DISTRIBUTION OF PRINTS	NAME OF PROJECT: Establishment of 765/400 kV, 2*1500 MVA & 400/220 kV 2*500 MVA GIS/AIS Bikaner-III Pooling Station (including 400kV, 2x125MVAR, reactor at Bikaner-III)

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

NO.	DATE	ADDED/ DRAWN/ APPROVED
ZONE		

ड्राइंग शीर्षक / TITLE	BIKANER III NEW S/S- TERMINATION KEY DIAGRAM LAYOUT PLAN & SECTION
स्केल / SCALE	
ड्राइंग नं./DRAWING NO.	TB-0-424-316-008
रिवि./REV.	00

	NAME	SIGN./DATE
DRAWN		
CHECKED		
APPROVED		
ISSUED		
CONSULTANT		

POWERGRID DRAWING NO.

FIRST ANGLE PROJECTION (ALL DIMENSIONS ARE IN MM.)

DRG. NO. TB-0-424-316-008

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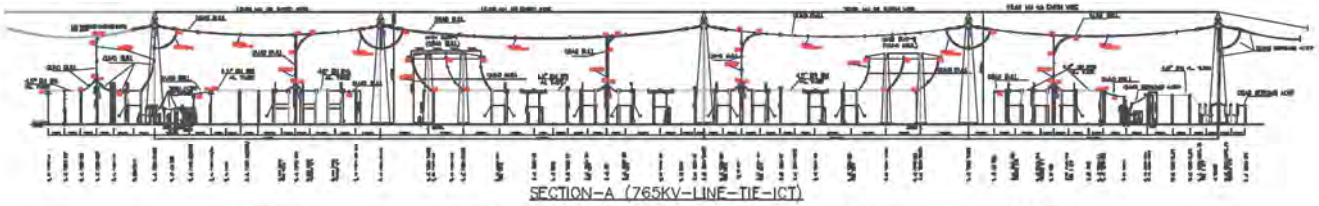
COMPUTER DRG. PATH NAME :

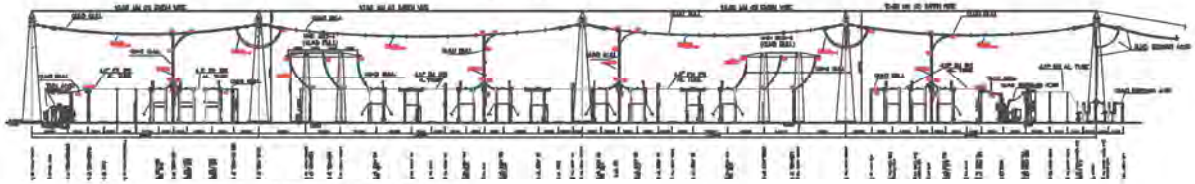
REF. DRG. NO.

SIGN. AND DATE

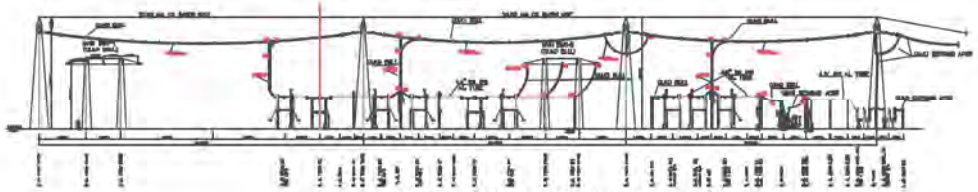
INVENTORY NO



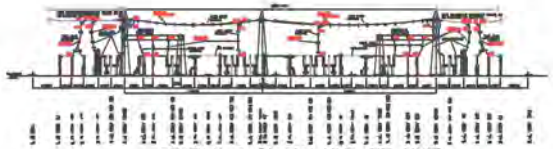
SECTION-A (765KV-LINE-TIE-ICT)



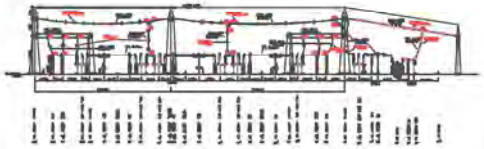
SECTION-B (765KV-REACTOR-TIE-ICT)



SECTION-C (765KV-FUTURE LINE-TIE-ICT)

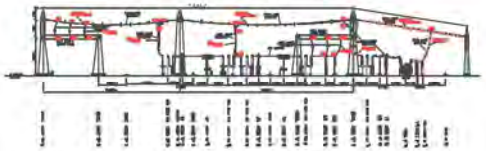


SECTION-D (400KV LINE-TIE-LINE)

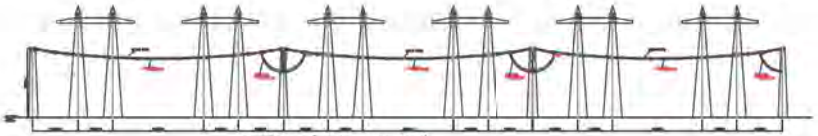


SECTION-F (400KV BAY-TIE-ICT)

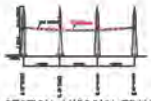
SECTION-E (765/400KV ICT BAY-TIE-400KV LINE)



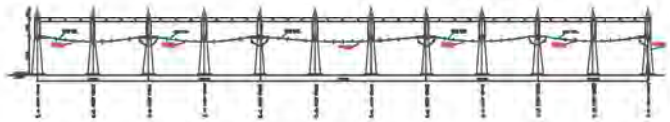
SECTION-G (400KV-FUTURE STATCOM-TIE-ICT)



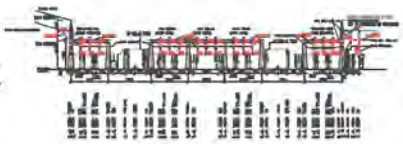
SECTION-Q(765KV MAIN BUS)



SECTION-V(220KV TRANSFER BUS)

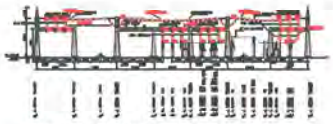


SECTION-R(400KV MAIN BUS)



SECTION-H (220KV ICT-TIE-LINE)

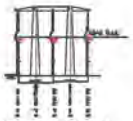
SECTION-I (220KV-BUS COUPLER-TIE-LINE)



SECTION-J (220KV-TBC)

SECTION-V (220KV ICT-TIE-TBC-2)

SECTION-K (765KV-400KV INTERCONNECTION)



SECTION-L (765KV BUS CVT SECTION)

SECTION-O(220KV BUS SECTIONALIZER)

SECTION-P

SECTION-U (400KV REACTOR)

SEC-M (400KV BUS CVT SECTION)

SEC-N (220KV BUS CVT SECTION)

SECTION-S(220KV MAIN BUS-I/II)

SECTION-T(220KV TRANSFER BUS)

REFER ENCLOSED DOCUMENT TB-424-316-008-B0Q FOR ITEM DESCRIPTION & QUANTITY OF CLAMPS, CONNECTOR & STRINGING HARDWARE

ADDITIONAL INFORMATION W.O.NO.		BIKANER-III NEEMRANA TRANSMISSION LIMITED POWERGRID CORPORATION OF INDIA LIMITED Establishment of 2x500 MVA, 765/400 kV & 2x500 MVA, 400/220 kV Bikaner-III Pooling Station (including 400kV, 220kV bay at Bikaner-II)	
STATUS OF DRAWING			
DISTRIBUTION OF PRINTS		BHARAT HEAVY ELECTRICALS LTD. TRANSMISSION BUSINESS GROUP	
REV.	DATE	ALTERED CHECKED APPROVED	DRAWN DES. TRACED CHK.	SCALE	DATE	COVERING DRAWING NO.
ZONE			DESIGN/TITLE: BIKANER III NEW S/S- ERECTION KEY DIAGRAM LAYOUT PLAN & SECTION			TB-0-424-316-008 REV. 00

BILL OF QUANTITIES FOR CLAMPS AND CONNECTORS-BIKANER-III-765KV

S.NO.	ITEM DESCRIPTION	CLAMP NO.	UNIT	BAY WISE QUANTITY																			TOTAL QUANTITY
				SPARE REACTOR	SPARE ICT	SPARE BAY-1 OF HALF DIA.	SPARE BAY-2 OF HALF DIA.	BUS REACTOR BAY -1	BUS REACTOR BAY -2	TRANSFORMER BAY-1	TRANSFORMER BAY-2	TRANSFORMER BAY-3	TRANSFORMER BAY-4	TRANSFORMER BAY-5	TRANSFORMER BAY-6	LINE REACTORS BAY-1 (WITH NGR BYPASS)	LINE REACTORS BAY-2 (WITH NGR BYPASS)	NEEMRANA LINE BAY-1	NEEMRANA LINE BAY-2	765 KV MAIN BUS 1	765 KV MAIN BUS 2	COMMON	
				BPS NO. 62 (4 LOT)	BPS NO. 63 (6 LOT)	BPS NO. 64 (2 set)		BPS NO. 65 (2 set)		BPS NO. 66 (6 set)						BPS NO. 67 (2 set)		BPS NO. 68 (2 set)		BPS NO. 69 (2 set)			
1	765KV ,3150 A, CIRCUIT BREAKER, EXPANSION TYPE CONNECTOR SUITABLE FOR 4.5" IPS ALUMINIUM TUBE WITH HORIZONTAL APPROACH	701	No.	2	0	3	3	9	9	9	9	9	9	9	9	6	6	9	9	0	0	0	**110**
2	765KV , 3150A, VERTICAL KNEE ISOLATOR , RIGID TYPE CONNECTOR SUITABLE FOR 4.5" IPS ALUMINIUM TUBE	702	No.	0	0	3	3	12	12	9	9	9	9	9	9	6	6	6	6	0	0	0	**108**
3	765KV , 3150A, VERTICAL KNEE ISOLATOR, EXPANSION TYPE CONNECTOR SUITABLE FOR 4.5" IPS ALUMINIUM TUBE	703	No.	0	0	0	0	8	8	11	11	11	11	11	11	3	3	5	5	0	0	0	**98**
4	765KV , 3150A, VERTICAL KNEE ISOLATOR, CONNECTOR SUITABLE FOR QUAD BULL AAC CONDUCTOR	704	No.	0	0	3	3	16	16	16	16	16	16	16	16	13	13	9	9	0	0	0	**178**
5	765KV , 3150A, CURRENT TRANSFORMER , RIGID TYPE CONNECTOR SUITABLE FOR 4.5" IPS ALUMINIUM TUBE	705	No.	0	0	0	0	6	6	12	12	12	12	12	12	0	0	6	6	0	0	0	**96**
6	765KV, BUS POST INSULATOR, RIGID/SLIDING TYPE CONNECTOR SUITABLE FOR 4.5" IPS AL TUBE	706	No.	4	4	0	0	5	5	5	5	5	5	5	5	3	3	5	5	0	0	0	**64**
7	765KV , 3150A, BUS POST INSULATOR , RIGID-EXPANSION TYPE CONNECTOR SUITABLE FOR 4.5" IPS AL TUBE, TUBE CUT	707	No.	17	27	0	0	7	7	1	1	1	1	1	1	0	0	1	1	0	0	0	**66**
8	765KV , CAPACITOR VOLTAGE TRANSFORMER , EXPANSION TYPE CONNECTOR SUITABLE FOR 4.5" IPS AL TUBE, TUBE CUT	708	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	**6**
9	765KV , CAPACITOR VOLTAGE TRANSFORMER , SUITABLE FOR QUAD BULL AAC CONDUCTOR (UNIVERSAL TAKEOFF)	709	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	**6**

BILL OF QUANTITIES FOR CLAMPS AND CONNECTORS-BIKANER-III-765KV

S.NO.	ITEM DESCRIPTION	CLAMP NO.	UNIT	BAY WISE QUANTITY																			TOTAL QUANTITY
				SPARE REACTOR	SPARE ICT	SPARE BAY-1 OF HALF DIA.	SPARE BAY-2 OF HALF DIA.	BUS REACTOR BAY -1	BUS REACTOR BAY -2	TRANSFORMER BAY-1	TRANSFORMER BAY-2	TRANSFORMER BAY-3	TRANSFORMER BAY-4	TRANSFORMER BAY-5	TRANSFORMER BAY-6	LINE REACTORS BAY-1 (WITH NGR BYPASS)	LINE REACTORS BAY-2 (WITH NGR BYPASS)	NEEMRANA LINE BAY-1	NEEMRANA LINE BAY-2	765 KV MAIN BUS 1	765 KV MAIN BUS 2	COMMON	
				BPS NO. 62 (4 LOT)	BPS NO. 63 (6 LOT)	BPS NO. 64 (2 set)		BPS NO. 65 (2 set)		BPS NO. 66 (6 set)						BPS NO. 67 (2 set)		BPS NO. 68 (2 set)		BPS NO. 69 (2 set)			
10	624KV, LIGHTNING ARRESTER , RIGID/SLIDING TYPE CONNECTOR SUITABLE FOR 4.5" IPS AL TUBE	710	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	**6**
11	624KV, LIGHTNING ARRESTER, CONNECTOR SUITABLE FOR QUAD BULL AAC CONDUCTOR	711*	No.	1	1	0	0	3	3	3	3	3	3	3	3	3	3	0	0	0	0	0	**32**
12	765KV, 3150A, WAVE TRAP, RIGID TYPE CONNECTOR SUITABLE FOR QUAD BULL AAC CONDUCTOR WITH HORIZONTAL APPROACH	712*	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	0	0	0	**8**
13	765KV, 500MVA (1 PHASE) ICT HV BUSHING, 3150A, CONNECTOR SUITABLE FOR QUAD BULL AAC CONDUCTOR WITH HORIZONTAL APPROACH	713	No.	0	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**19**
14	765KV, 110MVAR (1 PHASE) LINE/BUS REACTOR HV BUSHING, 3150A, CONNECTOR SUITABLE FOR QUAD BULL AAC CONDUCTOR WITH HORIZONTAL APPROACH	714	No.	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**13**
15	765KV , 3150A, TEE CONNECTOR SUITABLE FOR 4.5" AL TUBE RUN AND QUAD BULL AAC TAP (UNIVERSAL TAKEOFF)	715	No.	14	20	0	0	8	8	8	8	8	8	8	8	0	0	11	11	0	0	0	**120**
16	765KV, 3150A, TEE CONNECTOR SUITABLE FOR QUAD BULL AAC CONDUCTOR (RUN) AND QUAD BULL AAC CONDUCTOR (TAP)	716	No.	0	0	3	3	9	9	9	9	9	9	9	9	0	0	12	12	24	18	0	**144**

BILL OF QUANTITIES FOR CLAMPS AND CONNECTORS-BIKANER-III-765KV

S.NO.	ITEM DESCRIPTION	CLAMP NO.	UNIT	BAY WISE QUANTITY																			TOTAL QUANTITY
				SPARE REACTOR	SPARE ICT	SPARE BAY-1 OF HALF DIA.	SPARE BAY-2 OF HALF DIA.	BUS REACTOR BAY -1	BUS REACTOR BAY -2	TRANSFORMER BAY-1	TRANSFORMER BAY-2	TRANSFORMER BAY-3	TRANSFORMER BAY-4	TRANSFORMER BAY-5	TRANSFORMER BAY-6	LINE REACTORS BAY-1 (WITH NGR BYPASS)	LINE REACTORS BAY-2 (WITH NGR BYPASS)	NEEMRANA LINE BAY-1	NEEMRANA LINE BAY-2	765 KV MAIN BUS 1	765 KV MAIN BUS 2	COMMON	
				BPS NO. 62 (4 LOT)	BPS NO. 63 (6 LOT)	BPS NO. 64 (2 set)		BPS NO. 65 (2 set)		BPS NO. 66 (6 set)						BPS NO. 67 (2 set)		BPS NO. 68 (2 set)		BPS NO. 69 (2 set)			
17	PG CLAMP SUITABLE FOR QUAD BULL AAC CUNDOCTOR (RUN) AND QUAD BULL AAC CONDUCTOR (TAP)	717	No.	0	0	6	6	24	24	24	24	24	24	24	24	0	0	33	33	0	0	0	**270**
18	765KV,TEE CONNECTOR SUITABLE FOR HEXA ZEBRA ACSR CONDUCTOR (RUN) AND QUAD BULL AAC CONDUCTOR (TAP)	718	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	**6**
19	PG CLAMP SUITABLE FOR HEXA ZEBRA ACSR CONDUCTOR (RUN) AND QUAD BULL AAC CONDUCTOR (TAP)	719	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	**6**
20	765KV FLEXIBLE SPACERS FOR QUAD BULL AAC CONDUCTOR	720	No.	0	0	57	57	108	108	102	102	102	102	102	102	0	0	114	114	174	174	0	**1518**
21	765KV RIGID SPACERS FOR QUAD BULL AAC CONDUCTOR	721	No.	0	0	48	48	48	48	48	48	48	48	48	48	6	6	72	72	3	3	0	**642**
22	765KV CORONA END BELL FOR 4.5" IPS AL TUBE	7CB	No.	5	3	0	0	5	5	5	5	5	5	5	5	0	0	8	8	0	0	0	**64**
23	ALUMINIUM WELDING SLEEVES FOR 4.5" IPS AL TUBE	WS1	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	117	**117**
24	TWO WAY PG CLAMPS FOR 7/9 SWG (10.98MM DIA) GS WIRE	E1	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	132	**132**
25	TENSION CLAMPS FOR 7/9 SWG(10.98MM DIA) GS WIRE BOLTED TYPE	E2	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	88	**88**
26	STRUCTURE CLAMPS FOR 7/9 SWG(10.98MM DIA) GS WIRE ON LATTICE TYPE STRUCTURE	E3	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1456	**1456**
27	PAD TYPE CLAMP FOR CONNECTING 7/9 SWG(10.98MM DIA) GS WIRE ON ONE SIDE AND 75X 12 MM GS STRIP ON OTHER SIDE	E4	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	56	**56**
28	STRUCTURE CLAMPS FOR 75X 12 MM GS STRIPS ON LATTICE TYPE STRUCTURE	E5	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7500	**7500**

* connector being supplied by OEM

BILL OF QUANTITIES FOR CLAMPS AND CONNECTORS-BIKANER-III-400KV

S.NO.	ITEM DESCRIPTION	CLAMP NO.	UNIT	BAY WISE QUANTITY																										TOTAL QUANTITY
				765KV SPARE ICT	SPARE BAY-1 OF HALF DIA.	BUS REACTOR BAY -1	BUS REACTOR BAY -2	765/400KV ICT-TRANSFORMER BAY-1	765/400KV ICT-TRANSFORMER BAY-2	765/400KV ICT-TRANSFORMER BAY-3	765/400KV ICT-TRANSFORMER BAY-4	765/400KV ICT-TRANSFORMER BAY-5	765/400KV ICT-TRANSFORMER BAY-6	400/220KV ICT-TRANSFORMER BAY-1	400/220KV ICT-TRANSFORMER BAY-2	400/220KV ICT-TRANSFORMER BAY-3	400/220KV ICT-TRANSFORMER BAY-4	400/220KV ICT-TRANSFORMER BAY-5	BIKANER PG LINE-1	BIKANER PG LINE-2	BIKANER II LILO LINE-3	BIKANER II LILO LINE-4	BIKANER-II LINE -1	BIKANER-II LINE -2	400KV MAIN BUS 1	400KV MAIN BUS 2	400KV MAIN BUS 1	400KV MAIN BUS 2	COMMON	
				BPS NO. 63 (6 LOT)	BPS NO. 75 (1 set)	BPS NO. 76 (2 set)		BPS NO. 77 (11 set)											BPS NO. 78 (6 set)						BPS NO. 79 (4 SET)		Erection Hardware for 400kV I type layout-Bus Work (For Three diameter) as per technical specification: 1 SET (NEW ITEM ADDITION TO BE AMENDED BY PG)			
1	420KV, 63KA FOR 1S, 3150A, CB CONNECTOR SUITABLE FOR AL TUBE 4.5 INCH IPS, EXPANSION TYPE	401	No.	0	3	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	0	0	0	0	0	174
2	420KV, 63KA FOR 1S, 3150A, CT CONNECTOR SUITABLE FOR AL TUBE 4.5 INCH IPS, RIGID TYPE	402	No.	0	6	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	0	0	0	0	0	177
3	420KV, 63KA FOR 1S, 3150A, ISOLATOR (HDB) CONNECTOR SUITABLE FOR AL TUBE 4.5 INCH IPS, RIGID TYPE	403	No.	0	0	11	11	8	8	8	8	8	8	11	11	11	11	11	8	8	11	11	11	11	0	0	0	0	0	185
4	420KV, 63KA FOR 1S, 3150A, ISOLATOR (HDB) CONNECTOR SUITABLE FOR AL TUBE 4.5 INCH IPS, EXPANSION TYPE	404	No.	0	3	12	12	9	9	9	9	9	9	12	12	12	12	12	15	15	12	12	12	12	0	0	0	0	0	219
5	400KV, 63KA FOR 1S, 3150A, ISOLATOR (HDB) CONNECTOR SUITABLE FOR QUAD BERSIMIS	405	No.	0	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	22
6	420KV, 63KA FOR 1S, 3150A, WAVE TRAP CONNECTOR SUITABLE FOR QUAD BERSIMIS	406*	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	4	4	4	4	0	0	0	0	0	24
7	336KV LIGHTNING ARRESTER, RIGID/SLIDING TYPE CONNECTOR SUITABLE FOR 4.5" IPS AL TUBE	407	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	0	0	0	0	0	18
8	336KV LIGHTNING ARRESTER, RIGID/SLIDING TYPE CONNECTOR SUITABLE FOR TWIN BERSIMIS	408*	No.	1	0	3	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0	40
9	400KV, 63KA FOR 1S, 2000A, CVT CONNECTOR SUITABLE FOR TWIN BERSIMIS (UNIVERSAL TAKEOFF)	409	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	0	0	0	0	0	18
10	420KV, 63KA FOR 1S, 3150A, BPI CONNECTOR SUITABLE FOR AL TUBE 4.5 INCH IPS, SLIDING THROUGH TYPE	410	No.	4	0	2	2	5	5	5	5	5	5	2	2	2	2	2	5	5	5	5	5	5	0	0	0	0	0	78
11	420KV, 63KA FOR 1S, 3150A, BPI RIGID-EXPANSION TYPE CONNECTOR SUITABLE FOR 4.5" IPS AL TUBE, TUBE CUT	411	No.	27	0	0	0	6	6	6	6	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63
12	400KV, 63KA FOR 1S, 3150A, BPI CONNECTOR SUITABLE FOR TWIN BERSIMIS THROUGH TYPE	412	No.	0	0	3	3	0	0	0	0	0	0	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0	21

BILL OF QUANTITIES FOR CLAMPS AND CONNECTORS-BIKANER-III-400KV

S.NO.	ITEM DESCRIPTION	CLAMP NO.	UNIT	BAY WISE QUANTITY																										TOTAL QUANTITY
				765KV SPARE ICT	SPARE BAY-1 OF HALF DIA.	BUS REACTOR BAY -1	BUS REACTOR BAY -2	765/400KV ICT-TRANSFORMER BAY-1	765/400KV ICT-TRANSFORMER BAY-2	765/400KV ICT-TRANSFORMER BAY-3	765/400KV ICT-TRANSFORMER BAY-4	765/400KV ICT-TRANSFORMER BAY-5	765/400KV ICT-TRANSFORMER BAY-6	400/220KV ICT-TRANSFORMER BAY-1	400/220KV ICT-TRANSFORMER BAY-2	400/220KV ICT-TRANSFORMER BAY-3	400/220KV ICT-TRANSFORMER BAY-4	400/220KV ICT-TRANSFORMER BAY-5	BIKANER PG LINE-1	BIKANER PG LINE-2	BIKANER II LILO LINE-3	BIKANER II LILO LINE-4	BIKANER-II LINE -1	BIKANER-II LINE -2	400KV MAIN BUS 1	400KV MAIN BUS 2	400KV MAIN BUS 1	400KV MAIN BUS 2	COMMON	
				BPS NO. 63 (6 LOT)	BPS NO. 75 (1 set)	BPS NO. 76 (2 set)		BPS NO. 77 (11 set)											BPS NO. 78 (6 set)						BPS NO. 79 (4 SET)		Erection Hardware for 400kV I type layout-Bus Work (For Three diameter) as per technical specification: 1 SET (NEW ITEM ADDITION TO BE AMENDED BY PG)				
13	420KV, 63KA FOR 1S, 2000A, 400KV REACTOR BUSHING CONNECTOR SUITABLE FOR TWIN BERSIMIS	413	No.	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
14	420KV, 63KA FOR 1S, 3150A, 400KV ICT BUSHING CONNECTOR FOR 400KV ICT SUITABLE FOR QUAD BERSIMIS	414	No.	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0	15
15	420KV, 63KA FOR 1S, 3150A, 400KV ICT BUSHING CONNECTOR FOR 765KV ICT SUITABLE FOR QUAD BERSIMIS	415	No.	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19
16	CONNECTORS 400KV, 63KA FOR 1S, TEE CONNECTOR SUITABLE FOR AL TUBE 4.5 INCH IPS TO QUAD BERSIMIS CONDUCTOR	416	No.	21	0	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	0	0	0	0	0	116
17	CONNECTORS 400KV, 63KA FOR 1S, TEE CONNECTOR SUITABLE FOR AL TUBE 4.5 INCH IPS TO TWIN BERSIMIS CONDUCTOR	417	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	0	0	0	0	0	18
18	400KV, 63KA FOR 1S, TEE CONNECTOR SUITABLE FOR QUAD BERSIMIS TO QUAD BERSIMIS	418	No.	0	6	3	3	12	12	12	12	12	12	3	3	3	3	3	3	3	6	6	3	3	0	0	0	0	0	123
19	400KV, 63KA FOR 1S, TEE CONNECTOR SUITABLE FOR QUAD BERSIMIS TO TWIN BERSIMIS	419	No.	0	0	3	3	0	0	0	0	0	0	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0	21
20	400KV, 63KA FOR 1S, TEE CONNECTOR SUITABLE FOR QUAD BULL TO QUAD BERSIMIS	420	No.	0	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0	0	0	60
21	400KV, 63KA FOR 1S, TEE CONNECTOR SUITABLE FOR QUAD AL59 MOOSE CONDUCTOR TO QUAD ACSR BERSIMIS CONDUCTOR	421	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	0	0	0	0	0	18
22	400KV, 63KA FOR 1S, TEE CONNECTOR SUITABLE FOR QUAD AL59 MOOSE CONDUCTOR TO TWIN ACSR BERSIMIS CONDUCTOR	422	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	0	0	0	0	0	18
23	420KV, 63KA FOR 1S, FLEXIBLE SPACER SUITABLE FOR QUAD BERSIMIS	423	No.	0	39	54	54	153	153	153	153	153	153	54	54	54	54	54	42	42	54	54	54	54	0	0	0	0	0	1635
24	420KV, 63KA FOR 1S,RIGID SPACER SUITABLE FOR QUAD BERSIMIS	424	No.	0	15	15	15	36	36	36	36	36	36	15	15	15	15	15	39	39	39	39	39	39	0	0	0	0	0	570

BILL OF QUANTITIES FOR CLAMPS AND CONNECTORS-BIKANER-III-400KV

S.NO.	ITEM DESCRIPTION	CLAMP NO.	UNIT	BAY WISE QUANTITY																										TOTAL QUANTITY
				765KV SPARE ICT	SPARE BAY-1 OF HALF DIA.	BUS REACTOR BAY -1	BUS REACTOR BAY -2	765/400KV ICT-TRANSFORMER BAY-1	765/400KV ICT-TRANSFORMER BAY-2	765/400KV ICT-TRANSFORMER BAY-3	765/400KV ICT-TRANSFORMER BAY-4	765/400KV ICT-TRANSFORMER BAY-5	765/400KV ICT-TRANSFORMER BAY-6	400/220KV ICT-TRANSFORMER BAY-1	400/220KV ICT-TRANSFORMER BAY-2	400/220KV ICT-TRANSFORMER BAY-3	400/220KV ICT-TRANSFORMER BAY-4	400/220KV ICT-TRANSFORMER BAY-5	BIKANER PG LINE-1	BIKANER PG LINE-2	BIKANER II LILO LINE-3	BIKANER II LILO LINE-4	BIKANER-II LINE -1	BIKANER-II LINE -2	400KV MAIN BUS 1	400KV MAIN BUS 2	400KV MAIN BUS 1	400KV MAIN BUS 2	COMMON	
				BPS NO. 63 (6 LOT)	BPS NO. 75 (1 set)	BPS NO. 76 (2 set)		BPS NO. 77 (11 set)											BPS NO. 78 (6 set)						BPS NO. 79 (4 SET)		Erection Hardware for 400kV I type layout-Bus Work (For Three diameter) as per technical specification: 1 SET (NEW ITEM ADDITION TO BE AMENDED BY PG)			
25	420KV, 63KA FOR 1S, FLEXIBLE SPACER SUITABLE FOR TWIN BERSIMIS	425	No.	0	0	3	3	0	0	0	0	0	0	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0	21
26	420KV, 63KA FOR 1S, RIGID SPACER SUITABLE FOR TWIN BERSIMIS	426	No.	0	0	18	18	0	0	0	0	0	0	18	18	18	18	18	15	15	15	15	15	15	6	6	0	0	0	228
27	CONNECTORS 420KV, 63KA FOR 1S, FLEXIBLE SPACER SUITABLE FOR QUAD BULL	427	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	126	126	51	51	0	354
28	PG CLAMP SUITABLE FOR QUAD BERSIMIS ACSR CONDUCTOR (RUN) AND QUAD BERSIMIS ACSR CONDUCTOR (TAP)	428	No.	0	6	6	6	6	6	6	6	6	6	6	6	6	6	6	9	9	9	9	9	9	0	0	0	0	0	138
29	PG CLAMP SUITABLE FOR QUAD BERSIMIS ACSR CONDUCTOR (RUN) AND TWIN BERSIMIS ACSR CONDUCTOR (TAP)	429	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	0	0	0	0	0	18
30	PG CLAMP SUITABLE FOR QUAD QUAD AL59 MOOSE CONDUCTOR (RUN) AND QUAD BERSIMIS ACSR CONDUCTOR (TAP)	430	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	0	0	0	0	0	18
31	PG CLAMP SUITABLE FOR QUAD QUAD AL59 MOOSE CONDUCTOR (RUN) AND TWIN BERSIMIS ACSR CONDUCTOR (TAP)	431	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	3	3	3	3	0	0	0	0	0	18
32	400KV CORONA END BELL FOR 4.5" IPS AL TUBE	4CB	No.	4	0	2	2	5	5	5	5	5	5	2	2	2	2	2	8	8	8	8	8	8	0	0	0	0	0	96
33	ALUMINIUM WELDING SLEEVES FOR 4.5" IPS AL TUBE	WS1	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	168	168
34	TWO WAY PG CLAMPS FOR 7/9 SWG (10.98MM DIA) GS WIRE	E1	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	126	126
35	TENSION CLAMPS FOR 7/9 SWG(10.98MM DIA) GS WIRE BOLTED TYPE	E2	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	84	84
36	STRUCTURE CLAMPS FOR 7/9 SWG(10.98MM DIA) GS WIRE ON LATTICE TYPE STRUCTURE	E3	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	690	690
37	PAD TYPE CLAMP FOR CONNECTING 7/9 SWG(10.98MM DIA) GS WIRE ON ONE SIDE AND 75X 12 MM GS STRIP ON OTHER SIDE	E4	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	46	46
38	STRUCTURE CLAMPS FOR 75X 12 MM GS STRIPS ON LATTICE TYPE STRUCTURE	E5	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3300	3300

* connector being supplied by OEM

BILL OF QUANTITIES FOR CLAMPS AND CONNECTORS-BIKANER-III-220KV

S.NO.	ITEM DESCRIPTION	CLAMP NO.	UNIT	400/220KV ICT-TRANSFORMER BAY-1	400/220KV ICT-TRANSFORMER BAY-2	400/220KV ICT-TRANSFORMER BAY-3	400/220KV ICT-TRANSFORMER BAY-4	400/220KV ICT-TRANSFORMER BAY-5	LINE BAY-1	LINE BAY-2	LINE BAY-3	LINE BAY-4	LINE BAY-5	BUS COUPLER-1	BUS COUPLER-2	TBC-1	TBC-2	220KV MAIN BUS 1	220KV MAIN BUS-2	220KV TRANSFER BUS	BUS SECTIONALISER-1	BUS SECTIONALISER-2	COMMON	TOTAL QUANTITY
				BPS NO. 87 (5 SET)					BPS NO. 86 (5 SET)					BPS NO. 88 (2 SET)		BPS NO. 89 (2 SET)		BPS NO. 84 (6 SET) & 85 (4 SET)			BPS NO. 90 (2 SET)			
1	220KV, 50KA FOR 1S, 1600A, CB CONNECTOR SUITABLE FOR AL TUBE 4 INCH IPS, EXPANSION TYPE	201	No.	6	6	6	6	6	6	6	6	6	6	0	0	6	6	0	0	0	0	0	0	72
	220KV, 50KA FOR 1S, 3150A, CB CONNECTOR SUITABLE FOR AL TUBE 4 INCH IPS, EXPANSION TYPE	202	No.	0	0	0	0	0	0	0	0	0	0	6	6	0	0	0	0	0	6	6	0	24
2	220KV, 50KA FOR 1S, 1600A, CT CONNECTOR SUITABLE FOR AL TUBE 4 INCH IPS, RIGID TYPE	203	No.	3	3	3	3	3	3	3	3	3	3	0	0	6	6	0	0	0	0	0	0	42
3	220KV, 50KA FOR 1S, 1600A, CT CONNECTOR SUITABLE FOR TWIN BERSIMIS	204	No.	3	3	3	3	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	30
4	220KV, 50KA FOR 1S, 2500A, CT CONNECTOR SUITABLE FOR AL TUBE 4 INCH IPS, RIGID TYPE	205	No.	0	0	0	0	0	0	0	0	0	0	6	6	0	0	0	0	0	6	6	0	24
6	220KV, 50KA FOR 1S, 1600A, ISOLATOR (TANDEM) CONNECTOR SUITABLE FOR AL TUBE 4 INCH IPS	206	No.	6	6	6	6	6	6	6	6	6	6	0	0	3	3	0	0	0	0	0	0	66
7	220KV, 50KA FOR 1S, 1600A, ISOLATOR (TANDEM) CONNECTOR SUITABLE FOR TWIN BERSIMIS	207	No.	6	6	6	6	6	6	6	6	6	6	0	0	3	3	0	0	6	0	0	0	72
8	220KV, 50KA FOR 1S, 1600A, ISOLATOR (HDB) CONNECTOR SUITABLE FOR AL TUBE 4 INCH IPS, RIGID TYPE	208	No.	6	6	6	6	6	9	9	9	9	9	0	0	5	5	0	0	0	0	0	0	85
9	220KV, 50KA FOR 1S, 1600A, ISOLATOR (HDB) CONNECTOR SUITABLE FOR AL TUBE 4 INCH IPS, EXPANSION TYPE	209	No.	6	6	6	6	6	3	3	3	3	3	0	0	3	3	0	0	0	0	0	0	51
10	220KV, 50KA FOR 1S, 1600A, ISOLATOR (HDB) CONNECTOR SUITABLE FOR TWIN BERSIMIS	210	No.	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	4

BILL OF QUANTITIES FOR CLAMPS AND CONNECTORS-BIKANER-III-220KV

S.NO.	ITEM DESCRIPTION	CLAMP NO.	UNIT	400/220KV ICT-TRANSFORMER BAY-1	400/220KV ICT-TRANSFORMER BAY-2	400/220KV ICT-TRANSFORMER BAY-3	400/220KV ICT-TRANSFORMER BAY-4	400/220KV ICT-TRANSFORMER BAY-5	LINE BAY-1	LINE BAY-2	LINE BAY-3	LINE BAY-4	LINE BAY-5	BUS COUPLER-1	BUS COUPLER-2	TBC-1	TBC-2	220KV MAIN BUS 1	220KV MAIN BUS-2	220KV TRANSFER BUS	BUS SECTIONALISER-1	BUS SECTIONALISER-2	COMMON	TOTAL QUANTITY
				BPS NO. 87 (5 SET)					BPS NO. 86 (5 SET)					BPS NO. 88 (2 SET)		BPS NO. 89 (2 SET)		BPS NO. 84 (6 SET) & 85 (4 SET)			BPS NO. 90 (2 SET)			
11	220KV, 50KA FOR 1S, 3150A, ISOLATOR (HDB) CONNECTOR SUITABLE FOR AL TUBE 4 INCH IPS, RIGID TYPE	211	No.	0	0	0	0	0	0	0	0	0	0	9	9	0	0	0	0	0	6	6	0	30
12	220KV, 50KA FOR 1S, 3150A, ISOLATOR (HDB) CONNECTOR SUITABLE FOR QUAD BERSIMIS	212	No.	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	6	6	0	18
13	220KV, 50KA FOR 1S, 1600A, WAVE TRAP CONNECTOR SUITABLE FOR TWIN BERSIMIS	213*	No.	0	0	0	0	0	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	10
14	220KV, 50KA FOR 1S, BPI CONNECTOR SUITABLE FOR AL TUBE 4 INCH IPS, RIGID/SLIDING THROUGH TYPE	214	No.	9	9	9	9	9	9	9	9	9	9	6	7	8	7	0	0	0	0	0	0	118
15	220KV, 50KA FOR 1S, BPI CONNECTOR SUITABLE FOR TWIN BERSIMIS (THROUGH)	215	No.	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
16	216KV, 50KA FOR 1S, LIGHTNING ARRESTER CONNECTOR SUITABLE FOR TWIN BERSIMIS	216*	No.	3	3	3	3	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	30
17	220KV, 50KA FOR 1S, 2000A, CVT CONNECTOR SUITABLE FOR TWIN BERSIMIS	217	No.	0	0	0	0	0	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	15
18	220KV, 50KA FOR 1S, 2000A, ICT BUSHING CONNECTOR SUITABLE FOR TWIN BERSIMIS	218	No.	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
19	220KV, 50KA FOR 1S, FLEXIBLE SPACER SUITABLE FOR QUAD AAC BULL	219	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	168	336	0	12	12	0	528
20	220KV, 50KA FOR 1S, RIGID SPACER SUITABLE FOR QUAD AAC BULL	220	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	0	12

BILL OF QUANTITIES FOR CLAMPS AND CONNECTORS-BIKANER-III-220KV

S.NO.	ITEM DESCRIPTION	CLAMP NO.	UNIT	400/220KV ICT-TRANSFORMER BAY-1	400/220KV ICT-TRANSFORMER BAY-2	400/220KV ICT-TRANSFORMER BAY-3	400/220KV ICT-TRANSFORMER BAY-4	400/220KV ICT-TRANSFORMER BAY-5	LINE BAY-1	LINE BAY-2	LINE BAY-3	LINE BAY-4	LINE BAY-5	BUS COUPLER-1	BUS COUPLER-2	TBC-1	TBC-2	220KV MAIN BUS 1	220KV MAIN BUS-2	220KV TRANSFER BUS	BUS SECTIONALISER-1	BUS SECTIONALISER-2	COMMON	TOTAL QUANTITY
				BPS NO. 87 (5 SET)					BPS NO. 86 (5 SET)					BPS NO. 88 (2 SET)		BPS NO. 89 (2 SET)		BPS NO. 84 (6 SET) & 85 (4 SET)			BPS NO. 90 (2 SET)			
21	220KV, 50KA FOR 1S, FLEXIBLE SPACER SUITABLE FOR QUAD ACSR BERSIMIS	221	No.	0	0	0	0	0	0	0	0	0	0	111	111	162	162	0	0	369	0	0	0	915
22	220KV, 50KA FOR 1S, RIGID SPACER SUITABLE FOR QUAD ACSR BERSIMIS	222	No.	0	0	0	0	0	0	0	0	0	0	30	30	0	0	0	0	0	0	0	0	60
23	220KV, 50KA FOR 1S, FLEXIBLE SPACER SUITABLE FOR TWIN ACSR BERSIMIS	223	No.	6	6	6	6	6	6	6	6	6	6	0	0	0	0	12	24	6	0	0	0	102
24	220KV, 50KA FOR 1S, RIGID SPACER SUITABLE FOR TWIN ACSR BERSIMIS	224	No.	30	30	30	30	30	46	37	46	46	46	0	0	31	31	6	12	9	0	0	0	460
25	220KV, 50KA FOR 1S,TEE CONNECTOR SUITABLE FOR QUAD AAC BULL TO QUAD ACSR BERSIMIS	225	No.	0	0	0	0	0	0	0	0	0	0	9	9	0	0	0	0	0	0	0	0	18
26	220KV, 50KA FOR 1S,TEE CONNECTOR SUITABLE FOR QUAD AAC BULL TO TWIN ACSR BERSIMIS	226	No.	4	4	4	4	4	5	3	5	5	5	0	0	6	6	6	12	0	0	0	0	73
27	220KV, 50KA FOR 1S,TEE CONNECTOR SUITABLE FOR QUAD ACSR BERSIMIS TO QUAD ACSR BERSIMIS	227	No.	0	0	0	0	0	0	0	0	0	0	9	9	6	6	0	0	0	0	0	0	30
28	220KV, 50KA FOR 1S,TEE CONNECTOR SUITABLE FOR QUAD ACSR BERSIMIS TO TWIN ACSR BERSIMIS	228	No.	6	6	6	6	6	3	3	3	3	3	0	0	12	12	0	0	9	0	0	0	78
29	220KV, 50KA FOR 1S,TEE CONNECTOR SUITABLE FOR TWIN ACSR BERSIMIS TO TWIN ACSR BERSIMIS	229	No.	0	0	0	0	0	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	15
30	220KV, 50KA FOR 1S,TEE CONNECTOR SUITABLE FOR SINGLE AL59 MOOSE (TO BE CONFIRMED BY POWERGRID) TO SINGLE ACSR BERSIMIS	230	No.	0	0	0	0	0	6	6	6	6	6	0	0	0	0	0	0	0	0	0	0	30

BILL OF QUANTITIES FOR CLAMPS AND CONNECTORS-BIKANER-III-220KV

S.NO.	ITEM DESCRIPTION	CLAMP NO.	UNIT	400/220KV ICT-TRANSFORMER BAY-1	400/220KV ICT-TRANSFORMER BAY-2	400/220KV ICT-TRANSFORMER BAY-3	400/220KV ICT-TRANSFORMER BAY-4	400/220KV ICT-TRANSFORMER BAY-5	LINE BAY-1	LINE BAY-2	LINE BAY-3	LINE BAY-4	LINE BAY-5	BUS COUPLER-1	BUS COUPLER-2	TBC-1	TBC-2	220KV MAIN BUS 1	220KV MAIN BUS-2	220KV TRANSFER BUS	BUS SECTIONALISER-1	BUS SECTIONALISER-2	COMMON	TOTAL QUANTITY
				BPS NO. 87 (5 SET)					BPS NO. 86 (5 SET)					BPS NO. 88 (2 SET)		BPS NO. 89 (2 SET)		BPS NO. 84 (6 SET) & 85 (4 SET)			BPS NO. 90 (2 SET)			
31	220KV, 50KA FOR 1S, 4000A, TEE CONNECTOR SUITABLE FOR AL TUBE 4 INCH IPS TO QUAD ACSR BERSIMIS	231	No.	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	0	0	6
32	220KV, 50KA FOR 1S, 4000A, TEE CONNECTOR SUITABLE FOR AL TUBE 4 INCH IPS TO TWIN ACSR BERSIMIS	232	No.	7	7	7	7	7	8	6	8	8	8	0	0	8	8	0	0	0	0	0	0	89
33	220KV, 50KA FOR 1S,TEE CONNECTOR SUITABLE FOR QUAD AAC BULL TO QUAD AAC BULL	233	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	220KV CORONA END BELL FOR 4" IPS AL TUBE	2CB	No.	0	0	0	0	0	0	0	0	0	0	0	2	2	1	0	0	0	0	0	5	10
35	ALUMINIUM WELDING SLEEVES FOR 4" IPS AL TUBE	WS2	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	133	133
36	TWO WAY PG CLAMPS FOR 7/9 SWG (10.98MM DIA) GS WIRE	E1	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	58	58
37	TENSION CLAMPS FOR 7/9 SWG(10.98MM DIA) GS WIRE BOLTED TYPE	E2	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	38	38
38	STRUCTURE CLAMPS FOR 7/9 SWG(10.98MM DIA) GS WIRE ON LATTICE TYPE STRUCTURE	E3	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	216	216
39	PAD TYPE CLAMP FOR CONNECTING 7/9 SWG(10.98MM DIA) GS WIRE ON ONE SIDE AND 75X 12 MM GS STRIP ON OTHER SIDE	E4	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	18
40	STRUCTURE CLAMPS FOR 75X 12 MM GS STRIPS ON LATTICE TYPE STRUCTURE	E5	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2000	2000

* connector being supplied by OEM

BILL OF QUANTITIES FOR CLAMPS AND CONNECTORS-BIKANER-III-145KV

S.NO.	ITEM DESCRIPTION	CLAMP NO.	UNIT	BAY WISE QUANTITY		TOTAL QUANTITY
				BPS NO. 62 (4 LOT)	BPS NO. 67 (2 SET)	
1	145KV, 25KA FOR 1S, 1250A, CB CONNECTOR SUITABLE FOR TWIN BERSIMIS	101	NO.	0	4	4
2	145KV, 25KA FOR 1S, NGR CONNECTOR SUITABLE FOR TWIN BERSIMIS	102	NO.	0	4	4
3	132KV, 25KA FOR 1S, SURGE ARRESTER CONNECTOR SUITABLE FOR TWIN BERSIMIS THROUGH TYPE	103	NO.	0	2	2
4	145KV, 25KA FOR 1S, BPI CONNECTOR SUITABLE FOR AL TUBE 3 INCH IPS, RIGID-SLIDING THROUGH TYPE	104	NO.	9	0	9
5	145KV, 25KA FOR 1S, BPI CONNECTOR SUITABLE FOR AL TUBE 3 INCH IPS, TUBE CUT	105	NO.	23	0	23
6	145KV, 25KA FOR 1S, BPI CONNECTOR SUITABLE FOR TWIN BERSIMIS CONDUCTOR THROUGH	106	NO.	14	4	18
7	TEE CONNECTOR/PG CLAMP SUITABLE FOR TWIN ACSR BERSIMIS CUNDOCTOR (RUN) AND TWIN ACSR BERSIMIS CONDUCTOR (TAP)	107	NO.	0	8	8
8	145KV, 25KA FOR 1S, 1250A, TEE CONNECTOR/PG CONNECTOR SUITABLE FOR 3" IPS AL TUBE TO TWIN BERSIMIS	108	NO.	23	0	23
9	WELDING SLEEVE SUITABLE FOR 3 INCH IPS AL TUBE	WS3	NO.	28	0	28
10	END CAP SUITABLE FOR 3 INCH IPS AL TUBE	3CB	NO.	10	0	10

BILL OF QUANTITIES FOR CLAMPS AND CONNECTORS-BIKANER-III-72.5KV

S.NO.	ITEM DESCRIPTION	CLAMP NO.	UNIT	BAY WISE QUANTITY		TOTAL QUANTITY
				BPS NO. 63 (6 LOT)	BPS NO. 98 (2 SET)	
1	72.5KV, 25KA FOR 1S, 1250A, CB CONNECTOR SUITABLE FOR TWIN BERSIMIS	501	NO.	0	12	12
2	72.5KV, 25KA FOR 1S, CT CONNECTOR SUITABLE FOR TWIN BERSIMIS	502	NO.	0	12	12
3	72.5KV, 25KA FOR 1S, 1250A, ISOLATOR (HDB) CONNECTOR SUITABLE FOR TWIN BERSIMIS	503	NO.	0	12	12
4	66KV, 25KA FOR 1S, PT CONNECTOR SUITABLE FOR TWIN BERSIMIS	504	NO.	0	6	6
5	72.5KV, 25KA FOR 1S, 1250A, BPI CONNECTOR SUITABLE FOR AL TUBE 3 INCH IPS, SLIDING THROUGH TYPE	505	NO.	146	0	146
6	72.5KV, 25KA FOR 1S, 1250A, BPI RIGID-EXPANSION TYPE CONNECTOR SUITABLE FOR 3" IPS AL TUBE, TUBE CUT	506	NO.	164	0	164
7	72.5KV, 25KA FOR 1S, 1250A, ICT BUSHING CONNECTOR SUITABLE FOR TWIN BERSIMIS (THROUGH TYPE)	507	NO.	38	0	38
8	72.5KV, 25KA FOR 1S, 1250A, TEE CONNECTOR/PG CONNECTOR SUITABLE FOR 3" IPS AL TUBE TO TWIN BERSIMIS	508	NO.	364	0	364
9	72.5KV, 25KA FOR 1S, 1250A, LT TRANSFORMER BUSHING CONNECTOR SUITABLE FOR TWIN BERSIMIS	509	NO.	0	6	6
10	WELDING SLEEVE SUITABLE FOR 3 INCH IPS AL TUBE	WS3	NO.	196	0	196
11	END CAP SUITABLE FOR 3 INCH IPS AL TUBE	3CB	NO.	146	0	146

BILL OF QUANTITIES FOR CLAMPS AND CONNECTORS-BIKANER-III-33KV

S.NO.	ITEM DESCRIPTION	CLAMP NO.	UNIT	QUANTITY
				BPS NO. 63 (6 LOT)
1	33KV, 25KA FOR 1S, BPI CONNECTOR SUITABLE FOR AL TUBE 3 INCH IPS, RIGID-SLIDING THROUGH TYPE	301	NO.	52
2	33KV, 25KA FOR 1S, BPI CONNECTOR SUITABLE FOR AL TUBE 3 INCH IPS, TUBE CUT	302	NO.	67
3	33KV, 25KA FOR 1S, BPI CONNECTOR SUITABLE FOR TWIN BERSIMIS CONDUCTOR THROUGH	303	NO.	19
4	33KV, 25KA FOR 1S, 2000A, BUSHING CONNECTOR SUITABLE FOR TWIN BERSIMIS	304	NO.	19
5	33KV, 25KA FOR 1S, 1250A, TEE CONNECTOR/PG CONNECTOR SUITABLE FOR 3" IPS Al tube TO TWIN BERSIMIS	305	NO.	69
6	33KV, 25KA FOR 1S, CURRENT TRANSFORMER CONNECTOR SUITABLE FOR AL TUBE 3 INCH IPS, RIGID TYPE	306	NO.	7
7	33KV, 25KA FOR 1S, CURRENT TRANSFORMER CONNECTOR SUITABLE FOR 75X12 MM FLAT	307	NO.	7
8	WELDING SLEEVE SUITABLE FOR 3 INCH IPS AL TUBE	WS3	NO.	68
9	END CAP SUITABLE FOR 3 INCH IPS AL TUBE	3CB	NO.	46

Bill of Quantity - String Insulators Hardware - Bikaner-III Station (765kV)

S.No	Engineering Description	Nomenclature	Sl. No. as per BPS	Description as per BPS	ICT-1 TIE FUTURE	ICT-2 TIE FUTURE	ICT-3 TIE NEEMRANA LINE-2 WITH REACTOR	ICT-4 TIE NEEMRANA LINE-1 WITH REACTOR	ICT-5 TIE BUS REACTOR-1	ICT-6 TIE BUS REACTOR-2	MAIN BUS-I	MAIN BUS-II	Engineered Quantity Total (Nos)	Quantity as per BPS (Nos)	UNIT	REMARKS
Tension Hardware																
1	765 kV Double Tension Hardware without Turnbuckle suitable for Quad Bull AAC Conductor	7H1	72	765KV TENSION INSULATOR STRING AND ASSOCIATED HARDWARE FITTINGSWITHOUT TURN BUCKLE SUITABLE FOR QUAD CONDUCTOR	9	9	12	12	12	12	9	9	84	84	Nos	
2	765 kV Double Tension Hardware with Turnbuckle suitable for Quad Bull AAC Conductor	7H2	74	765KV TENSION INSULATOR STRING AND ASSOCIATED HARDWARE FITTINGS WITHTURN BUCKLE SUITABLE FOR QUAD CONDUCTOR	9	9	12	12	12	12	9	9	84	84	Nos	
3	765 kV Double Tension Hardware with Turnbuckle suitable forHexa zebra Conductor	7H5	73	765KV TENSION INSULATOR STRING AND ASSOCIATED HARDWARE FITTINGS WITHTURN BUCKLE SUITABLE FOR HEXA CONDUCTOR	--	--	3	3	--	--	--	--	6	6	Nos	
4	765kv guy arrangement hardware with Turnbuckle suitable for Quad Bull AAC Conductor	7H6	--	--	6	6	15	15	12	12	--	--	66	--	Nos	
Suspension Hardware																
5	765 kV Single Suspension Hardware with Drop Clamp suitable for Quad Bull AAC Conductor	7H3	70	765KV SUSPENSION INSULATOR STRING AND ASSOCIATED HARDWARE FITTINGSWITH DROP CLAMP SUITABLE FOR QUAD CONDUCTOR	--	--	3	3	--	--	--	--	6	12	Nos	
6	765 kV Single Suspension Hardware with Through Clamp suitable for Quad Bull AAC Conductor	7H4	71	765KV SUSPENSION INSULATOR STRING AND ASSOCIATED HARDWARE FITTINGSWITH THROUGH CLAMP SUITABLE FOR QUAD CONDUCTOR	3	3	6	6	6	6	6	6	42	42	Nos	
COMPOSITE LONG ROD POLYMER INSULATOR-765KV																
1	765KV COMPOSITE LONG ROD POLYMER INSULATOR STRING - 31mm/kV, 210kN - For Tension Insulators	--	--	--	--	--	--	--	--	--	--	--	348	--	SET	1 set as per approved drawing
2	765KV COMPOSITE LONG ROD POLYMER INSULATOR STRING - 31mm/kV, 210kN - For Suspension Insulators	--	--	--	--	--	--	--	--	--	--	--	96	--	SET	1 set as per approved drawing
3	765KV COMPOSITE LONG ROD POLYMER INSULATOR STRING- 31mm/kV, 210kN - For guy wire arrangement	--	--	--	--	--	--	--	--	--	--	--	132	--	SET	1 set as per approved drawing

Bill of Quantity - String Insulators Hardware - Bikaner-III Station (400kV)

S.No	Engineering Description	Nomenclature	Sl. No. as per BPS	Description as per BPS	BIKANER PG LINE-2-TIE-BIKANER II LILO LINE-4	BIKANER PG LINE-1-TIE-BIKANER II LILO LINE-3	765KV ICT-1-TIE - BIKANER-II LINE -2	765KV ICT-2-TIE - BIKANER-II LINE -1	400KV REACTOR-1 - TIE-400KV ICT-1	765KV ICT-3 TIE-400KV ICT-2	FUTURE-TIE-400KV ICT-3	765KV ICT-4-TIE-400KV ICT-4	765KV ICT-5-TIE-400KV ICT-5	765KV ICT-6-TIE-400KV REACTOR-2	FUTURE BUS SECTIONALISER	400KV MAIN BUS 1	400KV MAIN BUS 2	Engineered Quantity Total (Nos)	Quantity as per BPS (Nos)	UNIT	REMARKS
Tension Hardware																					
1	400 kV Double Tension Hardware without Turnbuckle suitable for Quad ACSR Bersimis Conductor	4H1	80	400KV TENSION INSULATOR STRING AND ASSOCIATED HARDWARE FITTINGSWITHOUT TURN BUCKLE SUITABLE FOR QUAD CONDUCTOR	6	6	12	12	6	12	6	12	12	12	6	--	--	102	126	Nos	Amendment required for 6 no. additional quantity
2	400 kV Double Tension Hardware without Turnbuckle suitable for Quad AAC Bull Conductor	4H3			--	--	--	--	--	--	--	--	--	--	--	15	15	30		Nos	
3	400 kV Double Tension Hardware with Turnbuckle suitable for Quad ACSR Bersimis Conductor	4H2	81	400KV TENSION INSULATOR STRING AND ASSOCIATED HARDWARE FITTINGSWITH TURN BUCKLE SUITABLE FOR QUAD CONDUCTOR	6	6	12	12	6	12	6	12	12	12	6	--	--	102	108	Nos	Amendment required for 42 no. additional quantity
4	400 kV Double Tension Hardware with Turnbuckle suitable for Quad AAC Bull Conductor	4H4			--	--	--	--	--	--	--	--	--	--	--	15	15	30		Nos	
5	400 kV Double Tension Hardware with Turnbuckle suitable for Quad AL59 Moose	4H5			6	6	3	3	--	--	--	--	--	--	--	--	--	18		Nos	
6	400 kV Double anchoring points Guy arrangement Hardware with Turnbuckle suitable for ACSR Bersimis Conductor (INCLUDING ALL ACCESSORIES LIKE D-SHACKLE ETC. FOR FITTING)	4H6	--	--	--	--	3	3	--	3	--	3	3	3	--	--	--	18	--	Nos	
Suspension Hardware																					
7	400 kV Single Suspension Hardware with Drop Clamp suitable for Quad ACSR Bersimis Conductor	4H7	82	400KV SUSPENSION INSULATOR STRING AND ASSOCIATED HARDWARE FITTINGSWITH DROP CLAMP SUITABLE FOR QUAD CONDUCTOR	6	6	6	6	6	6	3	6	6	6	0	3	3	63	63	Nos	
COMPOSITE LONG ROD POLYMER INSULATOR-400KV																					
1	400KV COMPOSITE LONG ROD POLYMER INSULATOR - 31mm/kV, 120kN - For Tension Insulators	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	564	--	SET	1 set as per approved drawing
2	400KV COMPOSITE LONG ROD POLYMER INSULATOR - 31mm/kV, 120kN - For suspension Insulators	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	63	--	SET	1 set as per approved drawing
3	400KV COMPOSITE LONG ROD POLYMER INSULATOR - 31mm/kV, 120kN - For guy wire arrangement	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	36	--	SET	1 set as per approved drawing

Bill of Quantity - String Insulators Hardware - Bikaner-III Station (220kV)

S.No	Engineering Description	Nomenclature	Sl No. as per BPS	Description as per BPS	220KV SIDE OF ICT 1-TIE-LINE-1	BUS COUPLER-TIE-LINE-2	220KV SIDE OF ICT 2-TIE-LINE-3	220KV SIDE OF ICT 3-TIE-LINE-4	FUTURE-TIE-TBC-1	220KV SIDE OF ICT 4-TIE-TBC-2	220KV SIDE OF ICT 5-TIE-LINE-5	BUS COUPLER-2	220KV MAIN BUS 1	220KV MAIN BUS 2	220KV TRANSFER BUS	Engineered Quantity Total (Nos)	Quantity as per BPS (Nos)	UNIT	REMARKS
Tension Hardware																			
1	220 kV Double Tension Hardware without Turnbuckle suitable for Quad ACSR Bersimis Conductor	2H1	94	220KV TENSION INSULATOR STRING AND ASSOCIATED HARDWARE FITTINGSWITHOUT TURN BUCKLE SUITABLE FOR QUAD CONDUCTOR	3	6	3	3	9	12	3	6	--	--	21	**66**	63	Nos	Amendment required for 30 no. additional quantity
2	220 kV Double Tension Hardware without Turnbuckle suitable for Quad AAC Bull Conductor	2H3		220KV TENSION INSULATOR STRING AND ASSOCIATED HARDWARE FITTINGSWITHOUT TURN BUCKLE SUITABLE FOR QUAD CONDUCTOR	--	--	--	--	--	--	--	--	9	18	--	**27**		Nos	
3	220 kV Double Tension Hardware with Turnbuckle suitable for Quad ACSR Bersimis Conductor	2H2	92	220KV TENSION INSULATOR STRING AND ASSOCIATED HARDWARE FITTINGS WITHTURN BUCKLE SUITABLE FOR QUAD CONDUCTOR	3	6	3	3	9	12	3	6			21	**66**	63	Nos	Amendment required for 30 no. additional quantity
4	220 kV Double Tension Hardware with Turnbuckle suitable for Quad AAC Bull Conductor	2H4		220KV TENSION INSULATOR STRING AND ASSOCIATED HARDWARE FITTINGS WITHTURN BUCKLE SUITABLE FOR QUAD CONDUCTOR	--	--	--	--	--	--	--	--	9	18	--	**27**		Nos	
5	220 kV Double Tension Hardware with Turnbuckle suitable for Single AL59 Moose Conductor - Line Side	2H7		NOT IN BPS	3	3	3	3	--	--	3	--	--	--	--	**15**	--	Nos	Amendment required for 15 no. additional quantity
Suspension Hardware																			
6	220 kV Single Suspension Hardware with **Drop** Clamp suitable for Twin ACSR **Bersimis** Conductor	2H5	95	220KV SUSPENSION INSULATOR STRING AND ASSOCIATED HARDWARE FITTINGSWITH DROP CLAMP SUITABLE FOR TWIN CONDUCTOR	5		5	5	--	--	5	--	6	6	3	**35**	33	Nos	Amendment required for 2 no. additional quantity
7	220 kV Single Suspension Hardware with **Drop** Clamp suitable for **Quad AAC Bull** Conductor	2H6	97	220KV SUSPENSION INSULATOR STRING AND ASSOCIATED HARDWARE FITTINGSWITH DROP CLAMP SUITABLE FOR QUAD CONDUCTOR	--	--	--	--	--	--	--	--	6	6	--	**12**	12	Nos	
COMPOSITE LONG ROD POLYMER INSULATOR-220KV																			
1	220KV COMPOSITE LONG ROD POLYMER INSULATOR - 31mm/kV, 120kN - For Tension Insulators	--	--	--	--	--	--	--	--	--	--	--	--	--	--	372	--	SET	1 set as per approved drawing
2	220KV COMPOSITE LONG ROD POLYMER INSULATOR - 31mm/kV, 120kN - For suspension Insulators	--	--	--	--	--	--	--	--	--	--	--	--	--	--	47	--	SET	1 set as per approved drawing

SECTION -PROJECT

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ANNEXURE –I : LIST OF DRAWINGS.

ANNEXURE –II: BREAK UP OF MANDATORY SPARES

ANNEXURE-III: SPECIFIC REQUIREMENTS (Section-Project) C/ENGG/SPEC/SEC-PROJECT/SPECIFIC REQUIREMENT Rev. No 07

ANNEXURE-IV: SPECIFICAION FOR LABOUR HUT

SECTION -PROJECT

1.0 **GENERAL**

1.1 **PREMBLE**

Power Grid Corporation of India Ltd. (POWERGRID), a Govt. of India Enterprise is responsible for bulk Power transmission of electrical energy from various Central Govt. Power Projects to various utilities/beneficiaries and interconnecting regional grids, operating and maintaining the National electrical grid of India. It is established with mandate of "We will become a Global Transmission Company with Dominant Leadership in Emerging Power Markets with World Class Capabilities by:

- World Class: Setting superior standards in capital project management and operations for the industry and ourselves.
- Global: Leveraging capabilities to consistently generate maximum value for all stakeholders in India and in emerging and growing economies.
- Inspiring, nurturing and empowering the next generation of professionals.
- Achieving continuous improvements through innovation and state of the art technology.
- Committing to highest standards in health, safety, security and environment." as its mission.

1.2 Govt. of India (MoP) has identified the execution of "Transmission system for evacuation of power from Rajasthan REZ Ph-IV (Part-1: Bikaner Complex)-Part-A" through Tariff Based Competitive Bidding (TBCB) route for which POWERGRID is intending to participate in the bidding process. Further, POWERGRID is intending to arrange for pre-bid tie-up for the scope envisaged.

1.3 Following Transmission System is envisaged under "Transmission system for evacuation of power from Rajasthan REZ Ph-IV (Part-1: Bikaner Complex)-Part-A" through TBCB route:

A. Transmission lines:

i) LILO of both ckts of 400kV Bikaner (PG) - Bikaner-II D/c Line (Quad) at Bikaner-III PS
ii) Bikaner-II PS - Bikaner-III PS 400kV D/c Line (Quad).
iii) Bikaner-III-Neemrana-II 765kV D/c Line.

B. Substations:

i) Establishment of 6x1500 MVA, 765/400 kV & 5x500 MVA 400/220 kV Bikaner-III Pooling Station (including 400kV, 2x125MVAR, reactor at Bikaner-III)
ii) Extension of 765kV Neemrana-II S/s for termination of 765 kV D/c line Neemrana-II – Bikaner-III TL.
iii) Extension of 400kV Bikaner-II Substation for termination of 400kV Bikaner-II-Bikaner-III TL

This Specification covers Establishment of 6x1500 MVA, 765/400 kV & 5x500 MVA 400/220 kV Bikaner-III Pooling Station along with associated 400kV 125MVAR reactors, Extn of Neemrana & Extn of Bikaner-II substation only. 765/400/33kV & 400/220/33kV Auto Transformers at Bikaner-III (new) PS and 765/√3kV Shunt Reactors at Bikaner-III (New) PS & Neemrana-II S/s are being executed through separate package(s).

2.0 SCOPE

2.1 The broad scope for the substations is as following :

S. No.	Scope
1.	**765/400/220 kV Bikaner-III (New) PS** **765kV:** • ICTs: 19x500MVA, (765/√3)/(400/√3)/33 kV, 1-phase transformers (1 no. as spare unit) along with its auxiliaries • Bus reactor: 7X110 MVAR, 765/√3kV, 1-phase reactors (1 no. as spare unit) along with its auxiliaries • Switchable Line reactors: 6X110 MVAR, 765/√3kV, 1-phase reactors for Bikaner-III (New) PS-Neemrana-II 765 KV D/C line (each 330 MVAR reactor with NGR, 132kV Surge Arrester) along with its auxiliaries • Line with Switchable Reactor bays: 2 nos.(For Bikaner-III-(new) PS-Neemrana-II 765 KV D/C line • ICT bays: 6nos. • Bus reactor bay: 2 nos. • All associate tie bays • Future Bus Reactor:3X110 MVAR, 1-Ph • Future Line with switchable reactor bays: 6 nos • Future Bus Reactor Bay: 1 Nos **400 kV:** • ICTs: 5x500MVA, (400/220/33) kV, 3-phase transformers. • Bus reactor: 2X125 MVAR, 420kV, 3-phase reactors • Bays for 765/400kV ICT's: 6nos. • Bays for 400/220kV ICT's: 5nos • Line bays: 6nos. (4 nos. for LILO of Bikaner-Bikaner-II D/c line & 2 nos. for Bikaner-II D/c line) • Bus reactor bay: 2nos. • All associate tie bays • Future ICT's: 5X 500 MVA, 3-Ph • Future Bus Reactor:1X125MVAR, 3-Ph • Future Line with switchable reactor bays: 4 nos. • Future Line bay: 4 • Future ICT bays : 5 nos. • Future Bus Reactor Bay: 1 Nos • Future Sectionalizer Bay: 2sets • Future STATCOM (2x±300MVAr) along with MSC (4x125MVAr) & MSR (2x125MVAr) **220kV** • ICT bay: 5 nos. • Line bay: 6nos. • Bus Coupler bay: 2nos.

	• Transfer Bus Coupler bay: 2nos • 220 kV Sectionalisation bay: 1 set • Future Line bay: 8 Nos • Future ICT bays : 5nos. • Future Sectionalizer Bay: 2sets • Future Bus Coupler bay: 2 Nos • Future Transfer Bus Coupler bay: 2 Nos
2.	**Extension of Neemrana-II S/s** • 765kV line bays at Neemrana-II S/s- 2 nos. • 765 kV, 330MVAr Switchable line reactors at Neemrana-II S/s – 2 nos. • Switching equipment for 765kV 330MVAr switchable line reactors at Neemrana-II S/s – 2 nos.
3.	**Extension of Bikaner-II S/s** • 400kV line bays at Bikaner-II S/s- 2 nos.

2.2 The detailed scope of work of the substation package is brought out in subsequent clauses of this section.

2.2.1 765/400/220 kV Bikaner-III (New) S/s.

2.2.1.1 Design, engineering, manufacture, testing at manufacturer's works, supply including transportation and insurance, unloading, storage, erection, testing and commissioning at site the following equipment/items, complete in all respects:

a) 2x125MVAR, 420kV, 3-Ph Bus Reactors along with associated accessories.

b) 765kV Circuit Breakers, Isolators, Current Transformers, Capacitor Voltage Transformers, Wave Traps (to be pedestal mounted), Bus Post Insulators (including BPI for Wave Trap) and 624kV Surge Arresters.

c) 400kV Circuit Breakers, Isolators, Current Transformers, Capacitor Voltage Transformers, Wave Traps (to be pedestal mounted), Bus Post Insulators (including BPI for Wave Trap) and 336kV Surge Arresters.

d) 245kV Circuit Breakers, Isolators, Current Transformers, Capacitor Voltage Transformers, Wave Traps (to be pedestal mounted), Bus Post Insulators(including BPI for Wave Trap) and 216kV Surge Arresters.

e) Controlled Switching device for 765kV & 400kV Circuit breakers as per BPS

f) LT Transformer and associated equipment:

800 kVA, 33/0.433kV, LT Transformer (1st) and associated 72.5kV class Circuit Breakers, Isolators, Current Transformers, Potential Transformers, Bus Post Insulators, conductor, clamps, connectors, structures etc. complete in all respect for tertiary loading of 765/400/33kV Autotransformer.

800 kVA, 33/0.433kV LT Transformer (2nd) and associated 33kV class Isolator, HG fuse, Surge Arrestor, Bus Post Insulator, conductor, clamps, connectors, structures etc. complete in all respect for connection with DISCOM Power supply.

g) Complete control, relay and protection system as per Section–Control and Relay panels including control, monitoring and protection of LT Transformer connected to tertiary of 765/400/33kV Autotransformer. Decentralized (distributed) type of bus bar protection system shall be provided for 765/400/220kV Bikaner-III substation. For 400kV & 220kV, Peripheral units of future bays in present section is to be provided as a loose supply.

h) Complete Substation Automation System based on IEC-61850 as per Section Substation Automation (including hardware and software) along with associated equipment.

The contractor shall also supply necessary BCUs for control and monitoring of substation auxiliary system.

Necessary interface equipment (Router, Firewall, Ethernet Switches etc.) and integration work for transferring data to RLDC/ Backup RLDC /RTAMC/ NTAMC / Backup NTAMC through optical fiber based SDH communication link is also under present scope.

Necessary configuration of data at Gateway for remote operation from NTAMC, Backup NTAMC, RTAMC & supervision from RLDC/ Backup RLDC is included in present scope. However, no work is envisaged at remote end (RLDC/ Backup RLDC /RTAMC/ NTAMC / Backup NTAMC) under the present scope.

Integration of Digital RTCC relays for 400/220kV Transformers [being supplied under separate package] with substation automation system is also included under present scope.

i) PLCC equipments including Analogue protection coupler, Digital Protection Coupler (suitable for interfacing with E1 port of SDH equipment), FO Boxes, gantry, signal converters, communication cables etc. for the Bikaner-III both ends of following lines

i. 765kV Bikaner-III (new) PS-Neemrana-II D/C line
ii. 400kV Bikaner-III(New) PS- Bikaner-II D/C Line)
iii. LILO of both Ckt of Bikaner- PG-Bikaner-II TL at Bikaner-III PS
   a) Dismantling & shifting of PLCC equipment's from Bikaner-II and Installation of the same at Bikaner-III for use in Bikaner(PG)-Bikaner-III 400kV D/C Line.
   b) 400kV Bikaner-III(New) PS- Bikaner-II D/C Line)

j) Complete Fire protection system for 765kV class new substation including HVWS and hydrant system for 420kV 125MVAr reactor & Owner supplied $(765/\sqrt{3})/(400/\sqrt{3})/33kV$, 1-Phase Autotransformers, $765/\sqrt{3}kV$, 1-Phase Reactors and 400/220/33kV, 500 MVA, 3 Phase Transformer. Smoke detection, Fire alarm & annunciation System for Switchyard panel room, Control Room building, Auxiliary Building. Fire-fighting system including alarm & annunciation panels shall be suitable for complete substation scope i.e. for all present and future 765kV, 400kV & 220kV bays. Hydrant system for control building, FFPH, Auxiliary Building, LT system etc.

k) Air Conditioning System for Control Room Building, Battery room & Switchyard Panel Rooms.

l) LT switchgear (AC/DC Distribution boards) considering all present and future bays (as per Rfp document and subsequent amendment issued by BPC). AC/DC system shall be provided as per the specified scope of work, including future provisions, in line with the LT SLD drawing no. C/ENGG/STD/LTSWGR765/SLD/01 Rev-0.

Further, ACDB & DCDB section shall be split in two parts, one for 400/220kV Switchyard, same shall be located in Control room building along with other LT Switchgears (MSB, MLDB and ELDB) and other sections for 765kV Switchyard, same shall be located in Auxiliary Building. Outgoing feeders of appropriate rating shall be provided in each section of ACDB, DCDB located in control Room building for powering up ACDB & DCDB located in Aux power room. The location of Auxiliary Building shall be decided during detailed engineering.

m) Battery and Battery chargers: The capacity of Battery & Battery charger shall be worked out by contractor for complete substation scope including future bays (as per Rfp document and subsequent amendment issued by BPC) and shall be submitted for Employer's approval. However, minimum capacity of each battery bank for 220V set and 48V set shall be 1500AH. Further, the minimum rating of each battery charger for 220V set and 48V set shall be 180A In case, battery and battery chargers of higher capacity/rating are required to cater the load requirement based on design calculations during detailed engineering, same shall be provided by contractor without additional cost.

n) 500kVA Silent type outdoor DG Set along with AMF panel.

o) 1.1 kV grade Power & Control cables (and special cables, if any) along with complete accessories including cables for oil filtration units and cabling from common marshaling box of 765kV Transformers, Reactors, 400kV Transformer & reactors to bay kiosks /Relay panel room /control room/Auxiliary building, RTCC panel to common marshalling box, Power receptacle for oil filtration unit shall also be provided under present scope of work as per BPS. Methodology for supply, installation & sizing of cables shall be as per Specific requirement.

p) 33kV HV cable along with complete accessories viz. termination kit, lugs, glands, clamps etc. for connection of LT Transformer with DISCOM supply

q) Insulator strings and associated hardware fittings as per Bid Price Schedule (BPS).

r) Erection Hardware: Clamps & connectors (including terminal connectors for employer supplied $(765/\sqrt{3})/(400/\sqrt{3})/33kV$ Autotransformers, $765/\sqrt{3}$kV Reactors associates, SA, NGR , 400/220/33kV Auto transformer), Conductor, Aluminum tubes, Bus bar and earthing materials, Bay marshalling box, spacers, cable sealing arrangement, insulating mats, cable supporting angles/channels, Cable Pull pit, Cable trays & covers, Guy arrangement(including insulators and hardware), Junction box, buried cable trenches etc.

s) Main Earthmat shall be provided under present scope of work. All the equipments (including employer supplied $(765/\sqrt{3})/(400/\sqrt{3})/33kV$ & 400/220/33kV Autotransformers & $765/\sqrt{3}$kV Reactors associated SA , NGR), cable trenches, auxiliary earthmat for isolators etc. shall be earthed by connecting them to the main Earthmat. Earthing of structures for all auxiliary buses shall also be in the present scope. Employer supplied 1-Ph Spare unit of $(765/\sqrt{3})/(400/\sqrt{3})/33kV$ Autotransformers & $765/\sqrt{3}$kV Reactors shall also be connected to grounding system through jumper/Copper flat when they are in uncharged condition.

t) LED based Lighting and illumination for the switchyard area under present scope, LED based illumination for streets, Control Room cum administrative building, Switchyard Panel Rooms, Auxiliary building, Fire Fighting Pump house, DG Set area and LT station area, security room shall be provided by the contractor.

u) Visual monitoring system for watch and ward of substation premises as per technical specifications.

v) The lightning protection (DSLP) for complete switchyard is to be provided by the contractor. The contractor shall design the lightning protection by utilizing the structures being provided under present scope. In case, additional structures (Lightning Masts) are required to meet the lightning protection, the contractor shall provide the same without any additional cost to POWERGRID. The cost for provision of lightning masts, including associated earthing materials, hardware etc. shall deemed to be included under the respective switchyard bay structures. The civil works shall be payable as per relevant item of BPS.

w) The following works pertaining to employer supplied (765/√3)/(400/√3)/33kV autotransformers, 765/√3kV Reactors {supply of Transformers & Reactors is covered in separate package}as per details specified in Specific requirements enclosed at Annex-III:

iv. Formation of neutral bus for each bank, auxiliary bus (765kV & 145kV) for switching of spare reactor with Bus reactors and Switchable Line Reactors are in present scope of work.

v. Formation of neutral bus, Delta Bus for each bank of transformer, auxiliary bus (765kV & 400kV, neutral & Delta) for switching of spare transformer with Six banks of transformers are in present scope of work.

vi. Overhead connection of HV, MV & LV bushings of (765/√3)/(400/√3)/33kV Autotransformers and HV & Neutral bushings of 765/√3kV Reactors to substation equipment's.

vii. Overhead connection of substation equipments with 765kV & 400kV auxiliary bus of (765/√3)/(400/√3)/33kV Autotransformers.

viii. Supply, laying and termination of cables along with associated accessories from Common marshaling box of (765/√3)/(400/√3)/33kV Autotransformers & 765/√3kV Reactors to BMK /Switchyard Panel Rooms/Control Room/ auxiliary Building as per requirement.

ix. NGR Bypass arrangement for Line Reactors through 145kV Circuit Breakers, Bus Post Insulators along with associated support structures, clamps and connectors, conductors, spacers etc.

x. 33kV neutral CT for each bank of transformers and Line Reactors.

x) 765kV, 400kV & 220kV Lattice and Pipe structures (galvanized) Towers, Beams, LM's (if applicable) and all Equipment support structures except support structure for circuit breaker shall be provided as per employer's drawing. The Support structure for Circuit Breaker shall be as per manufacturer's design.

Structures for auxiliary buses for formation of delta, neutral, spare switching etc. for 3-phase bank formation of transformers & reactors and structures for neutral CT in the scope of vendor under present scope.

In the bid price schedule, the structures including Fasteners & foundation bolts are indicated in MT.

Single line diagram/ Fabrication Drawings of Towers/ Gantries and equipment support structures shall be provided by POWERGRID during detailed Engineering stage except for those structures that are in the scope of vendor.

y) The broad Scope of the procurement of FO based Communication Equipment shall include planning, designing, engineering, supply, transportation, insurance, delivery at site, unloading handling, storage, installation, termination, testing, training and demonstration for acceptance, commissioning and documentation for :

i. SDH Equipment along with suitable interfaces and line cards.
ii. All cabling, wiring, Digital Distribution frame patch facilities and interconnection to the supplied equipment at the defined interfaces,
iii. System integration of all supplied subsystem
iv. Integration with the existing communication system based on SDH and PDH of employer.
v. Integration of supplied subsystem with SCADA system, PLCC equipment, PABX of RLDC/NLDC, VOIP (SIP compliant) for voice.
vi. Fibre Optic Approach Cable (FOAC) along with duct and Fibre Optic Distribution Panel (FODP).
vii. Integration of new Communication equipment in the existing regional NMS. All required support to existing NMS vendor for integration of new Communication equipment.

z) The broad Scope of the procurement of PMU shall include planning, designing, engineering, supply, transportation, insurance, delivery at site, unloading handling, storage, installation, termination, testing and demonstration for acceptance, commissioning and documentation for PMU as per BPS and these PMU shall support IEEE C 37.118 protocols. These PMUs shall be integrated with Phasor data Concentrator (PDC) at Northern Regional Load Dispatch Centre.

2.3.1.2 Design, engineering, manufacture, testing and supply including transportation & insurance, storage of mandatory spares at site as per BPS.

3.3.1.3 Civil works

The design of foundation shall be based on the soil investigation report and other parameters as per relevant IS codes & technical specification. Wind and seismic data shall be considered as per the latest NBC 2016

All RCC shall be of Design mix with M-25 grade unless specified otherwise.

I The scope of civil work shall include but not be limited to the following based on **drawings developed by POWERGRID enclosed at Annex-I**:

I.1 **Control room Building**
I.2 **Auxiliary Building**
I.3 **Switchyard Panel Room**
I.4 **Firefighting pump house & Fire water tank**
I.5 **Foundation for 765kV, 400kV, 220kV, 72.5kV, 33kV Gantries and Equipment.**
I.6 **Transformer & Reactor foundations** (including for employer supplied transformers and Reactors), associated Fire walls between transformers and Reactors, rail track, oil pits, NGR, 132kV Surge Arrester etc.
I.7 **Foundations** for DG Set, LT Transformer, sump pit and other miscellaneous structures.
I.8 **Road works**: Road shall be constructed as per POWERGRID standard drawings

provided in tender. However, Road layout shall be prepared by contractor and submitted for Employer's approval.

I.9 **Cable Trenches:**

I.9.1 Cable trenches along with covers including road/rail crossing, sump pits, culverts etc. shall be constructed as per POWERGRID standard drawings provided in the tender. However, Cable trench layout including invert levels shall be prepared by contractor based on the standard sections and submitted for approval of POWERGRID.

I.9.2 **Mode of measurement:** Cable Trench along with its cover shall be measured in RM for payment purpose. All works such as Excavation, PCC, RCC, Reinforcement, Misc. Structural steel, cable trench crossings (using RCC Hume Pipe (NP-3)), sumps etc. required as per technical specification and drawings for successful completion of the works are deemed to be included in the quoted rates.

I.10 **Drains:**

I.10.1 Drainage system shall be based on the standard sections. Drainage layout drawing shall be prepared by contractor and shall be submitted for Employer's approval.

I.10.2 **Mode of measurement:** Drains shall be measured in running meter. The rate shall include the cost of all works such as Excavation, PCC, RCC, Reinforcement, Misc. Structural Steel, brickwork, screed concrete, plastering, etc. as per drawings and technical specifications.

I.11 **Switchyard fencing & Switchyard Gate**: Switchyard fencing & Gate as per tender drawings complete in all respect. Fencing layout drawings shall be prepared by the contractor and shall be approved by POWERGRID during detailed engineering.

I.12 Construction of **Boundary Wall** and **Main Gate** as per drawing.

I.13 Construction of **Security Post** as per drawing

I.14 **Car Parking Shed** as per drawings

I.15 Construction of **Rain water harvesting** as per drawing. The rate includes all such works as mentioned in the drawing

I.16 **Dry Stone Pitching**

I.17 **Retaining Wall**: If required, RCC retaining walls shall be constructed for which items such as excavation, PCC, RCC, reinforcement steel, etc. shall be measured and paid under respective items of BPS.

I.18 **Labour Hut:**

I.18.1 The reference drawings pertaining to Labour hut are attached as a part of tender drawings. The technical specifications of Labour Hut are enclosed at **Annexure IV**.

I.18.2 Mode of measurement of this item is in sqm of plinth area as per BOQ. The calculation of plinth area shall be as per IS:3861:2002. The items Excavation, PCC, RCC, Reinforcement, Misc Structural Steel and all other civil works, electrical works required as per technical specification and drawings for successful completion of the works are deemed to be included in the quoted rates.

I.20 **Miscellaneous**: For buildings, the complete civil works including internal and external finishing, stone soling for flooring, plinth protection, drain along plinth protection, electrical conduit and junction boxes, fan boxes, cable transit system etc. required to complete the building in all respect as per the drawing shall be payable in the plinth area rate. However, the quantity of the earthwork (excavation, backfilling, disposal etc.), concrete (all types of PCC & RCC), reinforcement steel, shall be measured and paid under respective items under BPS.

II The scope of civil work shall include but not limited to the following based on designs,

architectural, structural, foundation **drawings to be developed by the contractor**.

II.1 **Site Levelling**

II.1.1 The item of site levelling works includes Contouring of whole plot area within the boundary as per technical specification. The final area of levelling may be less than the whole plot area, which will be decided during detailed engineering.

II.1.2 The Quantity of earthwork cutting & filling, borrowed earth and FGL shall be proposed by vendor for approval of POWERGRID based on the approved contour level drawing and site HFL data.

II.1.3 Mode of measurement of this item is in Cum of earthwork as per BOQ and technical specification. The contouring of the plot area in scope as per technical specification is also deemed to be included in quoted rates of this item.

II.2 **Soil Investigation** work including soil resistivity.

II.2.1 Soil investigation needs to be conducted as per the technical specification. The necessary soil investigation layout and final soil report shall be proposed by vendor for approval of POWERGRID.

II.2.2 Mode of measurement of this item is Lumpsum as per BOQ.

II.3 **Structure and Foundation for transformers and reactors neutral and tertiary delta formation:**

II.3.1 Structure and foundation for neutral, tertiary delta formation for Transformers and neutral formation & earthing arrangement for Reactors along with associated spare unit connection arrangement.

II.4 **Stone spreading and anti-weed treatment in the switchyard:**

II.4.1 Stone spreading and anti-weed treatment in the switchyard as per Section-Civil Works. Layout for the same shall be developed by the contractor.

II.5 **Foundation** for lighting poles, bay marshalling boxes, panels and control cubicles wherever required. The cost of these foundations shall be deemed to be included in erection/installation of corresponding item/ equipment of BPS.

II.6 **Internal & external water supply layout** for Security Hut, Control Room Building, Firefighting Pump House Building, Fire Water Tank, Labour Hut and Transit Camp.

II.7 **Internal plumbing and external sewerage layout** for Control Room Building, Security Hut, Labour Hut and Transit Camp.

II.8 Any other item/design/drawing for completion of scope of works.

2.3.2 Extension of 765 kV Neemrana-II S/s

2.3.2.1 Design, engineering, manufacture, testing at manufacturer's works, supply including transportation and insurance, unloading, storage, erection, testing and commissioning at site the following equipment/items, complete in all respects

a) 765kV Circuit breakers, Isolators, Current Transformers, Capacitor Voltage Transformers, Wave Traps (to be pedestal mounted), Bus Post Insulators (including BPI for Wave Trap) and 624kV Surge Arresters.

b) Controlled Switching device for 765kV Circuit breakers as per BPS

c) Complete Control, Relay and Protection system as per Section–Control and Relay Panels. Augmentation of existing bus Bar protection for bays under present scope make and model of bus bar protection shall be provided during execution stage. Peripheral units for present scope

shall be available at Site, The Scope shall cover shifting of these peripheral units from existing panels to panels for present bays, wiring and commissioning

d) Augmentation of Substation Automation System for following bays (bay as defined in technical specification, Section-Substation Automation System):

- 765kV bays – 4 Nos

Existing Neemrana-III Substation is equipped with substation automation system (based on IEC-61850) Make & Model of existing SAS shall be shared with the successful bidder, during detailed engineering.

Under present scope Bidder shall include BCUs required for 765kV bays mentioned above, including all necessary hardware & software to integrate with the existing substation automation system.

The scope of bidder shall include but not limited to integration of IEDs under present scope of work with existing substation automation (which is based on IEC 61850) and capability enhancement of same as required including up-dating of system database, displays, development of additional displays and reports as per requirement.

Necessary configuration of data at Gateway for remote operation from NTAMC, Backup NTAMC, RTAMC & supervision from RLDC/ Backup RLDC is included in present scope. However, no work is envisaged at remote end (RLDC/ Backup RLDC /RTAMC/ NTAMC / Backup NTAMC) under the present scope.

e) Smoke detection, Fire alarm & Annunciation System for Switchyard panel Rooms.

f) Air Conditioning System for Switchyard Panel Room.

g) 1.1 kV grade Power & Control cables (and special cables, if any) along with complete accessories including cables for oil filtration units and cabling from common marshaling box of 765kV Reactors to bay kiosks /Relay panel room /control room. Power receptacle for oil filtration unit shall also be provided under present scope of work as per BPS. Methodology for supply, installation & sizing of cables shall be as per Specific requirement.

h) Insulator strings and associated hardware fittings as per Bid Price Schedule (BPS).

i) Erection Hardware: Clamps & connectors (including terminal connectors for employer supplied (765/√3kV Reactors associates, SA, NGR), Conductor, Aluminum tubes, Bus bar and earthing materials, Bay marshalling box, spacers, cable sealing arrangement, insulating mats, cable supporting angles/channels, Cable Pull pit, Cable trays & covers, Guy arrangement(including insulators and hardware), Junction box, buried cable trenches etc.

j) Existing Main Earthmat is to be extended for bays under present scope. All the equipments (including employer supplied 765/√3kV Reactors associated SA , NGR), cable trenches, auxiliary earthmat for isolators etc. shall be earthed by connecting them to the main Earthmat. Earthing of structures for all auxiliary buses shall also be in the present scope.

k) LED based Lighting and illumination for the switchyard area under present scope, LED based illumination for Switchyard Panel Rooms shall be provided by the contractor.

l) Augmentation of Visual monitoring system (VMS) for 765kV bays under present scope, and their integration with existing Substation VMS system. The bidder shall provide 2(Two)

Numbers of color IP camera, with PAN, TILT and ZOOM facilities, suitably located in the switchyard for monitoring of 765kV bays and equipments under present scope. The scope of bidder shall include providing all Items, Accessories, Line Interface units, Fiber patch cords, Power supply units, Junction Boxes, Cables, Fiber Optic Cables, Hardware and Software, etc., as are applicable to the product design, to meet functional requirements. Compatibility enhancement of exiting VMS system, as needed, shall be done to integrate visual monitoring for 765kV bays under present scope with existing Visual monitoring system of the station. A copy of specification for Visual Monitoring system is enclosed at Specific Requirement Rev 07, which shall, be read only for the Augmentation scope of existing VMS system

m) The following works pertaining to employer supplied 765/√3kV Reactors (supply of Reactors is covered in separate package) as per details specified in Specific requirements enclosed at Annex-III:

i. Formation of neutral bus for each bank, auxiliary bus (765kV & 145kV) for switching of spare reactor with Bus reactors and Switchable Line Reactors are in present scope of work.

ii. Overhead connection of HV & Neutral bushings of 765/√3kV Reactors to substation equipment's.

iii. Supply, laying and termination of cables along with associated accessories from Common marshaling box of 765/√3kV Reactors to BMK /Switchyard Panel Rooms/Control Room/ auxiliary Building as per requirement.

iv. NGR Bypass arrangement for Line Reactors through 145kV Circuit Breakers, Bus Post Insulators along with associated support structures, clamps and connectors, conductors, spacers etc.

v. 33kV neutral CT for each bank of Reactor.

n) 765kV Lattice and Pipe structures (galvanized) Towers, Beams and all Equipment support structures except support structure for circuit breaker shall be provided as per drawings issued by the employer. The Support structure for Circuit Breaker shall be as per manufacturer's design.

In the bid price schedule, the gantry support and equipment support structures including Fasteners & foundation bolts are indicated in Metric Tonnes.

Single line diagram/ Fabrication Drawings of Towers/ Gantries and equipment support structures shall be provided by POWERGRID.

o) The broad Scope of the procurement of FO based Communication Equipment shall include planning, designing, engineering, supply, transportation, insurance, delivery at site, unloading handling, storage, installation, termination, testing, training and demonstration for acceptance, commissioning and documentation for :

i. SDH Equipment along with suitable interfaces and line cards.
ii. All cabling, wiring, Digital Distribution frame patch facilities and interconnection to the supplied equipment at the defined interfaces,
iii. System integration of all supplied subsystem

iv. Integration with the existing communication system based on SDH and PDH of employer.

v. Integration of supplied subsystem with SCADA system, PLCC equipment, PABX of RLDC/NLDC, VOIP (SIP compliant) for voice.

vi. Fibre Optic Approach Cable (FOAC) along with duct and Fibre Optic Distribution Panel (FODP).

vii. Integration of new Communication equipment in the existing regional NMS. All required support to existing NMS vendor for integration of new Communication equipment.

p) The broad Scope of the procurement of PMU shall include planning, designing, engineering, supply, transportation, insurance, delivery at site, unloading handling, storage, installation, termination, testing and demonstration for acceptance, commissioning and documentation for PMU as per BPS and these PMU shall support IEEE C 37.118 protocols. These PMUs shall be integrated with Phasor data Concentrator (PDC) at Northern Regional Load Dispatch Centre.

2.3.2.2 Design, engineering, manufacture, testing and supply including transportation & insurance, storage of mandatory spares at site as per BPS.

2.3.2.3 Civil works

The design of foundation shall be based on the soil investigation report and other parameters as per relevant IS codes & technical specification.

Wind and seismic data shall be considered as per the latest NBC 2016

All RCC shall be of Design mix with M-25 grade unless specified otherwise.

I The scope of civil work shall include but not be limited to the following based on **drawings developed by POWERGRID**:

I.1 **Switchyard Panel Room**

I.2 **Foundation for 765kV Gantries and Equipment.**

I.3 **Reactor foundations** (including for employer supplied reactors), associated Fire walls between transformers, rail track, oil pits, NGR, 132kV Surge Arrester etc.

I.4 **Dry Stone Pitching**

I.5 **Retaining Wall**: If required, RCC retaining walls shall be constructed for which items such as excavation, PCC, RCC, reinforcement steel, etc. shall be measured and paid under respective items of BPS.

I.6 **Road works**: Road shall be constructed as per POWERGRID standard drawings provided in tender. However, Road layout shall be prepared by contractor and submitted for Employer's approval.

I.7 **Cable Trenches:**

I.7.1 Cable trenches along with covers including road/rail crossing, sump pits, culverts etc. shall be constructed as per POWERGRID standard drawings provided in the tender. However, Cable trench layout including invert levels shall be prepared by contractor based on the standard sections and submitted for approval of POWERGRID.

I.7.2 **Mode of measurement:** Cable Trench along with its cover shall be measured in RM for payment purpose. All works such as Excavation, PCC, RCC, Reinforcement, Misc. Structural steel, cable trench crossings (using RCC Hume Pipe (NP-3)), sumps etc. required as per technical specification and drawings for successful completion of the works are

deemed to be included in the quoted rates.

I.8 **Drains:**

I.8.1 Drainage system shall be based on the standard sections. Drainage layout drawing shall be prepared by contractor and shall be submitted for Employer's approval.

I.8.2 **Mode of measurement:** Drains shall be measured in running meter. The rate shall include the cost of all works such as Excavation, PCC, RCC, Reinforcement, Misc. Structural Steel, brickwork, screed concrete, plastering, etc. as per drawings and technical specifications.

I.9 **Miscellaneous**: For buildings, the complete civil works including internal and external finishing, stone soling for flooring, plinth protection, drain along plinth protection, electrical conduit and junction boxes, fan boxes, cable transit system etc. required to complete the building in all respect as per the drawing shall be payable in the plinth area rate. However, the quantity of the earthwork (excavation, backfilling, disposal etc.), concrete (all types of PCC & RCC), reinforcement steel, shall be measured and paid under respective items under BPS.

II The scope of civil work shall include but not limited to the following based on designs, architectural, structural, foundation **drawings to be developed by the contractor**.

II.1 **Site Levelling**

II.1.1 The item of site levelling works includes Contouring of Area under present Scope as per technical specification.

II.1.2 The Quantity of earthwork cutting & filling, borrowed earth and FGL shall be proposed by vendor for approval of POWERGRID based on the approved contour level drawing and site HFL data.

II.1.3 Mode of measurement of this item is in Cum of earthwork as per BOQ and technical specification. The contouring of the plot area in scope as per technical specification is also deemed to be included in quoted rates of this item.

II.2 **Soil Investigation** work including soil resistivity.

II.3 **Stone spreading and anti-weed treatment in the switchyard:**

II.3.1 Stone spreading and anti-weed treatment in the switchyard as per Section-Civil Works. Layout for the same shall be developed by the contractor.

II.3.2 Removal and re-spreading of stone after doing antiweed treatment

II.4 **Structure and Foundation for transformers and reactors neutral and tertiary delta formation:**

II.4.1 Structure and foundation for tertiary delta formation for neutral formation & earthing arrangement for Reactors along with associated spare unit connection arrangement.

II.5 **Foundation** for lighting poles, bay marshalling boxes, panels and control cubicles wherever required. The cost of these foundations shall be deemed to be included in erection/installation of corresponding item/ equipment of BPS.

II.6 Any other item/design/drawing for completion of scope of works.

2.3.3 Extension of 400kV Bikaner-II S/s

2.3.3.1 Design, engineering, manufacture, testing at manufacturer's works, supply including transportation and insurance, unloading, storage, erection, testing and commissioning at site the following equipment/items, complete in all respects

a) 400kV Circuit breakers, Isolators, Current Transformers, Capacitor Voltage Transformers, Wave Traps (to be pedestal mounted), Bus Post Insulators (including BPI for Wave Trap) and 336kV Surge Arresters.

b) Complete Control, Relay and Protection system as per Section–Control and Relay Panels. Augmentation of existing bus Bar protection for bays under present scope make and model of bus bar protection shall be provided during execution stage. Peripheral units for present scope shall be available at Site, The Scope shall cover shifting of these peripheral units from existing panels to panels for present bays, wiring and commissioning

c) Augmentation of Substation Automation System for following bays (bay as defined in technical specification, Section-Substation Automation System):

- 400kV bays – 4 Nos

Existing Bikaner-III Substation is equipped with substation automation system (based on IEC-61850). Make & Model of existing SAS shall be shared with the successful bidder, during detailed engineering.

Under present scope Bidder shall include BCUs required for 400kV bays mentioned above, including all necessary hardware & software to integrate with the existing substation automation system.

The scope of bidder shall include but not limited to integration of IEDs under present scope of work with existing substation automation (which is based on IEC 61850) and capability enhancement of same as required including up-dating of system database, displays, development of additional displays and reports as per requirement.

Necessary configuration of data at Gateway for remote operation from NTAMC, Backup NTAMC, RTAMC & supervision from RLDC/ Backup RLDC is included in present scope. However, no work is envisaged at remote end (RLDC/ Backup RLDC /RTAMC/ NTAMC / Backup NTAMC) under the present scope.

d) Smoke detection, Fire alarm & Annunciation System for Switchyard panel Rooms.

e) Air Conditioning System for Switchyard Panel Room.

f) 1.1 kV grade Power & Control cables (and special cables, if any) along with complete accessories. Methodology for supply, installation & sizing of cables shall be as per Specific requirement.

g) Insulator strings and associated hardware fittings as per Bid Price Schedule (BPS).

h) Erection Hardware: Clamps & connectors, Conductor, Aluminum tubes, Bus bar and earthing materials, Bay marshalling box, spacers, cable sealing arrangement, insulating mats, cable supporting angles/channels, Cable Pull pit, Cable trays & covers, Junction box, buried cable trenches etc.

i) Existing Main Earthmat is to be extended for bays under present scope. All the equipments, cable trenches, auxiliary earthmat for isolators etc. shall be earthed by connecting them to the main Earthmat. Earthing of structures for all auxiliary buses shall also be in the present scope.

j) LED based Lighting and illumination for the switchyard area under present scope, LED based illumination for Switchyard Panel Rooms shall be provided by the contractor.

k) Augmentation of Visual monitoring system (VMS) for 400kV bays under present scope, and their integration with existing Substation VMS system. The bidder shall provide 2(Two)

Numbers of color IP camera, with PAN, TILT and ZOOM facilities, suitably located in the switchyard for monitoring of 400kV bays and equipments under present scope. The scope of bidder shall include providing all Items, Accessories, Line Interface units, Fiber patch cords, Power supply units, Junction Boxes, Cables, Fiber Optic Cables, Hardware and Software, etc., as are applicable to the product design, to meet functional requirements. Compatibility enhancement of exiting VMS system, as needed, shall be done to integrate visual monitoring for 400kV bays under present scope with existing Visual monitoring system of the station. A copy of specification for Visual Monitoring system is enclosed at Specific Requirement Rev 07, which shall, be read only for the Augmentation scope of existing VMS system

l) 400kV Lattice and Pipe structures (galvanized) Towers, Beams and all Equipment support structures except support structure for circuit breaker shall be provided as per drawings issued by the employer. The Support structure for Circuit Breaker shall be as per manufacturer's design.

In the bid price schedule, the Gantry structures and Equipment support structures including Fasteners & foundation bolts are indicated in Metric Tonnes.

Single line diagram/ Fabrication Drawings of Towers/ Gantries and equipment support structures shall be provided by POWERGRID.

m) The broad Scope of the procurement of FO based Communication Equipment shall include planning, designing, engineering, supply, transportation, insurance, delivery at site, unloading handling, storage, installation, termination, testing, training and demonstration for acceptance, commissioning and documentation for :

viii. SDH Equipment along with suitable interfaces and line cards.
ix. All cabling, wiring, Digital Distribution frame patch facilities and interconnection to the supplied equipment at the defined interfaces,
x. System integration of all supplied subsystem
xi. Integration with the existing communication system based on SDH and PDH of employer.
xii. Integration of supplied subsystem with SCADA system, PLCC equipment, PABX of RLDC/NLDC, VOIP (SIP compliant) for voice.
xiii. Fibre Optic Approach Cable (FOAC) along with duct and Fibre Optic Distribution Panel (FODP).
xiv. Integration of new Communication equipment in the existing regional NMS. All required support to existing NMS vendor for integration of new Communication equipment.

n) The broad Scope of the procurement of PMU shall include planning, designing, engineering, supply, transportation, insurance, delivery at site, unloading handling, storage, installation, termination, testing and demonstration for acceptance, commissioning and documentation for PMU as per BPS and these PMU shall support IEEE C 37.118 protocols. These PMUs shall be integrated with Phasor data Concentrator (PDC) at Northern Regional Load Dispatch Centre.

2.3.2.2 Design, engineering, manufacture, testing and supply including transportation & insurance, storage of mandatory spares at site as per BPS.

2.3.2.3 Civil works

The design of foundation shall be based on the soil investigation report and other parameters as per relevant IS codes & technical specification.

Wind and seismic data shall be considered as per the latest NBC 2016

All RCC shall be of Design mix with M-25 grade unless specified otherwise.

The scope of civil work shall include but not be limited to the following based on **drawings developed by POWERGRID**:

I.1 **Switchyard Panel Room**

I.2 **Foundation for 400kV Gantries and Equipment.**

I.3 **Dry Stone Pitching**

I.4 **Retaining Wall**: If required, RCC retaining walls shall be constructed for which items such as excavation, PCC, RCC, reinforcement steel, etc. shall be measured and paid under respective items of BPS.

I.5 **Road works**: Road shall be constructed as per POWERGRID standard drawings provided in tender. However, Road layout shall be prepared by contractor and submitted for Employer's approval.

I.6 **Cable Trenches:**

I.6.1 Cable trenches along with covers including road/rail crossing, sump pits, culverts etc. shall be constructed as per POWERGRID standard drawings provided in the tender. However, Cable trench layout including invert levels shall be prepared by contractor based on the standard sections and submitted for approval of POWERGRID.

I.6.2 **Mode of measurement:** Cable Trench along with its cover shall be measured in RM for payment purpose. All works such as Excavation, PCC, RCC, Reinforcement, Misc. Structural steel, cable trench crossings (using RCC Hume Pipe (NP-3)), sumps etc. required as per technical specification and drawings for successful completion of the works are deemed to be included in the quoted rates.

I.7 **Drains:**

I.7.1 Drainage system shall be based on the standard sections. Drainage layout drawing shall be prepared by contractor and shall be submitted for Employer's approval.

I.7.2 **Mode of measurement:** Drains shall be measured in running meter. The rate shall include the cost of all works such as Excavation, PCC, RCC, Reinforcement, Misc. Structural Steel, brickwork, screed concrete, plastering, etc. as per drawings and technical specifications.

I.8 **Miscellaneous**: For buildings, the complete civil works including internal and external finishing, stone soling for flooring, plinth protection, drain along plinth protection, electrical conduit and junction boxes, fan boxes, cable transit system etc. required to complete the building in all respect as per the drawing shall be payable in the plinth area rate. However, the quantity of the earthwork (excavation, backfilling, disposal etc.), concrete (all types of PCC & RCC), reinforcement steel, shall be measured and paid under respective items under BPS.

II The scope of civil work shall include but not limited to the following based on designs, architectural, structural, foundation **drawings to be developed by the contractor**.

II.1 **Site Levelling**

II.1.1 The item site levelling works includes Contouring of area under present scope as per technical specification

II.1.2 The Quantity of earthwork cutting & filling, borrowed earth and FGL shall

be proposed by vendor for approval of POWERGRID based on the approved contour level drawing and site HFL data.

II.1.3 Mode of measurement of this item is in Cum of earthwork as per BOQ and technical specification. The contouring of the plot area in scope as per technical specification is also deemed to be included in quoted rates of this item.

II.2 **Stone spreading and anti-weed treatment in the switchyard:**

II.2.1 Stone spreading and anti-weed treatment in the switchyard as per Section-Civil Works. Layout for the same shall be developed by the contractor.

II.3 **Foundation** for lighting poles, bay marshalling boxes, panels and control cubicles wherever required. The cost of these foundations shall be deemed to be included in erection/installation of corresponding item/ equipment of BPS.

II.4 Any other item/design/drawing for completion of scope of works.

2.4 The work to be done under this specification shall include all labour, plant, equipment, material and performance of all work necessary for the complete installation and commissioning of switchyard. All apparatus, appliances, material and labour etc. not specifically mentioned or included, but are necessary to complete the entire work or any portion of the work in compliance with the requirements implied in this specification is deemed to be included in the scope of contractor.

2.5 Before proceeding with the construction work the Contractor shall fully familiarize himself with the site conditions and General arrangements & scheme etc. Though the Employer shall endeavor to provide the information, it shall not be binding for the Employer to provide the same. The bidders are advised to visit the substation sites (for existing substations) and acquaint themselves with the topography, infrastructure and also the design philosophy. The bidder shall be fully responsible for providing all equipment, materials, system and services specified or otherwise which are required to complete the construction and successful commissioning, operation & maintenance of the substation in all respects. All materials required for the Civil and construction/installation work including cement and steel shall be supplied by the Contractor. The complete design (unless specified otherwise in specification elsewhere) and detailed engineering shall be done by the Contractor based on conceptual tender drawings.

2.6 The Contractor shall also be responsible for the overall co-ordination with internal/external agencies, project management, loading, unloading, handling, moving to final destination for successful erection, testing and commissioning of the substation/switchyard.

2.7 Design of substation and its associated electrical & mechanical auxiliaries systems includes preparation of single line diagram, electrical layout, foundation & cable trench layouts (including invert levels), erection key diagrams, direct stroke lightning protection, electrical and physical clearance diagrams, Control and protection schematics, wiring and termination schedules, design of firefighting system, outdoor lighting/illumination and other relevant drawings & documents required for engineering of all facilities within the fencing to be provided under this contract, are covered under the scope of the Contractor.

2.8 Any other items not specifically mentioned in the specification but which are required for erection, testing and commissioning and satisfactory operation of the substation are deemed to be included in the scope of the specification unless specifically excluded.

2.9 Employer has standardized its technical specification for various equipments and works for different voltage levels. Items, which are not applicable for the scope of this package as per schedule of quantities described in BPS, the technical specification for the items should not be referred to.

3.0 SPECIFIC EXCLUSIONS

The following items of work are specifically excluded from the scope of the specifications

A) 765/400/220kV Bikaner-III (new) PS

i) Employer's site office and stores.

ii) Transit camp.

iii) Store building

iv) Supply, erection, testing & commissioning of 500 MVA, (765/√3)/(400/√3)/33kV, single phase autotransformers.

v) Supply, erection, testing & commissioning of 110 MVAR, 765/√3 kV, single phase Bus/ Shunt reactor, NGR & 132kV LA.

vi) Supply, erection, testing & commissioning of 500MVA, 400/220/33kV three phase Auto transformer.

vii) Cabling from IMB to CMB of 765kV Transformer/Reactor.

B) 765/400/220kV Neemrana-II S/S

i) Extension of ACDB & DCDB

ii) Approach Road.

iii) Cabling from IMB to CMB of 765kV Reactor.

C) 765/400/220kV Bikaner-II S/S

i) Extension of ACDB & DCDB

ii) Approach Road

4.0 PHYSICAL AND OTHER PARAMETERS

4.1 Location of the Substation - The location of substation is indicated below:

Sr. No	Name of Substation	Name of State	Nearest Rail Head
1.	765/400/220kV Bikaner-III (New) PS	Rajasthan	Bikaner
2.	765/400kV Neemrana-II PS	Rajasthan	Alwar
3.	400/220kV Bikaner-II PS	Rajasthan	Bikaner

4.2 **Meteorological data**

The meteorological data are as below

Station Name	**765/400/220kV Bikaner-III (new) PS**	**Extension of 765kV Neemrana-II**	**Extension of 400kV Bikaner-II S/s**
Altitude	Less than 1000 meter	Less than 1000 meter	Less than 1000 meter

	above mean sea level (MSL)	above mean sea level (MSL)	above mean sea level (MSL)
Snow fall	NIL	NIL	NIL
Seismic Zone	NBC 2016	NBC 2016	NBC 2016
Wind Zone	NBC 2016	NBC 2016	NBC 2016
Min./Max. Ambient Temperature	0 / 50 degree centigrade	0 / 50 degree centigrade	0 / 50 degree centigrade
Coastal Area consideration	No	No	No

4.3 Fault level shall be considered as mentioned below:-

Sl. No.	**Name of Substation**	**765kV**	**400kV**	**220kV**
1.	765/400/220kV Bikaner-III (New) PS	50kA for 1 Sec	63kA for 1 Sec	50kA for 1 sec
2.	765/400kV Neemrana-II PS	50kA for 1 Sec	NA	NA
3.	400/220kV Bikaner-II PS	NA	63kA for 1 Sec	50kA for 1 sec

5.0 SCHEDULE OF QUANTITIES

The requirement of various items/equipments and civil works are indicated in Bid price Schedules. All equipments/items, Structures and civil works for which quantities has been given in the BPS shall be payable on unit rate basis. During actual execution, any variation in such quantities shall be paid based on the unit rate under each item incorporated in Letter of award.

Wherever the quantities of items/works are indicated in Set/LOT/LS, the bidder is required to estimate the quantity required for entire execution and completion of works and incorporate their price in respective Bid price schedules. For erection hardware items, Bidders shall estimate the total requirement of the works and indicate module-wise lump sum price bay wise and include the same in relevant Bid price schedules.

No cost compensation shall be considered on account of "Set/LOT/LS" items in any case of number of bays specified in section project remains unchanged.

Bidder should include all such items in the bid proposal sheets, which are not specifically mentioned but are essential for the execution of the contract. Item which explicitly may not appear in various schedules and required for successful commissioning of substation shall be included in the bid price and shall be provided at no extra cost to Employer.

6.0 BASIC REFERENCE DRAWINGS

The substation shall be designed considering current ratings as indicated below-

Sl. No	Description of bay	765/400/220kV Bikaner-III (new) PS			Extn of Neemrana-II S/s	Extn of Bikaner--II S/s
		765kV	400kV	220 kV	765kV kV	400 kV
1.	Bus Bar	4000A	4000A	4000A	4000A	4000A
2.	Line bay	3150A	3150A	1600A	3150A	3150A
3.	ICT bay	3150A	3150A	1600A		-
4.	Bus Reactor bay	3150A	3150A	-		-
5.	Bus Coupler bay	-	-	3150A		-
6.	Transfer Bus coupler bay	-	-	1600A		-
7	Bus Sectionalizer			3150A		

Following switching schemes are proposed for the substations envisaged under this specification:

Name of s/s	765kV	400 kV	220 kV
765/400/220kV Bikaner-III (New) PS	One & half breaker scheme	One & half breaker scheme	Double main & Transfer
765/400kV Neemrana-II PS	One & half breaker scheme	--	--
400/220kV Bikaner-II PS	--	One & half breaker scheme	Double main & Transfer

6.1 The reference drawings, which form a part of the specifications, are given at **Annexure-I**. The bidder shall maintain the phase to earth clearance, phase to phase clearance and sectional clearances, clearances between buses, bus heights but may alter the locations of equipment to obtain the statutory electrical clearances required for the substation.

6.2 It is responsibility of contractor to develop general arrangement drawing, layout drawings, single line drawing, foundation & cable trench layout, erection key diagram & all other layout drawings for present scope of work.

6.5 INPUTS TO BE PROVIDED DURING DETAILED ENGINEERING

i) Location of identified land and Plot plan for land shall be provided to successful bidder during detailed engineering.

ii) Transmission line side conductor type & configuration of conductors for transmission lines of various voltage levels.

7.0 DIFFERENT SECTIONS OF TECHNICAL SPECIFICATION

For the purpose of present scope of work, technical specification (Vol. II) shall consist of following sections and they should be read in conjunction with each other.

1	Section-Project	Rev 00
2	Section-General Technical Requirement (GTR)	Rev 15
3	Section-Switchgear- CB	Rev 11
4	Section-Switchgear- ISO	Rev 12

5	Section-Switchgear- Instrument Transformer	Rev 11
6	Section-Switchgear-Surge Arrester	Rev 12
7	Section-Power and Control Cables	Rev 06
8	Section-Lighting System	Rev 07
9	Section-Fire Protection System	Rev 06
10	Section – LT Transformer	Rev 05
11	Section – DG Set	Rev 05
12	Section – Battery & Battery Charger	Rev 06
13	Section – LT Switchgear	Rev 05
14	Section-Air Conditioning System	Rev 04
15	Section-Switchyard Erection	Rev 10
16	Section- Structures	Rev 06
17	Section-Civil Works	Rev 11A with correction slips
18	Section-Control and Relay Panels	Rev 09
19	Section-Substation Automation System	Rev 04
20	Section-PLCC	Rev 05
21	Section-Telecommunication Systems	Rev 03
22	Section – PMU	Rev 00
23	Section Shunt Reactors up to 400kV, Neutral Grounding Reactor an Surge Arrester	Rev 11

In case of any discrepancy between Section-PROJECT and Section-GTR and other technical specifications on scope of works, Section-PROJECT shall prevail over all other sections.

In case of any discrepancy between Section-GTR and individual sections for various equipments, requirement of individual equipment section shall prevail.

8.0 SPARES

The Mandatory Spares shall be included in the bid proposal by the bidder. The prices of these spares shall be given by the Bidder in the relevant schedule of BPS. The breakup of mandatory spares is enclosed at Annex-II.

The bidder is clarified that no mandatory spares shall generally be used during the commissioning of the equipment. Any spares required for commissioning purpose shall be arranged by the Contractor. The unutilized spares if any brought for commissioning purpose shall be taken back by the contractor.

Wherever spares in BPS/Technical Specification has been specified as "each type/each rating/each type & rating": If the offered spare/spares are sufficient to replace the respective main equipment of all types/ratings, then such offered spare/spares shall be acceptable. It implies that common spare/spare set fulfilling the spare requirement of all types/ratings shall also be acceptable, provided it is configurable at site itself without special assistance of OEM

Mandatory Spares, wherever mentioned, are envisaged for the equipment/items being supplied under the main equipment heads under present scope meeting the requirements of Technical Specifications. The component/sub-component of an equipment/item specified in BPS under

Mandatory Spare, which is not applicable as per the offered design of respective main equipment, shall not be referred to.

9.0 **SPECIFIC REQUIREMENT**

9.1 The specific requirements as mentioned at C/ENGG/SPEC/SEC-PROJECT/SPECIFIC REQUIREMENT Rev. no 07 enclosed at Annex-III and relevant/applicable clauses shall be referred for specified scope of work. Any discrepancy between clause 9.0 Section-PROJECT and Annex-III on scope of works, the requirement stipulated at clause 9.0 of section project shall prevail.

9.2 Clause **No. 9.2 of Section GTR rev 15 is amended as :**

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	10
12	GIS & Hybrid GIS	15
13	LT Switchgear	10
14	Cable and associated accessories	10
15	Relays	7
16	Capacitors	10
17	Battery and Battery charger	10
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 core details for 245kV, 2500A, 120% extended Current Transformer shall be as follows:

i. Primary ratio tap: 2500-1600-800/1-1-1-1-1A
ii. Class: PX, PX, 0.2S, PX, PX
iii. Core: 5
iv. Min. Knee point voltage Vk: 2500-1600-800 V for each core except metering
v. Burden: 20VA (For Metering core)
vi. Max. CT sec. winding resistance Rct (ohms): 12.5/8/4 for 2500/1600/800 tapping
vii. Max. excitation current at Vk (Imax in mA): 16/25/50 for 2500/1600/800 tapping

9.4 **Following** items for Reactor are excluded from the scope of this specification:

i) Online Dissolved Gas (Multi-gas) and Moisture analyser
ii) On line dissolved Hydrogen and Moisture Measuring Equipment
iii) Temperature measuring unit
iv) Ethernet switch, LIU patch cords etc. and associated cables

As Ethernet switch is not included in present scope, OTI & WTI shall be integrated in SCADA through 4-20 mA signals.

9.5 Minimum specified creepage distance for insulator string/ longrod insulators/ outdoor bushings shall be 31 mm/kV.

9.6 Technical Specification of 33kV Horn Gap fuse shall be as follows:

Rated voltage	33kV
Maximum Continuous voltage	36 kV
Rated current	50 Amps
Rated short time withstand (in KA)	25KA for 1 sec.
Lighting Impulse voltage withstand	170 KV (Between Live and earth) 195 KV (Across open terminals)
One minute Power frequency voltage withstand (Dry and Wet)	70 KV (Between Live and earth) 80 KV (Across open terminals)

9.7 Technical Parameters of 36kV Neutral Current Transformer (Outdoor type) for bank of 765kV, 1-Ph Transformer

Location: Common Neutral Side (for each three phase bank)

a. Rated current: 3000A (120% extended)

b. Ratio: 3000/1 A
c. Minimum knee point voltage: 3000 V
d. Accuracy class: PX
e. Maximum CT Resistance: 12 Ohms
f. Application: REF (High Impedance)
g. Maximum magnetization current (at knee-point voltage): 20 mA

9.8 Technical Parameters of 36kV Neutral Current Transformer (Outdoor type) for bank of 765kV, 1-Ph Reactor
Location: Common Neutral Side (for each three phase bank)

a. Rated current: 300A (200% extended)
b. Ratio: 300/1 A
c. Minimum knee point voltage: 300 V
d. Accuracy class: PX
e. Maximum CT Resistance: 1 Ohms
f. Application: Earth fault protection
g. Maximum magnetization current at Vk/4 (Vk= knee-point voltage): 40 mA

9.9 **Standalone Disturbance Recorder as mentioned at clause no. 37. I) (Line Protection Panel) of Section-CRP Rev-09 is not envisaged under present scope. (for 765kV)**

9.10 Each circuit of a double circuit transmission line shall be terminated in different diameters.

9.11 Two transformers of same HV rating shall not be connected in the same diameter and similarly two bus reactors of same HV rating shall also not be connected in the same diameter

9.12 **New Clause No. 2.0. f) of Section Switchgear Isolator rev 12 as under:-**

The values of transfer current and recovery voltage of 220kV class bus isolators shall be specified by manufacturer & Bus Isolators shall be type tested for bus transfer current switching duty as per latest IEC62271-102. Test reports is to be submitted for the Employer's review."

9.13 Following clause in the Standard technical specification of –Power & Control Cable Rev 06 has been modified: -

Sl. No	Description
1.	1.2.2. **XLPE Power Cables** 1.2.2.1. The XLPE (90°C) insulated cables shall be of FRLSH type, C2 category conforming to IS: 7098 (Part-I) and its amendments read alongwith this specification. The conductor shall be stranded aluminium circular/sector shaped and compacted. In multicore cables, the core shall be identified by red, yellow, blue and black coloured strips or colouring of insulation. A distinct inner sheath shall be provided in all multicore cables. For XLPE cables, the inner sheath shall be of extruded PVC of type ST-2 of IS:5831. All cables shall be of armoured type. For single core cables, the armouring shall consist of aluminium wires/strips. The outer sheath shall be extruded PVC of Type ST-2 of IS:5831 for all XLPE cables
2.	1.2.3. **PVC Power Cables**

	1.2.3.1. The PVC (70°C) insulated power cables shall be of FRLSH type, C2 category, conforming to IS: 1554 (Part-I) and its amendments read alongwith this specification and shall be suitable for a steady conductor temperature of 70°C. The conductor shall be stranded aluminium. The Insulation shall be extruded PVC to type-A of IS: 5831. A distinct inner sheath shall be provided in all multicore cables. All cables shall be of armoured type. For multicore armoured cables, the inner sheath shall be of extruded PVC. The outer sheath shall be extruded PVC to Type ST-1 of IS: 5831 for all cables.
3.	1.2.4. **PVC Control Cables** 1.2.4.1. The PVC (70°C) insulated control cables shall be of FRLSH type C2 category conforming to IS: 1554 (Part-1) and its amendments, read alongwith this specification. The conductor shall be stranded copper. The insulation shall be extruded PVC to type A of IS: 5831. A distinct inner sheath shall be provided in all cables. All cables shall be of armoured type. The over sheath shall be extruded PVC to type ST-1 of IS: 5831 and shall be grey in colour.
4.	**5 TYPE TESTS** 5.1 All cables shall conform to all type, routine and acceptance tests listed in the relevant IS. 5.2 ***XLPE INSULATED POWER CABLES (For working voltages up to and including 1100V):-*** 5.2.1 Following type tests (on one size in a contract) as per IS: 7098 (Part 1) – 1988 including its amendments shall be carried out as a part of acceptance tests on XLPE insulated power cables for working voltages up to and including 1100 V: a) Physical tests for insulation i) Hot set test ii) Shrinkage test b) Physical tests for outer sheath i) Shrinkage test ii) Hot deformation iii) Heat shock test iv) Thermal stability **c) Test for Smoke density (as per relevant IS/IEC standard)** **d) Test for halogen acid gas evolution**. **e) Flame Retardant on Single cable.** **f) Flame Retardant on bunched cable.** 5.2.2 Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Section: GTR for the following tests a) Water absorption (gravimetric) test. b) Ageing in air oven c) Loss of mass in air oven d) Short time current test on power cables of sizes 240 sqmm and above on i) Conductors. ii) Armours. e) Test for armouring wires/strips.

	f) Oxygen and Temperature Index test. g) Flammability test. **h) Smoke density test (on sheathing material) (as per relevant IS/IEC standard)**
5.	5.3 ***PVC INSULATED POWER & CONTROL CABLES (For working voltages up to and including 1100V)-*** 5.3.1 Following type tests (on one size in a contract) as per IS: 1554 (Part 1) -1988 including its amendments shall be carried out as a part of acceptance tests on PVC insulated power & control cables for working voltages up to and including 1100 V: a) Physical tests for insulation and outer sheath i) Shrinkage test ii) Hot deformation iii) Heat shock test iv) Thermal stability b) High voltage test (water immersion test only a.c. test as per clause no. 16.3.1). **c) Test for Smoke density (as per relevant IS/IEC standard)** **d) Test for halogen acid gas evolution**. **e) Flame Retardant on Single cable** 5.3.2 Contractor shall submit type test reports as per clause no. 9.2 of Technical Specification, Section: GTR for the following a) High voltage test (water immersion d.c. test as per clause no. 16.3.2 of IS: 1554 (Part 1) - 1988). b) Ageing in air oven. c) Loss of mass in air oven. d) Short time current test on power cables of sizes 240 sqmm and above on i) Conductors. ii) Armours. e) Test for armouring wires/strips. f) Oxygen and Temperature Index test. g) Flammability test **h) Flame Retardant on bunched cable** **i) Test for Specific optical density of smoke (as per relevant IS/IEC standard)**

Note:- In technical data sheet for 1.1kV XLPE/PVC Power cable & PVC control cable, wherever Type & Category of Cable is written FR & C1 shall be read as FR-LSH & C2, other details kept the same.

9.14 Equipment/Material/Items from a Indian manufacture who have specified transfer of technology (TOT) arrangement with an entity from a country which shares land border with India shall be accepted only if the Indian Manufacturer is complying the requirement of prevailing Guideline by Government of India under Rule 144(xi) of the General financial Rule (GFR) 2017.

9.15 **CLAUSE 24 of GTR Rev.15 shall be read as below:-**

24.0 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.

: **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 disconnector and three nos. of single phase CTs / Bushing CTs

NOA: means Notification Of Award

24.1 Technical requirements for 765/400/220/132kV* Air Insulated Switchgear (AIS) Equipment*:

A) Circuit Breaker

(i) The manufacturer(s) whose 765/400/220/132kV* Circuit Breaker(s) are offered, must have, manufactured, type tested (as per IEC/IS or equivalent standard) and supplied 715/345/220/132kV* or higher voltage class Circuit Breaker(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 Circuit Breaker and not meeting the requirement stipulated in (i) above, can also be considered provided that

a) 715/345/220/132kV* or higher Voltage class Circuit Breaker(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 Circuit Breaker(s) to be supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 10% of the ex-works cost of the Circuit Breaker(s)* for the additional warranty period in addition to the contract performance guarantee to be submitted by the contractor.

B) Isolator, Current Transformer, Capacitive Voltage transformer, Inductive Voltage transformer, Surge Arrester and Wave Trap)

(i) The manufacturer whose 765/400/220/132kV* equipment(s) are offered, must have manufactured, type tested (as per IS/IEC or equivalent standard) and supplied 715/345/220/132kV* or higher voltage class equipment(s), which are in satisfactory operation# for at least two (2) years as on the date of NOA.

OR

(ii) The manufacturer, who have established manufacturing and testing facilities in India for the offered equipment(s) and not meeting the requirement stipulated in (i) above, can also be considered provided that:

a) 715/345/220/132kV* or higher Voltage class equipment(s) must have been manufactured in the above Indian works & type tested (as per IS/IEC standard) as on the date of NOA

b) Manufacturer has manufactured, type tested (as per IS/IEC or equivalent standard) and supplied equipment(s) of 345kV or above voltage class (applicable for 765kV* Equipment)/220kV or above voltage class (applicable for 400kV* equipment) /132kV or above voltage class (applicable for 220kV* equipment) / 66kV or higher voltage class (applicable for 132kV* equipment), which are in satisfactory operation# for at least two (2) years as on the date of NOA.

c) 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(s) to be supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 10% of the ex-works cost of the equipment(s)* for the additional warranty period in addition to the contract Performance guarantee to be submitted by the contractor.

OR

(iii) The manufacturer, who have established manufacturing and testing facilities in India for the offered equipment(s) based on technological support of a parent company or collaborator and not meeting the requirement stipulated in (i) above, can also be considered provided that:

a) 715/345/220/132kV* or higher Voltage class equipment(s) must have been manufactured in the above Indian works & type tested (as per IS/IEC standard) as on the date of NOA.

b) The parent company or collaborator meets the qualifying requirements stipulated under (i) given above. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply the 765/400/220/132kV* Air Insulated Switchgear (AIS) Equipment(s)* in India, shall be submitted.

c) The parent company/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

Legends:

* : voltage class of respective equipment as applicable.

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

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 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 **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

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 **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.

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

(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 132kVclass 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 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.

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:

345kVor 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	applicable for supply of 400kV class 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	applicable for supply of 132kV class Transformer

or at least three (3) nos. 1-phase Shunt Reactors each having capacity of at least 5 MVAR	

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 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.

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

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 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.

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 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

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

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 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 10% 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 at least 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 10% 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 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 (at least 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 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.

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.

(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 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 bidder.

Note :-

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

24.21 Technical Requirement for 220/132/66 kV* level GIS/Hybrid GIS/MTS Equipment:

(i) The manufacturer whose 220/132/66 kV* level GIS/Hybrid GIS/MTS 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 220/110/66kV* 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.

(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. 220/110/66kV* or above voltage level 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 GIS 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 220/110/66*kV or above voltage level GIS equipment in India shall be submitted.

c) The Collaborator(s) 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 bidder.

Note: 1. (*) voltage class of respective equipment as applicable

2. (@) 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 disconnector and three nos. of single phase CTs / Bushing CTs. GIS means SF6 Gas insulated Switchgear.

3. Experience with combination of GIS CB bay/Hybrid GIS CB Bay/MTS CB Bay is also acceptable if supply of only Hybrid/MTS equipment is envisaged. Hybrid GIS means outdoor SF6 Gas insulated switchgear connected to outdoor Air insulated bus-bar System (AIS bus-bars System), MTS means outdoor SF6 Gas insulated Mixed Technology Switchgear connected to outdoor AIS bus bar system. (**) Type test reports of the collaborator/ parent company/ subsidiary company/ group company shall also be acceptable

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

TECHNICAL SPECIFICATION
SECTION-GENERAL TECHNICAL REQUIREMENTS

पावर ग्रिड कार्पोरेशन आफ 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**

SECTION-GENERAL TECHNICAL REQUIREMENTS (GTR)

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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.

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".

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 µV at 508 kV rms	1000 µV at 266kV rms	1000 µV 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

SL No	Description of parameters	765kV System	400kV System	220kV System
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

SL No	Description of parameters	132 kV System	66kV System	52 kV System	33 kV System	11kV System
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.	Rated Insulation Levels					
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 µV at 92kV rms	-	-	-	-
7.	Minimum creepage distance	3625 mm (4495mm for coastal area)	1813 mm (2248mm for coastal area)	1300mm (1612 mm for coastal area)	900 mm (1116mm for coastal area)	300 mm (372mm for coastal area)

SL No	Description of parameters	132 kV System	66kV System	52 kV System	33 kV System	11kV System
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	3100mm	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.

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

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

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

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

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.

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.

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 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

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

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.

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

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

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 waival, 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.

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.

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.

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

S.No.	PIPE LINE	Base colour	Band colour
Fire Protection System			
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	
Air Conditioning Plant			
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.

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

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.

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:

Normal Voltage	Variation in Voltage	Frequency in HZ	Phase/Wire	Neutral connection
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.

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 :

Sl. No.	Description	Materials
a)	For connecting ACSR conductors/AAC conductors/ Aluminium tube	Aluminum alloy casting, conforming to designation **4600** 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 **4600** 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.

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 ingression of dust and moisture

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

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.

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.

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.

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.

: **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 disconnector 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

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

(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 132kVclass 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:

345kVor above class 3-phase shunt	applicable for supply of 400kV class

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

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

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

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

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.

(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:

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:

Minimum Average Annual Turnover (MAAT) = Cost of the work to be sub-contracted x 1.5 / 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 disconnector and three nos. of single phase CTs / Bushing CTs. GIS means SF6 Gas insulated Switchgear. AIS Means Air Insulated Switchgear.

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

ANNEXURE-A

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,

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.

ANNEXURE-B

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.

ANNEXURE-C

LIST OF GENERAL STANDARDS AND CODES

CODES	TITLE
--	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 Hexafloride
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

ANNEXURE-C

CODES	TITLE
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	Techniquest 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
TRANSFORMERS AND REACTORS	
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

ANNEXURE-C

CODES	TITLE
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

ANNEXURE-C

CODES	TITLE
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

ANNEXURE-C

CODES	TITLE
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)
CIRCUIT BREAKERS	
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
CURRENT TRANSFORMERS, VOLTAGE TRANSFORMERS AND COUPLING CAPACITOR VOLTAGE TRANSFORMERS	
IS-2705- (P1 to P4)	Current Transformers

ANNEXURE-C

CODES	TITLE
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
BUSHING	
IS-2099	Bushings for Alternating Voltages above 1000V
IEC-60137	Insulated Bushings for Alternating Voltages above 1000V
SURGE ARRESTERS	
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
CUBICLES AND PANELS & OTHER RELATED EQUIPMENTS	
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

CODES	TITLE
	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
Disconnecting switches	
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
PLCC and line traps	
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
Protection and control equipment	
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)

CODES	TITLE
	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
MOTORS	
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
Electronic equipment and components	
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
Clamps & connectors	
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
Bus hardware and insulators	
IS: 2121	Fittings for Aluminum and steel cored Al conductors for overhead

CODES	TITLE
	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
Strain and rigid bus-conductor	
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

ANNEXURE-C

CODES	TITLE
ASTM-B 231-81	Concentric - lay - stranded, aluminum 1350 conductors
ASTM-B 221	Aluminum - Alloy extruded bar, road, 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)
Batteries	
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
Battery Charger	
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

ANNEXURE-C

CODES	TITLE
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
Wires and cables	
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 polyethyle 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

ANNEXURE-C

CODES	TITLE
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
AIR conditioning and ventilation	
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

ANNEXURE-C

CODES	TITLE
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
Galvanizing	
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 Galavanizing) 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
Painting	
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
Fire protection system	
--	Fire protection manual issued by tariff advisory committee (TAC) of India
HORIZONTAL CENTRIFUGAL PUMPS	
IS:1520	Horizontal centrifugal pumps for clear, cold and fresh water
IS:9137	Code for acceptance test for centrifugal & axial pumps

ANNEXURE-C

CODES	TITLE
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
DIESEL ENGINES	
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
PIPING VALVES & SPECIALITIES	
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

CODES	TITLE
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
MOTORS & ANNUNCIATION PANELS	
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 (Part-I)	Classification of hazardous areas for electrical 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

ANNEXURE-C

CODES	TITLE
IS:2147	Degree of protection
IS:5	Colour Relay and timers
IS:2959	Contactors
PG Test Procedures	
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
D.G. SET	
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
Steel structures	
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

ANNEXURE-C

CODES	TITLE
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

ANNEXURE-C

CODES	TITLE
Piping and pressure vessels	
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 threated 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 flangesand glanged 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 piple 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
NSI-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
Other civil works standards	

ANNEXURE-C

CODES	TITLE
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
National building code of India 1970	
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)

CODES	TITLE
	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
ACSR MOOSE CONDUCTOR	
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
GALVANISED STEEL EARTHWIRE	
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

CODES	TITLE
Lighting Fixtures and Accessories	
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
Conduits, Accessories and Junction Boxes	
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
Lighting Panels	
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

ANNEXURE-C

CODES	TITLE
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
Electrical Installation	
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
LT SWITCHGEAR	
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

ANNEXURE-C

CODES	TITLE
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.

ANNEXURE-D

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

ANNEXURE-D

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.

ANNEXURE-E

Comprehensive List of Drawing Submission Schedule		
SL.NO.	**DRAWINGS/DOCUMENTS TITLE**	**CATEGORY**
1.00	**DRAWING FOR SWITCHYARD**	
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	DSLP 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 Halll)	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
2.00	**DESIGN CALCULATION**	
2.01	DSLP 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
3.00	**GAS INSULATED SWITCHGEAR**	
3.01	Design Review along with all supporting documents for new design of GIS	A

Comprehensive List of Drawing Submission Schedule		
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
4.00	**AUTOTRANSFORMER**	
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

Comprehensive List of Drawing Submission Schedule		
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
5.00	**REACTOR**	
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
6.0	**NEUTRAL GROUNDING REACTOR (NGR)**	
A	**Air Core NGR**	
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	**Oil Filled Type NGR**	
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
7.00	**CIRCUIT BREAKER**	
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

Comprehensive List of Drawing Submission Schedule		
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
8.00	**ISOLATOR**	
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
9.00	**INSTRUMENT TRANSFORMER (CT/CVT/IVT)**	
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
10.00	**SURGE ARRESTER**	

Comprehensive List of Drawing Submission Schedule		
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
11.00	**BUS POST INSULATOR**	
11.01	GA drawing & GTP	A
11.02	Type Test Reports	A
12.00	**Marshaling Box, Junction Boxes**	
12.01	GA Drawings	A
12.02	Schematic Drawing	A
12.03	Type Test reports	A
13.00	**Conductor, Al Tube & GS Earth Switch**	
13.01	Type Test Reports (if applicable)	A
14.00	**DISC INSULATOR (if applicable)**	
14.01	GA drawing	A
14.02	Type Test Reports	A
15.00	**LONG ROD POLYMER INSULATOR**	
15.01	GA drawing	A
15.02	Type Test Reports	A
16.00	**INSULATOR STRINGS WITH HARDWARE ASSEMBLY**	
16.01	GA DRG	A
16.02	Component drawings	R
16.03	Type Test Reports	A

Comprehensive List of Drawing Submission Schedule		
17.00	**CLAMPS & CONNECTORS**	
17.01	Drawings	A
17.02	Type Test Reports	A
18.00	**HORN GAP FUSE**	
18.01	GA OF HG FUSE	A
18.02	Type Test Reports	A
19.00	**BATTERY AND BATTERY CHARGER**	
19.01	GTP	A
19.02	Drawings	A
19.03	Type Test Reports	A
20.00	**ILLUMINATION**	
20.01	GTP of all types of fittings/fixtures & cotrol 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
21.00	**LT SWITCHGEAR**	
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
22.00	**HT Power Cable**	
22.01	GTP & Catalogue	A
22.02	Type Test Reports	A
23.00	**POWER & CONTROL CABLE**	
23.01	Type Test Reports for Power Cable	A
23.02	**Type Test Reports for Control Cable**	**A**

ANNEXURE-E

Comprehensive List of Drawing Submission Schedule		
24.00	**CONTROL AND RELAY PANELS & SUBSTATION AUTOMATION SYSTEM (SAS)**	
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
25.00	**Visual Monitoring System**	
25.01	GTP/Catalogue of VMS Equipment and Camera	A
25.02	VMS Architectural Drawing	A
26.00	**PLCC EQUIPMENTS**	
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
27.00	**DG SET**	
27.01	GTP	A
27.02	Drawings/manuals	A
28.00	**AIR CONDITIONING & VENTILATION SYSTEM**	

Comprehensive List of Drawing Submission Schedule		
28.01	GTP	A
28.02	Drawings	A
28.03	A/C sizing calculation	A
29.00	**LT TRANSFORMER**	
29.01	GTP	A
29.02	Drawings	A
29.03	Type Test Reports	A
30.00	**FIRE PROTECTION SYSTEM**	
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 stainers (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 quatrzoid 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
31.00	**CONTROL ROOM BUILDING / TRANSIT CAMP /FFPH BUILDING/SWITCHAYRD PANEL ROOM/INDOOR HT SWITCHGEAR ROOM/TOWNSHIP BUILDINGS (AS applicable)**	
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
32.00	**DRAWING FOR GIS BUILDING (if Applicable)**	A
31.01	Architectural drawing	A
a)	Plan, section & elevation	A
b)	Doors & windows schedule	A

Comprehensive List of Drawing Submission Schedule		
31.02	GIS Building Superstructure drawings & design calculation	A
31.03	Civil Construction Drawings	A
31.04	GIS Equipment foundation inside GIS building	A
33.0	**SWITCHYARD CIVIL CONSTRUCTION DRAWING (AS APPLICABLE)**	
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
34.00	**DESIGN, FABRICATION & PROTO CORRECTED DRAWINGS OF ALL TYPES OF TOWERS & BEAMS**	R
35.00	**DESIGN, FABRICATION DRAWINGS FOR EQUIPMENT SUPPORT STRUCTURES**	R
36.00	**MISCELLANEOUS CIVIL DRGS**	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.

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

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

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 Stablizer	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

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

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

Annexure-G

Sl. No	Item / Equipment	Reference document for inspection	Inspection Level
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

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.

ANNEXURE-H

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 applicant 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

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*10^12 ohm.m
Tracking and Erosion test	1000 Hours
Min. Salinity Level withstood during "Artificial Pollution Test using Salt Fog Method"	≥160 kg/m^3
Hydrophobic Recovery Test	HC2 or HC1
Method of Application	Airless Spray
Dry Arc resistance	Tract ≥ 140 seconds Burn Out ≥ 420 seconds

RTV Silicone high voltage insulation coating (HVIC)

Parameters	Requirement
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 (± 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

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^{o}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^{o}C. The coating shall not exhibit any water blisters at the interface between the insulator surface and the coating.

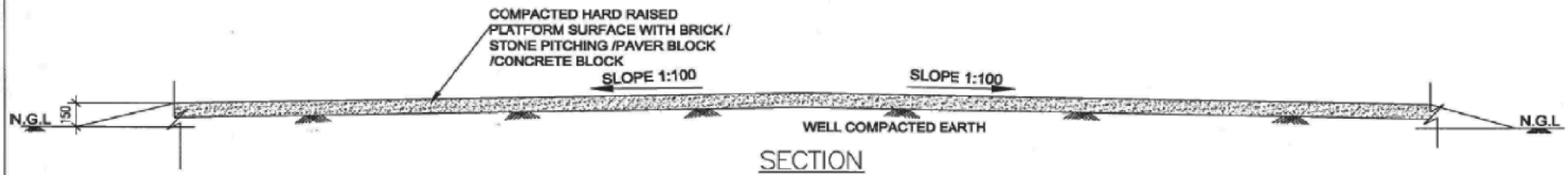
c) High Pressure Water Withstand Test:

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



SECTION

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

11/8/16				11/8/16	POWER GRID CORPORATION OF INDIA LIMITED (A Government of India Enterprise)
ACDE(ENGG CIVIL)	CDE(ENGG CIVIL)	REVD. BY AGM(ENGG CIVIL)	APVD. BY GM(ENGG CIVIL)	DATE	PROJECT: STANDARD DRAWING FOR OPEN PLATFORM
					TITLE: INDICATIVE DRAWINGS FOR OPEN STORAGE PLATFORM
					DRAWING NO. C-ENGG-CVL-STD-PLATFORM-01 SCALE NTS REV 0

ANNEXURE-J

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

Sl. No.	ITEM DESCRIPTION	MAKE
A.	***Substation Accessories [Type Testing is not envisaged]***	
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.	***ACCESSORIES FOR TRANSFORMER & REACTOR [Earlier approved type test reports is applicable and not required to be submitted]***	
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

Sl. No.	ITEM DESCRIPTION	MAKE
		(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.SYJ9-50-25TH]
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.SYJ9-50-25TH]
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

Sl. No.	ITEM DESCRIPTION	MAKE
		(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]
C.	***TESTING EQUIPMENT FOR TRANSFORMER & REACTOR***	
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.

ANNEXURE-K

SL.NO.	Power System Equipment
A	**Power System Equipment**
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	**Telecom Products, Services and Works**
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

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

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

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

S.No	Clause ref	Existing Clause	Proposed Text	Reason/Background for proposed changes
1.	**Clause2.1 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	New Clause Added..
2.	**Clause 2.6**	The bidder shall be responsible for safety of **human and equipment during the working…..**	The **contractor** 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.

			(IEC/Equivalent), as per the specification, shall be accepted.	
4.	**Clause 3.3**	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.	**Clause 3.4**	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.	**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.** 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. 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.**	Changes incorporated In line with recent Guidelines from GOI
6.	**Clause 4.1**	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.	**Switching surge over voltage and power frequency over voltage is specified in the system parameters below**. 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.	**Clause 4.4**	The bidder shall design terminal connectors of the equipment taking into account various forces that are required to withstand.	The ~~bidder~~ 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.	

Major Changes in Section GTR (Rev 15)

<table>
<tr>
<td>8.</td>
<td>Clause 4.6</td>
<td>4.6 System parameters
132kV,66kV,33kV & 11kV System
<table>
<tr><td>S.No</td><td>Description of parameters</td><td>66kV System</td></tr>
<tr><td>9</td><td>Rated Short circuit current</td><td>31.5kA</td></tr>
</table>
</td>
<td>4.6 System parameters
132kV,52kV 66kV,33kV & 11kV System
<table>
<tr><td>S.No</td><td>Description of parameters</td><td>66kV System</td></tr>
<tr><td>9</td><td>Rated Short circuit current</td><td>31.5kA/25kA* for 3 Sec/</td></tr>
<tr><td colspan="3">* For Tertiary loading Equipment’s fault level shall be 25kA for 3 Sec. For Other Switchyards shall be as specified in Section Project

• Further Parameters of 52 kV System is also added
• Sectional Clearance of 66kV System is updated in line with Safety regulation of CEA</td></tr>
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<td></td>
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<tr>
<td>9.</td>
<td>Clause 5.2</td>
<td>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.</td>
<td>The Contractor shall submit ~~4 (four) sets of~~ 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. ~~The contractor shall also submit the softcopy of the above documents in addition to hardcopy~~</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Clause 5.7</td>
<td>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 & layout drawings shall be submitted for the entire substation in case of substation extension also</td>
<td>Approval Procedure
Note (2) All drawings should be submitted in ~~softcopy form~~ 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 & layout drawings shall be submitted for the entire substation in case of substation extension also.

For Civil drawings, associated documents shall be submitted in</td>
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Major Changes in Section GTR (Rev 15)

			STAAD/Excel format as supporting document in DREAMS.	
11.	**Clause 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 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 source of oil/grease /other consumables in the ~~proposal~~ 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.	
12.	**Clause 6.2.4**	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 IS/IEC60947; IS/IEC60529. Type test report of relevant Degree of Protection test, shall be submitted for approval.	IS 13947 is superseded by IS/IEC 60947 IS 12063 is superseded by IS/IEC 60529
13.	**Clause 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, , 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**, 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.	
14.	**Clause 9.2**	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

		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. 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	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. 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	

			<table><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 & Battery Charger</td><td>7</td></tr><tr><td>18</td><td>Conductor & 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> 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	
15.	**Clause no. 9.5**	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 ~~in Compendium of Vendor (COV)~~ **at Annex-J**	
16.	**Clause 12.2**	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 (30km from sea shore approximately) or as specified in Section-**	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 (~~30km from sea shore approximately~~ if defined in Section Project) ~~or as specified in Section Project~~**. For items lower than 6mm thickness requirement of coating thickness shall be as per relevant ASTM. For	

<table>
<tr><td></td><td></td><td>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 as specified in Section-Project</td><td>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 as specified in Section-Project</td><td></td></tr>
<tr><td>17.</td><td>Clause 12.3.2</td><td>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</td><td>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</td><td></td></tr>
<tr><td>18.</td><td>Clause 12.3.6</td><td><table><tr><td>S.No</td><td>PIPE LINE</td><td>BASE COLOUR</td><td>BAND COLOUR</td></tr><tr><td>1</td><td>Hydrant and Emulsifier system pipeline</td><td>Fire red</td><td></td></tr></table></td><td><table><tr><td>S.No</td><td>PIPE LINE</td><td>BASE COLOUR</td><td>BAND COLOUR</td></tr><tr><td>1</td><td>Hydrant and Emulsifier system pipeline /NIFPS</td><td>Fire red</td><td></td></tr></table></td><td></td></tr>
<tr><td>19.</td><td>Clause no. 12.3.8</td><td></td><td>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.</td><td>New Clause added</td></tr>
<tr><td>20.</td><td>Clause No. 13.14</td><td></td><td>Erection, testing and commissioning of Transformers, Reactors, Circuit breakers, Isolators, Substation automation system, Control & protection panels, PLCC, PMU, Telecommunication Equipments, NIFPS System ,</td><td>New Clause added</td></tr>
</table>

<table>
<tr><td></td><td></td><td></td><td>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.</td><td></td></tr>
<tr><td>21.</td><td>Clause no. 15.2</td><td></td><td>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.</td><td>New Clause added</td></tr>
<tr><td>22.</td><td>Clause no. 16.2</td><td>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.</td><td>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.</td><td></td></tr>
<tr><td>23.</td><td>Clause 17.1</td><td>
<table>
<tr><td>S.No</td><td>Description</td><td>Material</td></tr>
<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 mad of</td><td>Bimetallic connectors made from aluminum alloy casting, conforming</td></tr>
</table>
</td><td>
<table>
<tr><th>Sl. No.</th><th>Description</th><th>Materials</th></tr>
<tr><td>a)</td><td>For connecting ACSR conductors/AAC conductors/ Aluminium tube</td><td>Aluminum alloy casting, conforming to designation <s>A6</s> 4600 of IS:617 and all test shall conform to IS:617</td></tr>
</table>
</td><td></td></tr>
</table>

				copper with ACSR conductors/AAC conductors/ Aluminium tube	to designation A6 of IS:617 with 2mm thick bimetallic liner/strip 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 ~~A6~~4600 of IS:617 with 2mm thick bimetallic liner/strip and all test shall conform to IS:617	
24.	**Clause 17.11**	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 i) Temperature rise test (maximum temperature rise allowed is 35°C over 50°C ambient) ii) Short time current test iii) Corona (dry) [for 400kV and above] and RIV (dry) test [for 132kV and above voltage level clamps]						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) ~~[for 400kV and above]~~ and RIV (dry) test [for 132kV and above voltage level clamps] iv) Resistance test and ~~tensile test~~ Pullout strength test v) Cantilever strength test on bus support clamps & connectors	

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

		iv) Resistance test and tensile test		
25.	**Clause 18.1**	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 ~~IS-5039/IS-8623, IEC-60439~~ IS/IEC 61439-0, as applicable, and the clauses given below:	
26.	**Clause 18.2**	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, 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.	

Major Changes in Section GTR (Rev 15)

27.	**Clause 18.4**	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.	**Clause 18.13**	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 **IS/IEC60947** including application of minimum 1KV rms for 1 (one) minute, ~~insulation resistance and functional test~~ after IP-55 test	
29.	**Clause 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. **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.**	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. ~~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~~.	
30.	**Clause 20.14**	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.	**Clause 21.3.2**	All fuses shall be of HRC cartridge type	All fuses shall be of HRC cartridge type conforming to relevant IS	

		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.	**Clause 22.8**	**Tests** 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.	**Clause No. 22.10**		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. **Silicon RTV coating**:- Equipment/insulators (except equipments with polymer insulator) including mandatory spares being supplied at	New Clause added

			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.	**Clause No. 24**	**TECHNICAL REQUIREMENT OF EQUIPMENTS** 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.	**24. TECHNICAL REQUIREMENT OF EQUIPMENTS** **24.1** 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 ar**e not covered under the Bidder's Qualifying** requirement of the Bidding Documents.	
35.	**Clause 24.1**	**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.	**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	

		(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. 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.	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. 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.	
25.	**Clause No. 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 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	**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.	

		(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) 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. 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 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.	(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 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 ~~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	
26.	**Clause No. 24.3**	~~24.3 Technical Requirement for 765kV class Reactor~~	**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	

		~~(i) The Manufacturer whose 765kV Reactor(s) are offered must have designed, manufactured, tested & 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.~~ ~~OR~~ ~~(ii) The Manufacturer must have designed, manufactured, tested & 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 & 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.~~ ~~(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~~	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)	

		~~(iv) 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.~~ ~~(v) 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.~~ ~~(vi) 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.~~	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.	
27.	**Clause 24.4**	**24.4 Technical Requirement for 400kV, 220kV, 132kV and 110kV class Transformer** (i) The manufacturer whose transformer(s) are offered must have designed, manufactured, tested and supplied 400kV/220kV/132kV/110kV* or	**24.4 Technical Requirement for 400kV, 220kV, 132kV ~~and 110kV~~ class Transformer** (i) The manufacturer whose transformer(s) are offered must have designed, manufactured, tested and supplied transformers as per table below:	

		higher voltage class transformers. 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 and 220kV class Transformer)/ 132kV (applicable for supply of 132kV & 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. b) The collaborator meets the requirements stipulated in (i) above. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply	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	

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		400kV/220kV/132kV/110kV* transformer in India, shall be submitted. 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.	requirement stipulated in (i) above, can also be considered provided that a) 220kV (applicable for supply of 400kV ~~and 220kV~~ class Transformer)/ 132kV (applicable for supply of 220kV class Transformer)/ 66kV (applicable for supply of 132kVclass 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~~/110kV~~* transformer in India, shall be submitted. 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.	
28.	**Clause 24.5**	**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	**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:	

		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. (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 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	345kVor 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	applicable for supply of 400kV class 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		

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		Reactor in India, shall be submitted. 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.	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. 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.	
29.	**Clause 24.6**	**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	**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	

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		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 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.	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 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.	
30.	**Clause 24.7**	**24.7 Technical Requirement for 220KV Grade XLPE Power Cables**	**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	

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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**	**24.8 Technical Requirement for 132KV, 110kV, 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, 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. (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	**24.8 Technical Requirement for ~~132KV, 110kV~~, 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, ~~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. 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 ~~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.	

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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.	**Clause No. 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 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	**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 originally scheduled date of bid opening~~ 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	
33.	**Clause No. 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 orhigher grade PVC insulated power cables as on the date of NOA/award. Further themanufacturer 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.	**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~~/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.	**Clause 24.15**	**24.15 Technical Requirements for LT**	**24.15 Technical Requirements for LT Transformer**	

		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 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. ii) Alternatively, the manufacturer, who have established manufacturing and testing facilities in India and not meeting the requirement stipulated in (i) above, can alsobe considered provided that 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. 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.	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~~ 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 630 kVA~~ 315kVA 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. 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	
35.	**Clause 24.16**	**24.16 Technical Requirements for Composite Long Rod Polymer Insulator (765kV & 400kV)** (i) The manufacturer whose Composite Long rod Insulator are	**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	

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		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.	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. 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.	

		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.	**Clause 24.19**	**24.19 Technical Requirement of Communication Equipment** ~~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.~~	**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	
37.	**Clause 24.20**	**24.20 Technical Requirement of "Indian Associate" for execution of on shore supply and services for 765 kV Transformer & Reactor package** 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	.	Clause Deleted
38.	**Clause 24.20**		**24.20 Technical Requirement for 400kV GIS Equipment**	New Clause added

			(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. (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	
39.	**Clause 25.0**		**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)	New Clause added

			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:** 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:	

<table>
<tr><td></td><td></td><td></td><td>Minimum Average Annual Turnover (MAAT) = Cost of the work to be contracted x 1.5/Completion period in years**

**The completion period shall be considered as 1 year even if the same is less than 1 year.</td><td></td></tr>
<tr><td>40.</td><td></td><td></td><td>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.

<table>
<tr><th>S. no</th><th>Voltage class of GIS Package</th><th>Minimum Voltage class Circuit Breaker Equipped of Bay(**)</th></tr>
<tr><td>1</td><td>765kV & 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>
</table>
</td><td>New Clause added</td></tr>
</table>

			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 disconnector and three nos. of single phase CTs / Bushing CTs. GIS means SF6 Gas insulated Switchgear. AIS Means Air Insulated Switchgear. 2. # satisfactory operation means certificate issued by the Owner/Utility certifying the operation without any adverse remark.	
41.	**Section GTR Rev 14 Annexure-A**	Annex-A: Corona and Radio Interface Voltage(RIV) Test		Annexure updated
42.	**Section GTR Rev 14 Para-1 at Annexure-B**		"**The seismic withstanding test on the complete e**quipment (**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**	Annexure updated
43.	**Annexure-D**	List of General Standard/Document for second advance		The Annexure is updated with incorporation of requirement for GIS & EHV cables (

ANNEXURE-L

Major Changes in Section GTR (Rev 15)

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

TECHNICAL SPECIFICATION
SECTION-SWITCHYARD ERECTION

पावर ग्रिड कार्पोरेशन आफ इन्डिया लिमिटेड

(भारत सरकार का उद्यम)

Power Grid Corporation of India Limited

(A Government of India Enterprises)

Document No.: C/ENGG/SPEC/SE (Rev.10) **April 2016**

TECHNICAL SPECIFICATION

SECTION- SWITCHYARD ERECTION
REVISION - 10

SECTION-(SE)
SWITCHYARD ERECTION

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SECTION-(SE)
SWITCHYARD ERECTION

1.0 **GENERAL**

This section covers erection of all equipment such as circuit breakers, isolators, current transformers, voltage transformers, surge arresters etc. This section also covers design, engineering, manufacture, testing at works, supply, insurance, handling, storage, erection, testing and commissioning of supply & erection of following items.

- String insulators and hardware
- AAC / ACSR conductor
- Galvanised Steel Earthwire
- Aluminium Tube
- Spacers
- Bus post insulators
- Earthing & Earthing materials
- Lightning protection materials
- Cabling material
- Other items

2.0 **String Insulators & Hardware**

The insulators for suspension and tension strings shall conform to IEC-60383 and long rod insulators shall conform to IEC-60433. Insulator hardware shall conform to IS:2486**.** Composite long rod polymer insulator shall conform to IEC:61109. Further, the contractor shall supply insulators as per details mentioned below:

A. Tension Insulator String

Sl. No.	System Voltage	Type
1.	765kV, 400kV, 220kV & 132kV (for all substations in coastal, pollution affected areas as identified in Section-Project and for all substations in Northern Region)	Composite Long Rod Polymer with 31mm/kV Creepage
2.	765kV, 400kV, 220kV & 132kV (for substations not covered in 1. above)	Composite Long Rod Polymer/Porcelain/Glass with 31mm/kV Creepage

B. Suspension Insulator String

Sl. No.	System Voltage	Type
1.	765kV, 400kV, 220kV & 132kV (for all substations)	Composite Long Rod Polymer with 31mm/kV Creepage

2.1 Construction Features (Porcelain & Glass Insulators)

2.1.1 Porcelain insulators

a) Suspension and tension insulators shall be wet process porcelain with ball and socket connection. Insulators shall be interchangeable and shall be suitable for forming either suspension or tension strings. Each insulator shall have rated strength, manufacturer's logo, month & year of manufacturing markings on porcelain printed and applied before firing.

b) Porcelain used in insulator manufacturing 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.

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

2.1.2 Glass insulators

It **shall** be made of toughened glass. Glass used for the shells shall be sound, free from defects, flows bubbles, inclusions, etc and be of uniform toughness over its entire surface. All exposed glass surfaces shall be smooth.

2.1.2.1 When operating at normal rated voltage, there shall be no electric discharge between conductor and insulator which would cause corrosion or **damage** to conductors or insulators by the formation of substances due to chemical action.

2.1.2.2 The design of the insulator shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration. All ferrous parts shall be hot dip galvanized in accordance with the latest edition of IS: 2629. The zinc used for galvanizing shall be of grade Zn-99.95 as per IS-209. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux, ash, rust stains bulky white deposits and blisters.

2.1.2.3 Contractor shall make available data on all the essential features of design including the method of assembly of discs and metal parts, number of discs per insulator string, the manner in which mechanical stresses are transmitted through discs to adjacent parts, provision for meeting expansion stresses, results of corona and thermal shock tests, recommended working strength and any special design or arrangement employed to increase life under service conditions.

2.1.3 Hardware Fittings

2.1.3.1 Clamps for insulator strings and Corona Control rings shall be of aluminium alloy as stipulated for clamps and connectors.

2.1.3.2 Insulator hardware shall be of forged steel. Malleable cast iron shall not be accepted except for insulator disc cap. The surface of hardware must be clean, smooth, without cuts, abrasion or projections. No part shall be subjected to excessive localized pressure. The metal parts shall not produce any noise generating corona under operating conditions.

2.1.3.3 The tension Insulator hardware assembly shall be designed for minimum 21000 kg tensile load for 765kV and minimum 12000 kg tensile load for hardware

assembly below 765kV. Earth wire tension clamp shall be designed for minimum 1000 kg tensile load with a factor of safety of two (2).

2.1.3.4 The tension string assemblies shall be supplied alongwith suitable turn buckle. Sag compensation springs if required may also be provided.

2.1.3.5 All hardware shall be bolted type.

2.2 Tests

In accordance with the stipulations of the specification, the suspension and tension strings, insulator and hardware shall be subjected to the following type tests, acceptance tests and routine tests:

2.2.1 **Type Tests on Insulator Strings:** The test reports for following type tests shall be submitted for approval as per clause 9.0 of Section - GTR.

a) Power frequency voltage withstand test with corona control rings **(if applicable)** under wet condition as per IEC- 60383.

b) Switching surge voltage withstand test [400 kV and above class only] under wet condition as per IEC-60383.

c) Lightning Impulse voltage withstand test with corona control rings under dry condition as per IEC-60383

d) Voltage distribution test (Dry) **[applicable for disc insulator string only]**

The voltage across each insulator unit shall be measured by sphere gap method. The result obtained shall be converted into percentage. The voltage across any disc shall not exceed 6.5% for 765 kV suspension and tension insulator strings, 9% and 10% for 400KV suspension string and tension insulator string respectively, 13% for 220KV suspension and tension insulator strings, 20% and 22% for 132KV suspension and tension insulator strings respectively.

e) Corona Extinction Voltage test (Dry) [**220kV** and above class only]

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage **as specified at clause 2.3.2**. There shall be no evidence of Corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IEC 60383.

f) RIV Test (Dry) [**220kV** and above class only]

Under the conditions as specified under (e) above the insulator string alongwith complete hardware fittings shall have a radio interference voltage as **specified in clause 2.3.2 of this section.** The test procedure shall be in accordance with IS 8263/IEC 60437.

g) Mechanical strength test: The test shall be carried out as per following procedure.

The complete insulator string alongwith its hardware fitting excluding arcing horn, corona control ring, grading ring, tension/suspension clamps shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for five minutes and then removed. After removal of the load, the string components shall not show any visual deformation and it shall be possible to dismantle them by hand. Hand tools may be used to remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

2.2.2 Type Tests on String Insulator Units

Type test report for Thermal Mechanical Performance tests **(applicable for porcelain type insulators)** as per IEC-60575, Clause 3 shall be submitted for approval as per clause 9.2 of Section - GTR.

2.2.3 Acceptance Tests for Insulators:

a) Visual examination as per IEC-60383/ IEC-61109 clause no. 7.2 (for composite long rod insulators).

b) Verification of Dimensions as per IEC- 60383.

c) Temperature cycle test as per IEC- 60383.

d) Puncture Test as per IEC-60383 (Applicable only for porcelain insulators).

e) Galvanizing Test as per IEC- 60383.

f) Mechanical performance test as per IEC-60575 Cl. 4 / IEC-61109 clause no. 7.2 (for composite long rod insulators).

g) Test on locking device for ball and socket coupling as per IEC-60372(2).

h) Porosity test as per IEC- 60383 (Applicable only for porcelain insulators).

i) Thermal shock test as per IEC-60383 (Applicable only for glass insulators)

2.2.4 Acceptance Test on Hardware Fitting

a) Visual Examination as per Cl. 5.10 of IS: 2486 (Part-I).

b) Verification of Dimensions as per Cl. 5.8 of IS:2486 (Part-I)

c) Galvanising/Electroplating tests as per Cl. 5.9 of IS:2486 (Part-I).

d) Slip strength test as per Cl 5.4 of IS-2486 (part-I)

e) Shore hardness test **by** the Elastometer

f) Mechanical strength test for each component (including corona control rings and arcing horns).

The load shall be so applied that the component is stressed in the same way as it would be in actual service and the procedure as given in 2.2.1.(g) above should be followed.

g) Test on locking devices for ball and socket coupling as per IEC -60372(2).

2.2.5 Routine Test on Insulator

a) Visual Inspection as per IEC-60383

b) Mechanical Routine Test as per IEC-60383

c) Electrical Routine Test as per IEC-60383

2.2.6 Routine Test on hardware Fittings

a) Visual examination as per Cl 5.10 of IS:2486 (Part-I)

b) Mechanical strength Test as per Cl. 5.11 of IS:2486 (Part-I)

2.2.7 Test during manufacture on all Components as applicable on insulator

a) Chemical analysis of zinc used for galvanising: Samples taken from the zinc ingot shall be chemically analyzed as per IS: 209. The purity of zinc shall not be less than 99.95%.

b) Chemical Analysis, mechanical hardness tests and magnetic particle inspection for malleable casting:

The chemical analysis, hardness tests and magnetic particle inspection for malleable casting will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding tests will be as discussed and mutually agreed to by the Contractor and Employer in Quality Assurance Program.

2.2.8 Test during manufacture on all components as applicable on hardware fittings:

a) Chemical analysis of zinc used for galvanising:

Samples taken from the zinc ingot shall be chemically analyzed as per IS:209. The purity of zinc shall not be less than 99.95%

b) Chemical analysis, hardness tests and magnetic particle for Forgings/ **fabricated hardware:**

The chemical analysis, hardness tests and magnetic particle inspection for forgings/fabricated hardware will be as per the internationally recognized procedures for these tests. The sampling will be based on heat number and heat treatment batch. The details regarding tests will be as discussed and mutually agreed to by the Contractor and Employer in Quality Assurance Programme.

2.3 Guaranteed technical Particular For

2.3.1 Disc Insulators

Sl. No.	Description	For 765kV	For 400/220/132kV
a)	Type of insulators	Anti Fog type	Anti Fog type
b)	Physical Size of insulator units		
(i)	Diameter of Disc	As per IEC	As per IEC
(ii)	Ball to ball spacing between discs	170 mm	145 mm
c)	Electro mechanical strength	210 kN	120 kN
d)	Minimum Creepage distance of individual insulator units	460 mm	430 mm
e)	Markings		
i)	For Porcelain insulators	Markings on porcelain	Markings on porcelain
ii)	For toughened glass insulators	Markings shall be done on initial parts	Markings shall be done on initial parts
f)	Power frequency puncture withstand voltage	1.3 times the actual wet flashover voltage	1.3 times the actual wet flashover voltage

2.3.2 INSULATOR STRING

Sl. No.	Description	765 kV	400kV	220kV	132kV
a)	Power frequency withstand voltage of the complete string with corona control ring (wet) – KV rms	870	680	460	275
b)	Lightning impulse withstand Voltage of string with corona control rings (dry) - kVp	± 2100	± 1550	± 1050	± 650
c)	Switching surge withstand voltage of string with corona control rings (wet) - kVp	± 1550	± 1050	NA	NA
d)	Minimum corona extinction voltage level of string with Corona Control rings (dry) - kV rms	508	320	156	NA
e)	Maximum RIV level in micro volts of string with Corona Control rings across 300 Ohms resistor at 1 MHz	1000 (Max) at 508 kV	1000 (Max) at 320 kV	1000 (Max) at 156 kV	NA
f)	**Minimum total creepage distance of the insulator string (mm)**	**24800**	**13020**	**7595**	**4495**
g)	**Minimum no. of discs per string (for tension string if applicable)**	**54**	**31**	**18**	**11**

h)	Electromechanical strength of Insulator Unit. (KN)	210	120	120	120

For tension application:-

Double insulator strings for 765kV, 400kV, 220kV and single insulator strings for 132 kV systems shall be used.

For suspension application:-

V-type polymer insulator string shall be used for 765kV system and single suspension polymer insulator string shall be used for 400kV, 220kV & 132 kV systems.

2.4 COMPOSITE LONG ROD POLYMER INSULATOR

Bidder shall offer composite long rod polymer insulators with suitable hardware fittings.

2.4.1 Details of Composite Long Rod Insulators

2.4.1.1 Insulators shall have sheds of the "open aerodynamic profile without any under ribs" with good self-cleaning properties. Insulator shed profile, spacing projection etc. shall be strictly in accordance with the recommendation of IEC-60815.

2.4.1.2 Ball and socket shall be 20mm designation for 120kN & 24mm designation for 210kN Insulators in accordance with the standard dimensions stated in IEC:60120/ IS:2486 (Part-II). Insulators shall be interchangeable and shall be suitable for forming either suspension or tension strings. Each insulator shall have laser markings on housings for manufacturer's name, month & year of manufacturing, rated strength markings on each composite insulator rod unit. No negative tolerance shall be applicable to creepage distance of composite insulators

2.4.1.3 **All ferrous parts shall be hot dip galvanized as per Section-GTR with minimum weight of zinc coating as 610 gm/sq.m for normal area and 900 gm/sq.m for coastal area as specified in Section-Project.**

2.4.2 Material

2.4.2.1 **Core**

It shall be a glass-fiber reinforced (FRP) epoxy resin rod of high strength. The rod shall be resistant to hydrolysis. The rod shall be of electrical grade corrosion resistant (ECR), boron free glass and shall exhibit both high electrical integrity and high resistance to acid corrosion.

2.4.2.2 **Housing & Weathersheds**

The FRP rod shall be covered by a sheath of a silicone rubber compound of a thickness of minimum **5mm**. The housing & weathersheds should have silicon content of minimum 30% by weight. It should protect the FRP rod against environmental influences, external pollution and humidity. It shall be extruded or directly molded on the core. The interface between the housing and the core must be uniform and without voids. The strength of the bond shall be greater than the tearing strength of the polymer. The manufacturer shall follow non-

destructive technique (N.D.T.) to check the quality of jointing of the housing interface with the core.

The weathersheds of the insulators shall be of alternate shed profile. The weathersheds shall be vulcanized to the sheath (extrusion process) or molded as part of the sheath (injection moulding process) and free from imperfections. The vulcanization for extrusion process shall be at high temperature and for injection moulding shall be at high temperature & high pressure. Any seams/ burrs protruding axially along the insulator, resulting from the injection moulding process shall be removed completely without causing any damage to the housing. The track resistance of housing and shed material shall be class 1A4.5 according to IEC60587. The strength of the weathershed to sheath interface shall be greater than the tearing strength of the polymer. The composite insulator shall be capable of high pressure washing.

2.4.2.3 **End Fittings**

End fittings transmit the mechanical load to the core. They shall be made of malleable cast iron/ spheroidal graphite or forged steel. They shall be connected to the rod by means of a controlled compression technique. The manufacturer shall have in-process Acoustic emission arrangement or some other arrangement to ensure that there is no damage to the core during crimping. This verification shall be in-process and done on each insulator. The system of attachment of end fitting to the rod shall provide superior sealing performance between housing and metal connection. The gap between fitting and sheath shall be sealed by a flexible silicone rubber compound. The sealing shall stick to both housing and metal end fitting. The sealing must be humidity proof and durable with time.

End fittings shall have suitable provisions for fixing grading rings at the correct position as per design requirements.

2.4.2.4 **Grading Rings**

Grading rings shall be used at both ends of each composite insulator unit for reducing the voltage gradient on and within the insulator and to reduce TV noise to acceptable levels. The size and placement of the metallic grading rings shall be designed to eliminate dry band arcing/corona cutting/ exceeding of permissible electrical stress of material. The insulator supplier shall furnish design calculations using appropriate electric field software showing electric field at surface of housing, inside housing & core and at the interface of housing and metal fittings with the proposed placement and design of corona **rings**. Grading rings shall be capable of installation and removal with hot line tools without disassembling any other part of the insulator assembly.

The design & supply of grading rings shall be in the scope of the composite insulator supplier.

2.4.3 Tests

2.4.3.1 **Type Tests**

The test reports for following type tests on long rod units, components, materials or complete strings shall be submitted for approval as per clause 9.2 of Section - GTR.

2.4.3.1.1 **On the complete composite Long Rod Polymer Insulator String with Hardware Fittings**:-

a) Power frequency voltage withstand test with corona control rings/grading ring and arcing horns (if provided) under wet condition as per IEC:60383-1993.

b) Switching surge voltage withstand test under wet condition as per IEC:60383-1993.

c) Impulse voltage withstand test under dry condition as per IEC:60383-1993

d) Corona and RIV test under dry condition. [132kV and above class only]

The sample assembly when subjected to power frequency voltage shall have a corona extinction voltage as specified in clause 2.3.2 of this section There shall be no evidence of Corona on any part of the sample. The atmospheric condition during testing shall be recorded and the test results shall be accordingly corrected with suitable correction factor as stipulated in IEC 60383.

Under the conditions as specified above the insulator string alongwith complete hardware fittings shall have a radio interference voltage level **as** specified at specified in clause 2.3.2 of this section. The test procedure shall be in accordance with IS 8263/IEC-60437.

e) Mechanical Strength test: The test shall be carried out as per following procedure.

The complete insulator string alongwith its hardware fitting excluding arcing horn, corona control ring, grading ring, tension/suspension clamps shall be subjected to a load equal to 50% of the specified minimum ultimate tensile strength (UTS) which shall be increased at a steady rate to 67% of the minimum UTS specified. The load shall be held for five minutes and then removed. After removal of the load, the string components shall not show any visual deformation and it shall be possible to dismantle them by hand. Hand tools may be used to remove cotter pins and loosen the nuts initially. The string shall then be reassembled and loaded to 50% of UTS and the load shall be further increased at a steady rate till the specified minimum UTS and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

f) Salt-fog pollution withstand test as per IEC: 60507. The salinity level for composite long rod insulators shall be 160 Kg/m3 NaCl.

2.4.3.1.2 **On Composite Polymer Insulator Units**

a) Tests on interfaces and connections of metal fittings as per IEC: 61109-2008.

b) Assembled core load time test as per IEC: 61109-2008.

c) Damage limit proof test and test of tightness of interface between end firings and insulator housing as per IEC: 61109-2008

d) High Pressure washing test

The washing of a complete insulator of each E&M rating is to be carried out at 3800 kPa with nozzles of 6 mm diameter at a distance of 3m from nozzles to the insulator, the washing shall be carried out for 10minutes. There shall be no damage to the sheath or metal fitting to housing interface. The verification shall be done by 1 minute wet power frequency withstand test at 680kV r.m.s for 400KV.

e) Brittle fracture resistance test

The test arrangement shall be according to Damage limit proof test with simultaneous application of 1N-HNO3 acid directly in contact with naked FRP rod. The contact length of acid shall not be less than 40mm and thickness around the core not less than 10mm.The rod shall withstand 80% of SML for 96 hours.

f) Dye penetration test as per IEC: 61109-2008

g) Water diffusion test as per IEC: 61109-2008

h) Tracking and erosion test as per IEC: 61109-2008.

i) Hardness test as per IEC: 61109-2008.

j) Accelerated weathering test as per IEC: 61109-2008.

k) Flammability test as per IEC: 61109-2008.

l) Silicone content test

Minimum content of silicone shall be 30% and the same shall be verified through FT-IR spectroscopy & TGA analysis or any other approved/ acceptable method.

m) Recovery of Hydrophobicity test

1. The surface of selected samples shall be cleaned with isopropyl alcohol. Allow the surface to dry and spray with water. Record the HC classification. Dry the sample surface.

2. Treat the surface with corona discharges to destroy the hydrophobicity. This can be done utilizing a high frequency corona tester, Holding the electrode approximately 3mm from the sample surface, slowly move the electrode over an area approximately 1" x 1". Continue treating this area for 2 – 3 minutes, operating the tester at maximum output.

3. Immediately after the corona treatment, spray the surface with water and record the HC classification. The surface should be hydrophilic, with an HC value of 6 or 7. If not, dry the surface and repeat the corona treatment for a longer time until an HC of 6 or 7 is obtained. Dry the sample surface.

4. Allow the sample to recover and repeat the hydrophobicity measurement at several time intervals. Silicone rubber should recover to HC 1 – HC 2 within 24 to 48 hours, depending on the material and the intensity of the corona treatment.

n) Torsion test

Three complete insulators of each electrical and mechanical rating shall be subjected to a torsional load of 55Nm. The torsional strength test shall be made with test specimen adequately secured to the testing machine. The torsional load shall be applied to the test specimen through a torque member so constructed that the test specimen is not subjected to any cantilever stress. The insulator after torsion test must pass the Dye Penetration Test as per IEC 61109.

o) Accelerated ageing test of 5000hrs as described in appendix-C of IEC 61109 or Test at multiple stresses of 5000 hrs as described in Annex-B of IEC - 62217

2.4.3.2 **Acceptance Tests:**

For Composite Long Rod Polymer Insulators

a.	Verification of dimensions	IEC : 61109-2008
b.	Galvanizing test	IEC : 60383
c.	Verification of end fittings	IEC : 61109-2008
d.	Recovery of Hydrophobicity	As per **Cl. 2.4.3.1.2.m)** above
e.	Verification of tightness of interface between end fittings and insulator housing and of specified mechanical load	IEC : 61109-2008
f.	Silicone content test	As per **Cl. 2.4.3.1.2.l)** above
g.	Brittle fracture resistance test	As per **Cl. 2.4.3.1.2.e)** above
h.	Dye penetration test	IEC : 61109-2008
i.	Water diffusion test	IEC : 61109-2008

In the event of failure of the sample to satisfy the acceptance test(s) specified in **2.4.3.2** above, the **re-test** procedure shall be as per IEC 61109.

2.4.3.3 **Routine Tests**

For Composite Long Rod Polymer Insulator Units

a)	Visual Examination	As per IEC:61109-2008
b)	Mechanical routine test	As per IEC:61109 -2008

2.4.4 **Guaranteed Technical Particulars for Composite Long Rod Polymer Insulators**

The technical parameters for composite long rod polymer insulator string shall be same of the insulator string specified in clause 2.3.2 of this section.

3.0 AAC / ACSR CONDUCTOR

3.1 Details of AAC Conductor

3.1.1 The Conductor shall conform to IEC: 61089/IS: 398 (Part V) - 1992 except where otherwise specified herein.

The contractor shall supply the conductor as per the standard guaranteed technical particulars enclosed in Annexure-E of the technical specification, Section – Switchyard Erection and separate approval for **guaranteed technical particulars** is not required during detailed engineering.

3.2 Details of ACSR Conductor

3.2.1 The Conductor shall conform to IEC: 61089/IS: 398 (Part V) - 1992 except where otherwise specified herein.

3.2.2 The details of the ACSR Bersimis, ACSR Moose, ACSR Zebra and ACSR Panther conductors shall be as per the standard guaranteed technical particulars enclosed in Annexure-E of the technical specification, Section – Switchyard Erection and separate approval for **guaranteed technical particulars** is not required during detailed engineering.

3.**3** Workmanship

3.3.1 The finished conductor shall be smooth, compact, uniform and free from all imperfections including kinks (**protrusion** of wires), wire cross over, over riding, looseness (wire being dislocated by finger/hand pressure and/or unusual bangle noise on tapping), material inclusions, white rust, powder formation or black spot (on account of reaction with trapped rain water etc.), dirt, grit etc.

3.3.2 All the Aluminium and steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, diemarks, scratches, abrasions, etc., after drawing.

3.3.3 The steel strands shall be hot dip galvanised and shall have a minimum zinc coating as indicated in the guaranteed technical particulars. The zinc coating shall be smooth, continuous and of uniform thickness, free from imperfections and shall withstand minimum three dips in standard Preece test. The steel wire rods shall be of such quality and purity that, when drawn to the size of the strands specified and coated with zinc, the finished strands and the individual wires shall be of uniform quality and have the same properties and characteristics as prescribed in IEC: 60888.

3.3.4 The steel strands shall be preformed and post formed in order to prevent spreading of strands in the event of cutting of composite core wire. Care shall be taken to avoid, damages to galvanisation during pre-forming and post-forming operation.

3.4 Joints in Wires

3.4.1 Aluminium Wires

3.4.1.1 During stranding, no aluminium wire welds shall be made for the purpose of achieving the required conductor length.

3.4.1.2 No joints shall be permitted in the individual wires in the outer most layer of the finished conductor. However joints are permitted in the inner layer of the conductor unavoidably broken during stranding, provided such breaks are not associated with either inherently defective wire or with the use of short lengths of aluminium wires. Such joints shall not be more than four (4) per conductor length and shall not be closer than 15 meters from joint in the same wire or in any other aluminium wire of the completed conductor.

3.4.1.3 Joints shall be made by cold pressure butt welding and shall withstand a stress of not less than the breaking strength of individual strand guaranteed.

3.4.2 Steel Wires

There shall be no joint of any kind in the finished wire **used for** the **manufacturing** of the strand. There shall also be no strand joints or strand splices in any length of the completed stranded steel core of the conductor.

3.5 Tolerances

The manufacturing tolerances to the extent indicated in the guaranteed technical particulars shall be permitted in the diameter of individual aluminium and steel strands and lay-ratio of the conductor.

3.6 Materials

3.6.1 Aluminium

The aluminium strands shall be hard drawn from electrolytic aluminium rods having purity not less than 99.5% and a copper content not exceeding 0.04%. They shall have the same properties and characteristics as prescribed in IEC:60889.

3.6.2 **Steel**

The steel wire strands shall be drawn from high carbon steel wire rods produced by either the acid or the basic open-hearth process, the electric furnace process, or the basic oxygen process and shall conform to the chemical composition indicated in the guaranteed technical particulars.

The Steel wire strands shall have the same properties and characteristics as prescribed for regular strength steel wire in IEC: 60888.

3.6.3 **Zinc**

The zinc used for galvanising shall be electrolytic High Grade Zinc of 99.95% purity. It shall conform to and satisfy all the requirements of IS:209 -1979.

3.7 **Standard Length**

3.7.1 The conductor shall be supplied as required. No joint shall be allowed within a single span of stringing, jumpers and equipment interconnection.

3.8 Tests:

3.8.1 The following type, acceptance & routine tests and tests during manufacturing shall be carried out on the conductor.

3.8.1.1 **Type Tests**

In accordance with the stipulation of specification, the following type tests reports of the conductor shall be submitted for approval as per clause 9.2 of Section -GTR.

a)	UTS test on stranded conductor.	
b)	Corona extinction voltage test (dry)	As per Annexure-A
(c)	Radio Interference voltage test (dry)	
(d)	DC resistance test on stranded conductor	

3.8.1.2 **Acceptance Tests**

a)	Visual check for joints, scratches etc. and lengths of conductor	As per Annexure - A
b)	Dimensional check on steel and aluminium strands	
c)	Check for lay ratios of various layers	-do-
d)	Galvanising test on steel strands	
e)	Torsion and Elongation test on steel strands	
f)	Breaking load test on steel and aluminium strands	
g)	Wrap test on steel and aluminium strands	As per IEC:60888 & 60889
h)	DC resistance test on aluminium strands	As per IEC:60889
i)	UTS test on welded joint of aluminium strands	As per Annexure - A

NOTE:

All the above tests except test mentioned at (a) shall be carried out on aluminium and steel strands after stranding only.

3.8.1.3 **Routine Tests**

a) Check to ensure that the joints are as per specification.

b) Check that there are no cuts, fins etc. on the strands.

c) All acceptance tests as mentioned above to be carried out on each coil/drum (as applicable).

3.8.1.4 **Tests During Manufacture**

a)	Chemical analysis of zinc used for galvanising	As per Annexure - A
b)	Chemical analysis of aluminium used for making aluminium strands	
c)	Chemical analysis of steel used for making steel strands	

4.0 Galvanised Steel Earth wire

4.1 Details of Earth wire

4.1.1 The galvanised steel earth wire shall generally conform to the specification of ACSR core wire as mentioned in IEC:60888/IS: 398 (Part-II)-1976 except where otherwise specified herein.

The contractor shall supply the earthwire as per the standard guaranteed technical particulars enclosed in Annexure-E of the technical specification, Section – Switchyard Erection and separate approval **for guaranteed technical particulars** is not required during detailed engineering.

4.2 Workmanship

4.2.1 All steel strands shall be smooth, uniform and free from all imperfections, such as spills and splits, die marks, scratches, abrasions and kinks after drawing and also after stranding.

4.2.2 The finished material shall have minimum brittleness as it will be subjected to appreciable vibration while in use.

4.2.3 The steel strands shall be hot dip qalvanised and shall have minimum Zinc coating after stranding, as stipulated in guaranteed technical particulars attached with. The zinc coating shall be smooth, continuous, of uniform thickness, free from imperfections. The steel wire rod shall be of such quality and purity that, when drawn to the size of the strands specified and coated with zinc, the finished strands shall be of uniform quality and have the same properties and characteristics as prescribed in ASTM designation B498-74.

4.2.4 The steel strands shall be preformed and post formed in order to prevent spreading of strands while cutting of composite earth wire. Care shall be taken to avoid damage to galvanisation during preforming and postforming operation.

4.2.5 To avoid susceptibility towards wet storage stains (white rust), the finished material shall be provided with a protective coating of boiled linseed oil.

4.3 Joints in Wires

There shall be no joints of any kind in the finished steel wire strand entering into the manufacture of the earth wire. There shall be no strand joints or strand splices in any length of the completed stranded earth wire.

4.4 Tolerances

The manufacturing tolerance to the extent of the limits as stipulated in guaranteed Technical Particulars attached with this specification shall only be permitted in the diameter of the individual steel strands and lay length of the earth wire.

4.5 **Materials**

4.5.1 Steel

The steel wire strands shall be drawn from high carbon steel rods and the chemical composition shall conform to the requirements as stipulated in Guaranteed Technical Particulars attached with.

4.5.2 Zinc

The zinc used for galvanising shall be electrolytic High Grade Zinc. It shall conform to and satisfy all the requirements of IS: 209 -1979.

4.6 Standard Length

4.6.1 The standard length of the earth wire shall be as stipulated in Guaranteed Technical Particulars attached with, with the specified tolerance on standard length.

4.8 **TESTS**

4.8.1 The following type, routine & acceptance tests and tests during manufacturing shall be carried out on the earthwire.

4.8.2 **TYPE TESTS**

In accordance with the stipulation of specification, the following type tests reports of the earthwire shall be submitted for approval as per clause 9.2 of Section - GTR.

a)	UTS test	)	
		)	As per Annexure - B
b)	DC resistance test	)	

4.8.3 **ACCEPTANCE TESTS**

a)	Visual check for joints, scratches etc. and length of Earthwire	)	
b)	Dimensional check	)	As per Annexure - B
c)	Galvanising test	)	
d)	Lay length check	)	

e)	Torsion test	)	
f)	Elongation test	)	
g)	Wrap test	)	IS:398 (Part-III) - 1976
h)	DC resistance test	)	
i)	Breaking load test	)	
j)	Chemical Analysis of steel	)	

4.8.4 **ROUTINE TESTS**

a) Check that there are no cuts, fins etc. on the strands.

b) Check for correctness of stranding.

4.8.5 **TESTS DURING MANUFACTURE**

a)	Chemical analysis of zinc used for galvanising	)	As per Annexure - B
b)	Chemical analysis of steel	)	

5.0 **ALUMINIUM TUBE**

5.1 **General**

Aluminium used shall be grade 63401 WP (range 2) conforming to IS:5082.

The contractor shall supply the aluminium tubes as per the standard guaranteed technical particulars enclosed in Annexure-E of **this section** and separate approval **for guaranteed technical particulars** is not required during detailed engineering.

5.2 **Constructional Features**

5.2.1 For outer diameter (OD) & thickness of the tube there shall **not** be **any negative** tolerance, other requirements being as per IS: 2678 and IS: 2673.

5.2.2 The welding of aluminium tube shall be done by the qualified welders duly approved by the Employer.

5.3 **Tests**

In accordance with stipulations of the specification, Routine tests shall be conducted on tubular bus conductors as per IS:5082. Also the wall thickness and ovality of the tube shall be measured.

5.4 **Technical Parameters**

Sl. No.	Description	3" AL. TUBE	4" AL. TUBE	4.5" AL. TUBE	5" AL. TUBE
1.	Type	3" IPS	4" IPS	4.5" IPS	5" IPS

		(EH Type)	(EH Type)	(EH Type)	(H Type)
2.	Outer diameter	88.9 mm	114.2 mm	120.00 mm	141.30 mm
3.	Thickness	7.62 mm	8.51 mm	12.00 mm	9.53 mm
4.	Cross-sectional area of aluminium	1945.76 sq.mm	2825.61 sq.mm	4071.50 sq.mm	3945.11 sq.mm
5.	Weight	5.25 kg/m	7.7 kg/m	11.034 kg/m	10.652 kg/m

Sl. No.	Description	6" AL. TUBE	8" AL. TUBE	10" AL. TUBE
1.	Type	6" IPS (H Type)	8" IPS (H Type)	10" IPS (H Type)
2.	Outer diameter	150 mm	202 mm	252 mm
3.	Thickness	10 mm	16 mm	17 mm
4.	Cross-sectional area of aluminium	4398.2 Sq mm	9349.3 sq.mm	12550.6 sq.mm
5.	Weight	11.875 kg/m	25.243 kg/m	33.887 kg/m

6.0 EARTHING CONDUCTORS

6.1 General

All conductors burried in earth and concrete shall be of mild steel. All conductors above ground level and earthing leads shall be of galvanised steel, except for cable trench earthing. The minimum sizes of earthing conductor to be used are as indicated in clause 9.4 of this Section.

6.2 Constructional Features

6.2.1 Galvanised Steel

a) Steel conductors above ground level shall be galvanised according to IS:2629.

b) The minimum weight of the zinc coating shall be **610** gm/sq.m **for normal area and 900 gm/sq.m for coastal area as specified in Section-Project** and minimum thickness shall be 85 microns.

c) The galvanised surfaces shall consist of a continuous and uniformly thick coating of zinc, firmly adhering to the surfaces 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 surfaces, 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.

6.3 Tests

In accordance with stipulations of the specifications galvanised steel shall be subjected to four one minute dips in copper sulphate solution as per IS : 2633.

7.0 SPACERS

7.1 General

Spacers shall conform to IS: 10162. The spacers are to be located at a suitable spacing to limit the short circuit forces as per IEC -60865. Wherever Employer's 765kV, 400 kV, 220kV & 132kV standard gantry structures are being used, the spacer span(s) for different conductor / span configurations and corresponding short circuit forces shall be as per Annexure-D. For strung buses, flexible type spacers shall be used whereas for jumpers and other connections rigid type spacers shall be used. All quad/twin conductors between equipments/ bus shall be provided with at least one spacer.

Wherever Employer's 765kV, 400 kV, 220kV & 132kV standard gantry structures are not being used, necessary spacer span calculation shall be provided by the contractor during detailed engineering for the approval of Employer.

7.2 Constructional Features

7.2.1 No magnetic material shall be used in the fabrication of spacers except for GI bolts and nuts.

7.2.2 Spacer design shall be made to take care of fixing and removing during installation and maintenance.

7.2.3 The design of the spacers shall be such that the conductor does not come in contact with any sharp edge.

7.3 Tests

Each type of spacers shall be subjected to the following type tests, acceptance tests and routine tests:

7.3.1 **Type Tests: Following type test reports shall be submitted for approval as per clause 9.2 of Section - GTR.**

a) **Clamp slip tests**

The sample shall be installed on test span of twin conductor bundle string or quadruple conductor bundle string (as applicable) at a tension of 44.2 kN. One of the clamps of the sample when subjected to a longitudinal pull of 2.5 kN parallel to the axis of the conductor shall not slip on the conductor. The permanent displacement between the conductor and the clamp of sample measured after removal of the load shall not exceed 1.0 mm. Similar tests shall be performed on the other clamps of the same sample.

b) Fault current test as per Cl 5.14.2 of IS: 10162. Alternately, the same can be carried by simulated short circuit method for which compressive forces shall be based on IEC-60865.

c) Corona Extinction Voltage Test (Dry).

This test shall be performed on 765 kV, 400 kV and 220 kV spacers as per procedure mentioned at Annexure - C, Minimum Corona Extinction voltage shall be as per clause 2.3.2.

d) RIV Test (Dry)

This test shall be performed as per procedure mentioned at Annexure - C, Maximum RIV levels shall be as per clause 2.3.2.

e) Resilience test (if applicable)

f) Tension Test

g) Log decremant test (if applicable)

h) Compression test

i) Galvanising test

7.3.2 **Acceptance Test (As per IS:10162)**

a) Visual examination

b) Dimensional verification

c) Movement test

d) Clamp slip test

e) Clamp bolt torque test (if applicable)

f) Assembly torque test

g) Compression test

h) Tension test

i) Galvanising test

j) Hardness test for neoprene (if applicable)

The shore hardness of different points on the elastometer surface of cushion grip clamp shall be measured by shore hardness meter. It shall be between 65 to 80.

k) Ultimate Tensile Strength Test

The UTS of the retaining rods shall be measured. It shall not be less than 35 kg/Sq. mm.

7.3.3 **Routine test**

a) Visual examination

b) Dimensional verification

8.0 **BUS POST INSULATORS**

The post insulators shall conform in general to latest IS: 2544, IEC-60168, IEC 60273 and IEC-60815.

SECTION - (SE)
SWITCHYARD ERECTION

8.1 **Constructional Features**

8.1.1 Bus Post insulators shall consist of a porcelain part permanently secured in a metal base to be mounted on the supporting structures. They shall be capable of being mounted upright. They shall be designed to withstand any shocks to which they may be subjected to by the operation of the associated equipment. Only solid core insulators will be acceptable.

8.1.2 Porcelain used shall be homogeneous, free from lamination, cavities and other flaws or imperfections that might affect the mechanical or dielectric quality and shall be thoroughly vitrified, tough and impervious to moisture.

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

8.1.4 The insulator shall have alternate long and short sheds with aerodynamic profile, The shed profile shall also meet the requirements of IEC-60815 for the specified pollution level.

8.1.5 When operating at normal rated voltage there shall be no electric discharge between conductor and insulators which would cause corrosion or damage to conductors or insulators by the formation of substance produced by chemical action.

8.1.6 The design of the insulators shall be such that stresses due to expansion and contraction in any part of the insulator shall not lead to deterioration.

8.1.7 All ferrous parts shall be hot dip galvanised in accordance with the latest edition of IS: 2633, & IS: 2629. The zinc used for galvanising shall be grade Zn 99.95 as per IS: 209. The zinc coating shall be uniform, adherent, smooth, reasonably bright, continuous and free from imperfections such as flux ash, rust stains, bulky white deposits and blisters. The metal parts shall not produce any noise generating corona under the operating conditions.

8.1.8 a) Every bolt shall be provided with a hop dip galvanised steel washer under the nut so that part of the threaded portion of the bolts is within the thickness of the parts bolted together.

b) Flat washer shall be circular of a diameter 2.5 times that of bolt and of suitable thickness. Where bolt heads/nuts bear upon the beveled surfaces they shall be provided with square tapered washers of suitable thickness to afford a seating square with the axis of the bolt.

c) All bolts and nuts shall be of steel with well formed hexagonal heads forged from the solid and shall be hot dip galvanised. The nuts shall be good fit on the bolts and two clear threads shall show through the nut when it has been finally tightened up.

8.1.9 Bidder shall furnish drawings for the essential design features of assembly of shells and metal parts, and number of shells per insulator.

8.2 **Tests**

In accordance with the stipulations of the specification, the post insulators shall be subjected to type, acceptance, sample and routine tests as per IEC-60168.

8.2.1 In accordance with the stipulation of specification, the following **type tests** reports of the post insulators shall be submitted for approval as per clause 9.2 of Section - GTR.

a) Power frequency withstand test (dry & wet)

b) Lightning impulse test (dry)

c) Switching impulse test (wet) (For 420 kV and above class Insulator only)

d) Measurement of R.I.V (Dry) (As per Annexure – C)

e) Corona extinction voltage test (Dry) (As per Annexure – C)

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f) Test for deflection under load

g) Test for mechanical strength.

8.**2.2** In addition to acceptance/sample/routine tests as per IEC-60168, the following tests shall also be carried out.

a) Soundness test, metallurgical tests and magnetic particle Inspection **(MPI)** test on MCI/SGI caps as acceptance test.

b) All hot dip galvanised components shall be subjected to check for uniformity of thickness and weight of zinc coating on sample basis as an acceptance test.

c) The bending test shall be carried out at 50% minimum cantilever strength load in four directions as a routine test and at 100% minimum cantilever strength load in four directions as an acceptance test.

d) Acceptance norms for visual defects allowed at site and also at works shall be agreed in the Quality plan.

8.3 **Technical Parameters of Bus Post Insulators.**

Sl. No.	**Description**	**800 kV**	**420 kV**	**245 kV**	**145 kV**
a)	Type	Solid Core	Solid Core	Solid Core	Solid Core
b)	Voltage Class (kV)	800	420	245	145
c)	Dry and wet one minute power frequency withstand voltage (kV rms)	830	680	460	275
d)	Dry lightning impulse withstand Voltage (kVp)	±2100	±1425	±1050	±650
e)	Wet switching surge withstand voltage (kVp)	±1550	±1050	—	—
f)	Max. radio interference voltage (in microvolts) - **Dry**	1000 at 508 kV	500 at 305 kV	500 at 156 kV	500 at 105 kV
g)	Corona extinction voltage (kV rms) (min.)	508	320	156	105

h)	Cantilever Strength				
(i)	Total minimum cantilever strength (Kg)	800	800	800	600
i)	Minimum torsional moment	As per IEC-60273	As per IEC-60273	As per IEC-60273	As per IEC-60273
j)	Total height of insulator (mm)	5700	3650	2300	1500
k)	P.C.D Top (mm)	225	127	127	127
	Bottom (mm)	325	300	254	254
l)	No. of bolts				
	Top	4	4	4	4
	Bottom	8	8	8	8
m)	Diameter of bolt/holes (mm)				
	Top	M16	M16	M16	M16
	Bottom dia	18	18	18	18
n)	Pollution level as per IEC-60815	Heavy(III)	Heavy(III)	Heavy(III)	Heavy(III)
o)	Minimum total creepage distance for Heavy Pollution (mm)	20000	10500	6125	3165

8.3.1 If corona extinction voltage is to be achieved with the help of corona ring or any other similar device, the same shall be deemed to be included in the scope of the Contractor. Aluminium used for corona ring shall be of grade 63401 or 19501 conforming to IS:5082.

9.0 **EARTHING**

9.1 The earthing shall be done in accordance with requirements given hereunder and drawing titled 'Earthing Details' enclosed with the specification. The spacing for the main earthmat shall be provided by the Employer and the earthmat layout drawings shall be prepared by the contractor based on the spacing provided by the Employer. The resistivity of the stone for spreading over the ground shall be considered as 3000 ohm-m under wet condition. The resistivity measurement of stone (to be used for stone spreading) shall also be done by the Contractor to confirm the minimum resistivity value of stone considered in earth mat design. For measurement purpose, one sample of stones from each source (in case stones are supplied from more than one source) shall be used. The main earthmat shall be laid in the switchyard area in accordance with the approved earthmat layout.

9.2 Neutral points of systems of different voltages, metallic enclosures and frame works associated with all current carrying equipments and extraneous metal works associated with electric system shall be connected to a single earthing system unless stipulated otherwise.

9.3 Earthing and lightning protection system installation shall be in strict accordance with the latest editions of Indian Electricity Rules, relevant Indian Standards and Codes of practice and Regulations existing in the locality where the system is installed.

a) Code of practice for Earthing IS: 3043

b) Code of practice for the protection of Building and allied structures against lightning IS: 2309.

c) CEA Safety Regulations 2010 & Indian Electricity Act 2003 with latest amendments.

d) National Electricity Safety code IEEE-80.

9.4 **Details of Earthing System**

Sl. No.	Item	Size	Material
a)	Main Earthing Conductor to be buried in ground	40mm dia	Mild Steel rod as per IS:2062/ SAE1018
b)	Conductor above ground& earthing leads (for equipment)	75x12mm G.S. flat	Galvanised Steel
c)	Conductor above ground& earthing leads(for columns & aux. structures)	75x12mm G.S. flat	Galvanised Steel
d)	Earthing of indoor LT panels, Control panels and outdoor marshalling boxes, Junction boxes& Lighting Panels etc.	50x6 mm G.S. flat	Galvanised Steel
e)	Rod Earth Electrode	40mm dia, 3000mm long	Mild Steel as per IS:2062/ SAE1018
f)	Pipe Earth Electrode (in treated earth pit) as per IS.	40mm dia, 3000mm long	Galvanised steel
g)	Earthing for motors	25x3mm GS flat	Galvanised steel
h)	Earthing conductor along outdoor cable trenches	50x6mm MS flat	Mild steel as per IS:2062/ SAE1018
I)	Earthing of Lighting Poles (for lighting poles outside switchyard)	40 mm dia 3000 mm long	Mild steel rod as per IS:2062/ SAE1018
j)	Isolator MOM Box	75X12 mm GS flat & Flexible copper braid	Galvanised steel and copper braid

The sizes of the earthing conductor indicated above are the minimum sizes.

9.5 **Earthing Conductor Layout**

9.5.1 Earthing conductors in outdoor areas shall be buried at least 600 mm below finished ground level unless stated otherwise.

9.5.2 Wherever earthing conductor crosses cable trenches, underground service ducts, pipes, tunnels, railway tracks etc., it shall be laid minimum 300 mm below them and shall be circumvented in case it fouls with equipment/structure foundations.

9.5.3 Tap-connections from the earthing grid to the equipment/structure to be earthed shall be terminated on the earthing terminals of the equipment/structure as per "Standard Earthing Details **–** Drg No. **C/ENG/STD/EARTHINGS/09**" enclosed**.**

9.5.4 Earthing conductors or leads along their run on cable trench, ladder, walls etc. shall be supported by suitable welding/cleating at intervals of 750 mm. Wherever it passes through walls, floors etc., PVC sleeves shall be provided for the passage of the conductor and both ends of the sleeve shall be sealed to prevent the passage of water through the sleeves.

9.5.5 Earthing conductor around the building shall be buried in earth at a minimum distance of 1500 mm from the outer boundary of the building.

9.5.6 Earthing conductors crossing the road shall be laid 300mm below road or at greater depth to suit the site conditions.

9.5.7 Earthing conductors embeded in the concrete shall have approximately 50mm concrete cover.

9.**6** **ELECTRO-MAGNETIC FIELD CONTROL**

The contractor shall provide galvanised steel earth wire at 8m level in the area where three interconnection levels (equipment interconnection, bus & jack bus interconnection) are present at 765kV switchyard to limit electric and magnetic field within permissible limit.

9.7 **Equipment and Structure Earthing**

9.7.1 Earthing pads shall be provided for the apparatus/equipment at accessible position. The connection between earthing pads and the earthing grid shall be made by two short earthing leads (one direct and another through the support structure) free from kinks and splices. In case earthing pads are not provided on the item to be earthed, same shall be provided in consultation with Employer.

9.7.2 Whether specifically shown in drawings or not, steel/RCC columns, metallic stairs etc. shall be connected to the nearby earthing grid conductor by two earthing leads. Electrical continuity shall be ensured by bonding different sections of hand-rails and metallic stairs.

9.7.3 Metallic pipes, conduits and cable tray sections for cable installation shall be bonded to ensure electrical continuity and connected to earthing conductors at regular interval. Apart from intermediate connections, beginning points shall also be connected to earthing system.

9.7.4 Metallic conduits shall not be used as earth continuity conductor.

9.7.5 Wherever earthing conductor crosses or runs along metallic structures such as gas, water, steam conduits, etc. and steel reinforcement in concrete it shall be bonded to the same.

9.7.6 Light poles, junction boxes on the poles, cable and cable boxes/glands, lockout switches etc. shall be connected to the earthing conductor running alongwith the supply cable which in turn shall be connected to earthing grid conductor at a minimum two points whether specifically shown or not.

9.7.7 Railway tracks within switchyard area shall be earthed at a spacing of 30m and also at both ends.

9.7.8 Earthing conductor shall be buried 2000 mm outside the switchyard fence. All the gates and every alternate post of the fence shall be connected to earthing grid.

The stone spreading shall also be done 2000 mm outside switchyard fence. The criterian for stone spreading shall be followed in line with requirement specified elsewhere in the specification

9.7.9 Flexible earthing connectors shall be provided for the moving parts.

9.7.10 All lighting panels, junction boxes, receptacles fixtures, conduits etc. shall be grounded in compliance with the provision of I.E. rules

9.7.11 A continuous ground conductor of 16 SWG GI wire shall be run all along each conduit run. The conductor shall be connected to each panel ground bus. All junction boxes, receptacles, switches, lighting fixtures etc. shall be connected to this 16 SWG ground conductor.

9.7.12 50mm x 6mm MS flat shall run on the top tier and all along the cable trenches and the same shall be welded to each of the racks. Further this flat shall be earthed at both ends and at an interval of 30 mtrs. The M.S. flat shall be finally painted with two coats of Red oxide primer and two coats of Zinc riched enamel paint.

9.7.13 One number 40 mm dia, 3000 mm long MS earth electrode with test link, CI frame and cover shall be provided to connect each down conductor of surge arresters, capacitive voltage transformers, lightning masts and towers with peak.

9.8 **Jointing**

9.8.1 Earthing connections with equipment earthing pads shall be bolted type. Contact surfaces shall be free from scale, paint, enamel, grease, rust or dirt. Two bolts shall be provided for making each connection. Equipment bolted connections, after being checked and tested, shall be painted with anti corrosive paint/compound.

9.8.2 Connection between equipment earthing lead and main earthing conductors and between main earthing conductors shall be welded type. For rust protections, the welds should be treated with red oxide primer and afterwards coated with two layers bitumen compound to prevent corrosion.

9.8.3 Steel to copper connections shall be brazed type and shall be treated to prevent moisture ingression.

9.8.4 Resistance of the joint shall not be more than the resistance of the equivalent length of the conductor.

9.8.5 All ground connections shall be made by electric arc welding. All welded joints shall be allowed to cool down gradually to atmospheric temperature before putting any load on it. Artificial cooling shall not be allowed.

9.8.6 All arc welding with large dia. conductors shall be done with low hydrogen content electrodes.

9.8.7 The 75x12mm GS flat shall be clamped with the equipment support structures at 1000mm interval.

9.9 **Power Cable Earthing**

Metallic sheaths and armour of all multi core power cables shall be earthed at both equipment and switchgear end. Sheath and armour of single core power cables shall be earthed at switchgear end only.

9.10 **Specific Requirement for Earthing Systems**

9.10.1 Each earthing lead from the neutral of the power transformer/Reactor shall be directly connected to two numbers pipe electrodes in treated earth pit (as per IS) which in turn, shall be buried in Cement Concrete pit with a ISI marked cast iron cover hinged to a cast iron frame to have an access to the joints. All accessories associated with transformer/reactor like cooling banks, radiators etc. shall be connected to the earthing grid at minimum two points.

9.10.2 Earthing terminal of each lightning arrester & capacitor voltage transformer shall be directly connected to rod earth electrode which in turn, shall be connected to station earthing grid.

9.10.3 Auxiliary earthing mat comprising of 40mm dia M.S. rods closely spaced (300 mm x 300 mm) conductors shall be provided at depth of 300mm from ground level below the operating handles of the M.O.M. Box of the isolators. M.O.M. boxes shall be directly connected to the auxiliary earthing mat. Flexible copper braid connection to be provided between MOM box and GI flat to take care of soil sagging. The size of auxiliary earthing mat shall be of 1500mmx1500mm size for 220kV and above voltage class isolators and 900mmx900mm size for 132kV and below voltage class isolators. Factory welded auxiliary earthmat is preferable.

9.11 **Insulating mats**

9.11.1 The scope covers supply and laying of insulating mats of "class A" conforming to IS: 15652-2006.

9.11.2 These insulating mats shall be laid in front of all floor mounted AC and DC switchboards and control & relay panels located in control room building/ Switchyard panel room.

9.11.3 The insulating mats shall be made of elastomer material free from any insertions leading to deterioration of insulating properties. It shall be resistant to acid, oil and low temperature.

9.11.4 Upper surface of the insulating mats shall have small aberration (rough surface without edges) to avoid slippery effects while the lower surface shall be plain or could be finished slip resistant without affecting adversely the dielectric property of the mat.

9.11.5 Insulating mat **(wherever applicable)** shall be of pastable type, to be fixed permanently on the front of the panels except for the chequered plate area which shall not be pasted as per requirement. The insulating mats shall generally be fixed and joints shall be welded as per recommendations in Annexure-A of IS: 15652.

9.11.6 Width of insulating mats shall generally be of 1.5 meters or as per site requirements. Length shall be supplied as per site requirements.

9.11.7 The insulating mats offered shall conform to IS: 15652-2006.

10.0 **Bus Bars**

The brief description of the bus switching scheme, bus bar layout and equipment connection to be adopted are indicated elsewhere in the specification. The bus bar arrangements are shown in electrical layout drawings enclosed with the bid documents.

10.1 The Contractor shall furnish supporting calculations where the design is to be done by the contractor for the bus bars/conductors to show adequacy of design parameters for:

a) Fibre-stress (applicable for aluminum tube)

b) Cantilever strength of post insulators (applicable for aluminum tube)

c) Aeolain vibrations (applicable for aluminum tube)

d) Vertical deflection of bus bars (applicable for aluminum tube)

e) Short circuit forces in bundle conductor and spacer location for each span of ACSR conductor stringing as per layout drawings.

10.1.1 The welds in the aluminium tubes shall be kept to the minimum and there shall not be more than one weld per span. The procedure and details of welding shall be subject to Employer's approval. Material for welding sleeve shall be same as that of Aluminium tube. Welding sleeve shall be of 600mm length

10.1.2 Corona bells shall be provided wherever the bus extends beyond the clamps and on free ends, for sealing the ends of the tubular conductor against rain and moisture and to reduce the electrostatic discharge loss at the end points. There shall be a small drain hole in the corona bell. The material of Corona bell shall be Aluminium alloy similar to that of clamps & connectors.

10.1.3 To minimise the vibrations in the aluminium tubes, damping conductor shall be provided inside the aluminium tubes. For this purpose, the cut pieces of ACSR conductor which otherwise are considered wastages, shall be used as damping conductor.

10.1.4 Details of past experience of the persons proposed to be employed for Aluminium tube welding and the test reports of the welded pieces to prove the electrical and mechanical characteristics shall also be furnished **to Employer**. Welding at site shall be done by adopting a qualified procedure and employing qualified welders as per ASME-Section IX.

10.1.5 Joints shall be avoided in strung bus to avoid joint failure / hot spots and hardwares to be designed accordingly.

11.0 **BAY EQUIPMENT**

11.1 The disposition of various bay equipments shall be as per single line diagrams and layout drawings.

11.2 Bay Marshalling Kiosk:-

Bay marshalling kiosk shall be fabricated from 304 grade stainless steel of minimum thickness of 1.6mm. For other constructional details, technical specification of section-GTR shall be referred. Further, for stainless steel type bay marshaling kiosk, no painting is envisaged.

One no. of bay marshalling kiosk shall be provided for each 765 kV, 400 kV, 220 kV and 132 kV bay under present scope. For one and half breaker scheme, one number bay marshalling kiosk shall be provided for each controlling feeder (Line/ transformer/ bus reactor etc) of the diameter and no bay marshalling kiosks are required to be provided for the tie bays. In addition to the requirements specified elsewhere in the specification, the bay marshalling kiosk shall have two distinct compartments for the following purpose:-

A. For 765kV , 400 kV & 220 kV Bays

(i) To receive two incoming 415V, 3 phase, 63Amps, AC supply with auto changeover and MCB unit and distribute minimum nine (9) numbers outgoing 415V, 3 phase, 16 Amps AC supplies controlled by MCB.

(ii) To distribute minimum two numbers outgoing 415V, 63Amps three phase supplies to be controlled by MCB to be drawn from above 3 phase incomers for supply to switchyard panel rooms.

(iii) To distribute minimum ten numbers outgoing 240V, 10 Amps single phase supplies to be controlled by MCB to be drawn from above 3 phase incomers.

(iv) Necessary Terminal Blocks for terminating cables from ACDB and necessary heating circuits.

B. For 132kV & 66 kV Bays

(i) To receive two incoming 415V, 3 phase, 63Amps, AC supply with auto changeover and MCB unit and distribute minimum four (4) number outgoing 415V, 3 phase, 16 Amps AC supplies controlled by MCB.

(ii) To distribute minimum six (6) numbers outgoing 240V, 10 Amps single phase supplies to be controlled by MCB to be drawn from above 3 phase incomers.

(iii) 100 nos. terminal blocks in vertical formation for interlocking facilities for substations without automation system.

(iv) Necessary Terminal Blocks for terminating cables from ACDB and necessary heating circuits.

11.**3** Further, all Bay Marshalling Kiosks shall be erected such that a minimum height of 1000mm is maintained between FGL & bottom of the marshalling box. Size of Marshalling box shall be such that cables are properly terminated and wires are dressed with provision of loop.

11.4 **BAY AND PHASE IDENTIFICATION**

11.4.1 The name plate for the bays shall be provided by the contractor as per standard drawing (Drawing no. C/ENG/STD/BAY NAME PLATE) enclosed in this technical specification.

11.4.2 All the phases are to be identified by painting the structures Red, Yellow and Blue by reflecting colour as per as built condition. Phase identification colour is to be provided around the top of the structure with colour band of 100 mm width at a height of approximately 2000mm from the finished ground level.

12.0 **LIGHTNING PROTECTION**

12.1 Direct stroke lightning protection (DSLP) shall be provided in the EHV switchyard by lightning masts and shield wires**.** The layout drawings enclosed indicate the tentative arrangement. The final arrangement shall be decided after approval of the DSLP calculations.

12.2 The lightning protection system shall not be in direct contact with underground metallic service ducts and cables.

12.3 Conductors of the lightning protection system shall not be connected with the conductors of the safety earthing system above ground level.

12.4 Down conductors shall be cleated on the structures at 2000 mm interval.

12.5 Connection between each down conductor and rod electrodes shall be made via test joint (pad type compression clamp) located approximately 1500 mm above ground level. The rod electrode shall be further joined with the main earthmat.

12.6 Lightning conductors shall not pass through or run inside G.I. conduits.

12.7 Lightning protection shall also be provided for various buildings like control building, FFPH, Township buildings as per relevant standard.

13.0 **EQUIPMENT ERECTION DETAILS**

13.1 All circuit breaker and isolator erection shall be done under the supervision of equipment manufacturer and erection of all switchyard equipments shall be done as per POWERGRID approved Field Quality Plan (FQP) and as per provision of Technical Specification.

13.2 For equipment interconnection, the surfaces of equipment terminal pads, Aluminium tube, conductor & terminal clamps and connectors shall be properly cleaned. After cleaning, contact grease shall be applied on the contact surfaces of equipment terminal pad, Aluminium tube/conductor and terminal clamps to avoid any air gap in between. Subsequently bolts of the terminal pad/terminal connectors shall be tightened and the surfaces shall be cleaned properly after equipment interconnection.

13.3 Muslin or leather cloth shall be used for cleaning the inside and outside of hollow insulators.

13.4 All support insulators, circuit breaker interrupters and other fragile equipment shall preferably be handled with cranes having suitable booms and handling capacity.

13.5 Bending of Aluminium tube and compressed air piping if any should be done by a bending machine and through cold bending only. Bending shall be such that inner diameter of pipe is not reduced.

All welding done at site for equipment and structures, shall be painted with zinc rich paint immediately to avoid corrosion.

13.6 Cutting of the pipes wherever required shall be such as to avoid flaring of the ends. Hence only a proper pipe cutting tool shall be used. Hack saw shall not be used.

13.7 Handling of equipment shall be done strictly as per manufacturer's/supplier's

instructions/instruction manual.

13.8 Handling equipment, sling ropes etc. should be tested periodically before erection for strength.

13.9 The slings shall be of sufficient length to avoid any damage to insulator due to excessive swing, scratching by sling ropes etc.

14.0 **STORAGE**

14.1 The Contractor shall provide and construct adequate storage shed as per the Filed Quality Plan for proper storage of equipments, where sensitive equipments shall be stored indoors. All equipments during storage shall be protected against damage due to acts of nature or accidents. The storage instructions of the equipment manufacturer/Employer shall be strictly adhered to. POWERGRID approved Field Quality Plan shall be followed alongwith the provision of Technical Specification for storage.

15.0 **CABLING MATERIAL**

15.1 **CABLE TAGS AND MARKERS**

15.1.1 Each cable and conduit run shall be tagged with numbers that appear in the cable and conduit schedule.

15.1.2 The tag shall be of aluminium with the number punched on it and securely attached to the cable conduit by not less than two turns of 20 SWG GI wire conforming to IS:280. Cable tags shall be of rectangular shape for power cables and of circular shape for control cables.

15.1.3 Location of cables laid directly underground shall be clearly indicated with cable route marker made of galvanised iron plate.

15.1.4 Location of underground cable joints shall be indicated with cable **route** marker with an additional inscription "Cable joints".

15.1.5 The **cable route** marker shall project 150 mm above ground and shall be spaced at an interval of 30 meters and at every change in direction. They shall be located on both sides of road and drain crossings as per relevant standard.

15.1.6 Cable tags shall be provided on all cables at each end (just before entering the equipment enclosure), on both sides of a wall or floor crossing, on each duct/conduit entry and at each end & turning point in cable tray/trench runs. Cable tags shall be provided inside the switchgear, motor control centres, control and relay panels etc., wherever required for cable identification, where a number of cables enter together through a gland plate.

15.2 **Cable Supports and Cable Tray Mounting Arrangements**

15.2.1 The Contractor shall provide embedded steel inserts on concrete floors/walls to secure supports by welding to these inserts or available building steel structures.

15.2.2 The supports shall be fabricated from standard structural steel members.

15.2.3 Insert plates will be provided at an interval of 750 mm wherever cables are to be supported without the use of cable trays, such as in trenches, while at all other

places these will be at an interval of 2000 mm.

15.2.4 Vertical run of cables on equipment support structure shall be supported on perforated cable trays of suitable width which shall be suitably bolted/clamped with the equipment support structure.

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15.3 **Cable Termination and Connections**

15.3.1 The termination and connection of cables shall be done strictly in accordance with cable and termination kit manufacturer's instructions, drawing and/or as directed by the Employer.

15.3.2 The work shall include all clamping, fittings, fixing, plumbing, soldering, drilling, cutting, taping, heat shrinking (where applicable), connecting to cable terminal, shorting and grounding as required to complete the job.

15.3.3 Supply of all consumable material shall be in the scope of Contractor.

15.3.4 The equipment will be generally provided with undrilled gland plates for cables/conduit entry. The Contractor shall be responsible for drilling of gland plates, painting and touching up. Holes shall not be made by gas cutting.

15.3.5 Control cable inside control panel/switchgear/MCCB/MCC/ miscellaneous panels shall be neatly bunched, clamped and tied with nylon strap or PVC perforated strap to keep them in position.

15.3.6 The Contractor shall use printed ferrules for control cable cores at all terminations, as instructed by the Employer. Each cable wire shall be identified with a number and detailed cable schedule may be prepared indicating the wire numbers.

15.3.7 Spare cores shall be similarly encaped & tagged with cable numbers and coiled up with end cap.

15.3.8 All cable entry points shall be sealed and made vermin and dust proof. Unused openings shall be effectively closed.

15.3.9 Double compression type nickel plated (coating thickness not less than 10 microns) brass cable glands shall be provided by the Contractor for all power and control cables to provide dust and weather proof terminations.

15.3.10 The cable glands shall conform to BIS:6121. They shall comprise of heavy duty brass casting, machine finished and nickel plated, to avoid corrosion and oxidation. Rubber components used in cable glands shall be neoprene and of tested quality. Cable glands shall be of approved make.

15.3.11 The cable glands shall also be suitable for dust proof and weather proof termination.

15.3.12 If the cable-end box or terminal enclosure provided on the equipment is found unsuitable and requires modification, the same shall be carried out by the Contractor, as directed by the Employer.

15.3.13 Crimping tool used shall be of approved design and make.

15.3.14 Control Cable lugs shall be tinned copper solderless crimping type conforming to

IS-8309 & 8394. Aluminium Bimetallic lugs for power cables as required shall be used depending upon type of cables and terminations.

15.3.15 Solderless crimping of terminals shall be done by using corrosion inhibitory compound. The cable lugs shall suit the type of terminals provided.

15. 4 **Storage and handling of Cable Drums**

15.4.1 Cable drums shall be unloaded, handled and stored in an approved manner and rolling of drums shall be avoided as far as possible. For short distances, the drums may be rolled provided they are rolled slowly and in proper direction as marked on the drum.

16.0 **DIRECTLY BURIED CABLES**

16.1 The Contractor shall construct the cable trenches required for directly buried cables. The scope of work shall include excavation, preparation of sand bedding, soil cover, supply and installation of brick or concrete protective covers, back filling and ramming, supply and installation of route markers and joint markers.

16.2 The cable (power and control) between LT station, DG set location and fire lighting pump house and control room shall be laid in the burried cable trenches. In addition to the above, for lighting purpose also, buried cable trench can be used in outdoor area.

16.3 Power cables from Main Switchboard to colony shall be laid in burried cable trench. Location of cable termination point at colony shall be as per site condition and shall be decided in consultation with Employer's site-in-charge. Power Cables for oil filtration plant shall be laid in open cable trench or burried trench upto transformer/reactor area and can be looped from adjacent receptacles provided for power supply of oil filtration plant.

16.4 Cable route and joint markers and RCC warning covers shall be provided wherever required. The voltage grade of cables shall be engraved on the marker. Cable markers shall be grounded in a concrete base.

17.0 **INSTALLATION OF CABLES**

17.1 Cabling in the control room shall be done on ladder type cable trays for vertical runs while cabling in switchyard area shall be done on angles in the trench.

17.2 All cables from bay cable trench to equipments including and all interpole cables (both power and control) for all equipment, shall be laid in PVC pipes of minimum 50 mm nominal outside diameter of class 4 as per IS 4985 which shall be buried in the ground at a depth of 250mm below finish formation level. Separate PVC pipes shall be laid for control and power cables. Cable pull boxes of adequate size shall be provided if required. **For vertical runs on equipments, perforated cable trays shall be provided for all equipments under scope of the contract or any equipment to be provided by the owner (including for owner supplied circuit breakers)**.

17.3 Cables shall be generally located adjoining the electrical equipment through the pipe insert embedded in the floor. In the case of equipments located away from cable trench either pipe inserts shall be embedded in the floor connecting the cable trench and the equipment or in case the distance is small, notch/opening on the wall shall be provided. In all these cases necessary bending radius as

recommended by the cable manufacturer shall be maintained. Embedded pipes shall be dressed properly at the equipment termination points.

17.4 Cable racks and supports shall be painted after installation with two coats of metal primer (comprising of red oxide and zinc chromate in a synthetic medium) followed by two finishing coats of aluminium paint. The red oxide and zinc chromate shall conform to IS:2074.

17.5 Suitable arrangement should be used between fixed pipe/cable trays and equipment terminal boxes, where vibration is anticipated.

17.6 Power and control cables in the cable trench shall be laid in separate tiers. The order of laying of various cables shall be as follows, for cables other than directly buried.

a) Power cables preferably on top tiers.
b) Control instrumentation and other service cables in bottom tiers.
c) For cabling from control room to switchyard in main cable trench, cable shall be laid such that bottom tiers are preferably filled first and top tiers are kept for filling future cables as per the instructions of Engineer-In-Charge.

17.7 For Single core cables in trefoil formation shall be laid with a distance of three times the diameter of cable between trefoil centre lines. Further, for horizontal cables a minimum centre to centre distance equal to twice the diameter of the cable of higher size of cables shall be maintained.

17.8 Trefoil clamps for single core cables shall be of pressure die cast aluminium (LM-6), Nylon-6 or fibre glass and shall include necessary fixing GI nuts, bolts, washer etc. These are required at every 2 metre of cable runs.

17.9 Power and control cables shall be securely fixed to the trays/supports with self locking type nylon ties with de-interlocking facility at every 5 metre interval for horizontal run. Vertical and inclined cable runs shall be secured with 25 mm wide and 2 mm thick aluminium strip clamps at every 2m.

17.10 Cables shall not be bent below the minimum permissible limit. The permissible limits are as follows:

Table of Cable and	Minimum bending radius
Power cable	12 D
Control cable	10 D

D is overall diameter of cable

17.11 Where cables cross roads, drains and rail tracks, these shall be laid in reinforced spun concrete or steel pipes buried at not less than one metre depth. The size of hume/steel pipe shall be such that approximately 70% area is only occupied. For meeting future requirement, additional hume/steel pipe shall be laid for future bay provision.

17.12 In each cable run some extra length shall be kept at a suitable point to enable one (for LT cables)/ two (for H.T. cables) straight through joints to be made in case the cable develop fault at a later date.

17.13 Selection of cable drums for each run shall be so planned as to avoid using straight through joints. Cable splices will not be permitted except where called for

by the drawings, unavoidable or where permitted by the Employer. If straight through joints are unavoidable, the Contractor shall use the straight through joints kit of reputed make.

17.14 Control cable terminations inside equipment enclosures shall have sufficient lengths so that changing of termination in terminal blocks can be done without requiring any splicing.

17.15 Metal screen and armour of the cable shall be bonded to the earthing system of the station, wherever required by the Employer.

17.16 Rollers shall be used at intervals of about two metres while pulling cables to avoid damage.

17.17 All due care shall be taken during unreeling, laying and termination of cable to avoid damage due to twist, kinks, sharp bends, etc.

17.18 Cable ends shall be kept sealed to prevent damage. In cable vault, fire resistant seal shall be provided underneath the panels.

17.19 Inspection on receipt, unloading and handling of cables shall generally be in accordance with IS:1255 and other Indian Standard Codes of practices.

17.20 Wherever cable pass through floor or through wall openings or other partitions, GI/PVC wall sleeves with bushes having a smooth curved internal surface so as not to damage the cable, shall be supplied, installed and properly sealed by the Contractor at no extra charges.

17.21 In case the outer sheath of a cable is damaged during handling/installation, the Contractor shall repair it at his own cost to the satisfaction of the Employer. In case any other part of a cable is damaged, the same shall be replaced by a healthy cable at no extra cost to the Employer, i.e. the Contractor shall not be paid for installation and removal of the damaged cable.

17.22 All cable terminations shall be appropriately tightened to ensure secure and reliable connections. The Contractor shall cover the exposed part of all cable lugs whether supplied by him or not with insulating tape, sleeve or paint.

17.23 **Cable trays**

i) The cable trays shall be of G.S Sheet and minimum thickness of sheet shall be 2mm.

ii) The Contractor shall perform all tests and inspection to ensure that material and workmanship are according to the relevant standards. Contractor shall have to demonstrate all tests as per specification and equipment shall comply with all requirements of the specification.

a) Test for galvanising (Acceptance Test)
The test shall be done as per approved standards.

17.24 **Conduits, Pipes and Duct Installation**

17.24.1 Contractor shall supply and install all rigid conduits, mild steel pipes, flexible conduits, hume pipes etc. including all necessary sundry materials such as tees, elbows, check nuts, bushing, reducers, enlargers, coupling cap, nipples, gland

sealing fittings, pull boxes etc as required. The size of the conduit/pipe shall be selected on the basis of 40% fill criterion.

17.24.2 Contractor shall have his own facility for bending, cutting and threading the conduits at site. Cold bending should be used. All cuts & threaded ends shall be made smooth without leaving any sharp edges. Anticorrosive paint shall be applied at all field threaded portions.

17.24.3 All conduit/pipes shall be extended on both sides of wall/floor openings. The fabrication and installation of supports and the clamping shall be included in the scope of work by Contractor.

17.24.4 Installation of optical cables/ special cables:

GI pipe (light grade) of suitable size (minimum 25 mm) along with required bends, joints etc. shall be used for special cables such as cables for visual monitoring system (VMS), substation automation system (SAS). Further, single pipe can be used for laying multiple cables.

17.24.5 All conduits/pipes shall have their ends closed by caps until cables are pulled. After cables are pulled, the ends of conduits/pipes shall be sealed in an approved manner to prevent damage to threaded portions and entrance of moisture and foreign material.

17.24.6 All unarmoured cables shall run within the conduits from lighting panels to lighting fixtures, receptacles etc.

17.24.7 Size of conduit for lighting shall be selected by the Contractor during detailed engineering.

17.24.8 Exposed conduits shall be run in straight lines parallel to building columns, beams and walls. Unnecessary bends and crossings shall be avoided to present a neat appearance.

17.24.9 Conduit supports shall be provided at an interval of 750mm for horizontal runs and 1000mm for vertical runs.

17.24.10 Conduit supports shall be clamped on the approved type spacer plates or brackets by saddles or U- bolts. The spacer plates or brackets in turn, shall be securely fixed to the building steel by welding and to concrete or brick work by grouting or by nylon rawl plugs. Wooden plug inserted in the masonary or concrete for conduit support is not acceptable.

17.24.11 Embedded conduits shall be securely fixed in position to preclude any movement. In fixing embedded conduit, if welding or brazing is used, extreme care should be taken to avoid any injury to the inner surface of the conduit.

17.24.12 Spacing of embedded conduits shall be such as to permit flow of concrete between them.

17.24.13 Where conduits are placed alongwith cable trays, they shall be clamped to supporting steel at an interval of 600mm.

17.24.14 For directly embedding in soil, the conduits shall be coated with an asphalt-base compound. Concrete pier or anchor shall be provided wherever necessary to support the conduit rigidly and to hold it in place.

17.24.15 Conduit shall be installed in such a way as to ensure against trouble from trapped condensation.

17.24.16 Conduits shall be kept, wherever possible, at least 300mm away from hot pipes, heating devices etc. when it is evident that such proximity may reduce the service life of cables.

17.24.17 Slip joints shall be provided when conduits cross structural expansion joints or where long run of exposed conduits are installed, so that temperature change will cause no distortion due to expansion or contraction of conduit run.

17.24.18 For long conduit run, pull boxes shall be provided at suitable intervals to facilitate wiring.

17.24.19 Conduit shall be securely fastened to junction boxes or cabinets, each with a lock nut inside and outside the box.

17.24.20 Conduits joints and connections shall be made thoroughly water-tight and rust proof by application of a thread compound which insulates the joints. White lead is suitable for application on embedded conduit and red lead for exposed conduit.

17.24.21 Field bends shall have a minimum radius of four (4) times the conduit diameter. All bends shall be free of kinks, indentations of flattened surfaces. Heat shall not be applied in making any conduit bend. Separate bends may be used for this purpose.

17.24.22 The entire metallic conduit system, whether embedded or exposed, shall be electrically continuous and thoroughly grounded. Where slip joints are used, suitable bounding shall be provided around the joint to ensure a continuous ground circuit.

17.24.23 After installation, the conduits shall be thoroughly cleaned by compressed air before pulling in the wire.

17.24.24 Lighting fixtures shall not be suspended directly from the junction box in the main conduit run.

17.25 **Cable Sealing System**

Modular multi-diameter cable sealing system consisting of frames, blocks and accessories shall be installed where the underground and over ground cables enter or leave concrete bay kiosks/switchyard panel room & control rooms in the substations. Cable sealing system shall consist of multi-diameter type peel-able or adjustable blocks of different sizes to suit the various cables. It should be simple, easy and quick to assemble & re-assemble the cable sealing system. Solid blocks shall not be used on frame. Frames & stay-plate material shall be of galvanized steel and for compression, single piece wedge with galvanized steel bolts shall be used. 30% spare blocks on the frame shall be provided for expansion in future. Cable sealing system should have been tested for fire/water/smoke tightness.

Cable sealing system having earthing strip can alternately be used in place of cable gland arrangement for indoor panels such as LCC, C&R, PLCC panels etc.

18.0 LIGHTING JUNCTION BOX

The Contractor shall supply and install ISI marked junction boxes complete with terminals as required. The brackets, bolts, nuts, screws etc required for erection are also included in the scope of the Contractor.

19.0 TESTING AND COMMISSIONING

19.1 **All pre/commissioning activities and works work for substation equipment shall be carried out in accordance with Employer's "Pre- Commissioning procedures for Switchyard Equipments (Doc. No. D-2-01-03-01-03)" by the contractor. This document shall be provided to the successful contractor during detailed engineering stage. Test results in the prescribed formats shall be duly filled by the contractor and shall be submitted to the Owner in soft form (CD or Pen Drive)**

The Contractor shall arrange all equipments instruments and auxiliaries required for testing and commissioning of equipments alongwith calibration certificates.

19.2 GENERAL CHECKS

(a) Check for physical damage.

(b) Visual examination of zinc coating/plating.

(c) Check from name plate that all items are as per order/specification.

(d) Check tightness of all bolts, clamps and connecting terminals using torque wrenches.

(e) For oil filled equipment, check for oil leakage, if any. Also check oil level and top up wherever necessary.

(f) Check ground connections for quality of weld and application of zinc rich paint over weld joint of galvanised surfaces.

(g) Check cleanliness of insulator and bushings.

(h) All checks and tests specified by the manufacturers in their drawings and manuals as well as all tests specified in the relevant code of erection.

(i) Check for surface finish of grading rings (Corona control ring).

19.3 STATION EARTHING

a) Check soil resistivity

b) Check continuity of grid wires

c) Check earth resistance of the entire grid as well as various sections of the same.

d) Check for weld joint and application of zinc rich paint on galvanised surfaces.

e) Dip test on earth conductor prior to use.

19.4 **AAC/ACSR STRINGING WORK, TUBULAR BUS WORK AND POWER CONNECTORS**

a) Physical check for finish

b) Electrical clearance check

c) Testing of torque by torque wrenches on all bus bar power connectors and other accessories.

d) Millivolt drop test on all power connectors.

e) Sag and tension check on conductors.

19.5 **ALUMINIUM TUBE WELDING**

a) Physical check

b) Millivolt drop test on all joints.

c) Dye penetration test & Radiography test on 10% sample basis on weld joints.

c) Test check on 5% sample joints after cutting the weld piece to observe any voids etc.

19.**6** **INSULATOR**

Visual examination for finish, damage, creepage distance etc.

ANNEXURE "A"

(Testing Procedure for ACSR/AAC Conductor)

1.0 **UTS Test on Stranded Conductor**

Circles perpendicular to the axis of the conductor shall be marked at two places on a sample of conductor of minimum 5m length suitably compressed with dead end clamps at either end. The load shall be increased at a steady rate upto 50% of minimum specified UTS and held for one minute. The circles drawn shall not be distorted due to Relative movement of strands. Thereafter the load shall be increased at a steady rate to 100% of minimum specified UTS and held for one minute. The conductor sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and the value recorded.

2.0 **Corona Extinction Voltage Test**

Two samples of conductor of 5m length shall be strung with a spacing of 450 mm between them at a height not exceeding 8.0 m above ground. This assembly shall be tested as per Annexure-C, Corona extinction voltage shall not be less than 510 kV (rms) & 320 KV (RMS) Line to ground for 765 kV & 400 kV respectively.

3.0 **Radio Interference Voltage Test**

Under the conditions as specified under (2.0) above, the conductor samples shall have radio interference voltage as indicated in the guaranteed technical particulars enclosed with. This test may be carried out with corona control rings and arcing horns. The test procedure shall be in accordance with IEC-60437.

4.0 **D.C Resistance Test on Stranded Conductor**

On a conductor sample of minimum 5 m length two contact clamps shall be fixed with a pre-determined bolt torque. The resistance shall be measured by a Kelvin double bridge by placing the clamps initially zero metre and subsequently one metre apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20°C as per clause no. 12.8 of IS:398 (Part V)-1982. The resistance corrected at 20°C shall conform to the requirements of this specification.

5.0 **Chemical Analysis of Zinc**

Samples taken from the zinc ingots shall be chemically/spectrographically analysed. The same shall be in conformity to the requirements stated in this specification.

6.0 **Chemical Analysis of Aluminium and Steel**

Samples taken from the Aluminium ingots/coils/strands shall be chemically/ spectrographically analysed. The same shall be in conformity to the requirements stated in this specification.

7.0 **Visual Check for Joints, Scratches etc.**

Conductor drums shall be rewound in the presence of the inspector. The

inspector shall visually check for scratches, joints, etc. and that the conductor generally conform to the requirements of this specification. The length of conductor wound on the drum shall be measured with the help of counter meter during rewinding.

8.0 **Dimensional Check for Steel and Aluminium Strands.**

The individual strands shall be dimensionally checked to ensure that they conform to the requirements of this specification.

9.0 **Check for Lay-ratios of various Layers.**

The lay-ratios of various layers shall be checked to ensure that they conform to the requirements of this Specification.

10.0 **Galvanising Test**

The test procedure shall be as specified in IEC:60888. The material shall conform to the requirements of this Specification. The adherence of zinc shall be checked by wrapping around a mandrel four times the diameter of steel wire.

11.0 **Torsion and Elongation Tests on Steel Strands**

The test procedures shall be as per clause No. 10.3 of IEC:60888. In torsion test, the number of complete twists before fracture shall not be less than that indicated in the GTP. In case test sample length is less or more than 100 times the stranded diameter of the strand, the minimum number of twists will be proportioned to the length and if number comes in the fraction then it will be rounded off to next higher whole number. In elongation test, the elongation of the strand shall not be less than 4% for a gauge length of 250 mm.

12.0 **Procedure Qualification test on welded Aluminium strands**

Two Aluminium wires shall be welded as per the approved quality plan and shall be subjected to tensile load. The breaking strength of the welded joint of the wire shall not be less than the breaking strength of individual strands.

ANNEXURE "B"

(Testing procedure for Galvanised Steel Earthwire)

1. **UTS TEST**

Circles perpendicular to the axis of the earthwire shall be marked at two places on a sample of earthwire of minimum 5m length suitably compressed with dead end clamps at either end. The load shall be increased at steady rate upto 50% of UTS and held for one minute. The circles drawn shall not be distorted due to relative movement of strands. Thereafter, the load shall be increased at a steady rate to 100% of UTS and held for one minute. The earthwire sample shall not fail during this period. The applied load shall then be increased until the failing load is reached and value recorded.

2. **D.C. RESISTANCE TEST**

On an earthwire sample of minimum 5m length, two contact clamps shall be fixed with a predetermined Bolt torque. The resistance shall be measured by a Kelvin double-bridge by placing the clamps initially zero meter and subsequently one meter apart. The test shall be repeated at least five times and the average value recorded. The value obtained shall be corrected to the value at 20°C shall conform to the requirements of this specification.

3. **Visual check for joints, scratches etc. and length of earthwire**

Earthwire drums shall be rewound in the presence of the inspector. The inspector shall visually check for joints, scratches etc. and see that the earthwire generally conforms to the requirements of this specification. The length of earthwire wound on the drum shall be measured with the help of counter meter during rewinding.

4. **TORSION TEST**

The minimum number of twists which a single steel strand shall withstand during torsion test shall be eighteen for a length equal to 100 times the standard diameter of the strand. In case the test sample length is less or more than 100 times the standard diameter of the strand, the minimum number of twists will be proportionate to the length and if number comes in the fraction then it will be rounded off to next higher whole number.

5. **DIMENSIONAL CHECK**

The individual strands shall be dimensionally checked to ensure that they conform to the requirements of this specification.

6. **LAY LENGTH CHECK**

The lay length shall be checked to ensure that they conform to the requirements of this specification.

7. **GALVANISING TEST**

The test procedure shall as specified in IS:4826-1968. The material shall conform to the requirements of this specification. The adherence of zinc shall be

checked by wrapping around a mandrel four times the diameter of steel wire.

8. **CHEMICAL ANALYSIS OF ZINC USED FOR GALVANIZING**

Samples taken from zinc ingots shall be chemically/spectrographically analysed. The same shall be in conformity to the requirements stated in this specification.

9. **CHEMICAL ANALYSIS OF STEEL**

Samples taken from steel ingots/coils/strands shall be chemically/ spectrographically analysed. The same shall be in conformity to the requirements stated in this specification.

ANNEXURE-C

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 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).

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 in accordance with NEMA standard Publication No. 107-1964, except otherwise noted herein.

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, 400kV, 220kV 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 noisel meter.

4. Test Methods for Visible Corona [applicable for 400kV and above]

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 RIV test voltage and maintained there for five minutes. In case corona inception does not take place at 110%, test shall be stopped, 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 4

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 four values at which visible corona (negative or positive polarity) disappears. Photographs with laboratory in complete darkness shall be taken under test conditions, at all voltage steps i.e. 85%, 100%, and 110%. Additional photographs shall be taken at corona inception and extinction voltages. At least two views shall be photographed in each case using Panchromatic film with an ASA daylight rating of 400 with an exposure of two minutes at a lens aperture of f/5.6 or equivalent. The photographic process shall be such that prints are available for inspection and comparison with conditions as determined from direct observation. Photographs shall be taken from above and below the level of connector so as to show corona on bushing, insulators and all parts of energised connectors. The photographs shall be framed such that test object essentially, fills the frame with no cut-off.

In case corona inception does not take place at 110%, voltage shall not be increased further and corona extinction voltage shall be considered adequate.

4.1 The test shall be recorded on each photograph. Additional photograph shall be taken from each camera position with lights on to show the relative position of test object to facilitate precise corona location from the photographic evidence.

4.2 In addition to photographs of the test object preferably four photographs shall be taken of the complete test assembly showing relative positions of all the test equipment and test objects. These four photographs shall be taken from four points equally spaced around the test arrangement to show its features from all sides. Drawings of the laboratory and test set up locations shall be provided to indicate camera positions and angles. The precise location of camera shall be approved by Purchaser's inspector, after determining the best camera locations by trial energisation of test object at a voltage which results in corona.

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

4.4 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 Purchaser'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.

ANNEXURE – D

A. SHORT CIRCUIT FORCES AND SPACER SPAN FOR 765kV GANTRY STRUCTURE

Sl. No.	Max. Span	Conductor Configuration	Ph-Ph Spacing	Normal Tension	SCF per Phase	Spacer span
I.	**For Fault Level of 40kA/50 kA for 1 sec.**					
1.	54.0 mtr	QUAD AAC BULL	15 mtr	3.96 T	5.98 T	3.5 mtr
2.	56.0 mtr	QUAD AAC BULL	15 mtr	4.52 T	6.77 T	4.0 mtr
3.	87.9 mtr	QUAD AAC BULL	15 mtr	8.35 T	11.22 T	6.5 mtr
4.	104.0 mtr	QUAD AAC BULL	15 mtr	9.00 T	12.72 T	7.5 mtr
5.	108.61 mtr	QUAD AAC BULL	15 mtr	9.00 T	12.72 T	8.0 mtr

B. SHORT CIRCUIT FORCES AND SPACER SPAN FOR 400kV GANTRY STRUCTURE

Sl. No.	Max. Span	Conductor Configuration	Ph-Ph Spacing	Normal Tension	SCF per Phase	Spacer span
I.	**For Fault Level of 40 kA for 1 sec.**					
1.	54 mtr	QUAD ACSR	7 mtr	4 T	5.64 T	6 mtr
2.	70 mtr	TWIN ACSR	7 mtr	4 T	5.64 T	5 mtr
3.	54 mtr	QUAD ACSR	6 mtr	4 T	5.10 T	5 mtr
4.	70 mtr	TWIN ACSR	6 mtr	4 T	5.10 T	5 mtr
5.	48 mtr	QUAD ACSR	6 mtr	4 T	4.82T	5 mtr
6.	52.5 mtr	QUAD ACSR	6 mtr	4 T	4.85T	5 mtr
7.	56.5 mtr	QUAD ACSR	6 mtr	4 T	4.88T	5 mtr
8.	52.5 mtr	TWIN ACSR	6 mtr	4 T	4.97T	5 mtr
9.	56.5 mtr	TWIN ACSR	6 mtr	4 T	5.00 T	5 mtr
II.	**For Fault Level of 50 kA for 1 sec.**					
1.	48 mtr	QUAD AAC BULL	6 mtr	4 T	5.10 T	4 mtr
2.	52.5 mtr	QUAD ACSR	6 mtr	4 T	5.18 T	4 mtr
3.	56.5 mtr	QUAD ACSR	6 mtr	4 T	5.20 T	4 mtr
III.	**For Fault Level of 63 kA for 1 sec.**					
1.	48 mtr	QUAD AAC BULL	6 mtr	4 T	6.00 T	4 mtr
2.	52.5 mtr	QUAD ACSR	6 mtr	4 T	6.33 T	4 mtr
3.	56.5 mtr	QUAD ACSR	6 mtr	4 T	6.37 T	4 mtr

ANNEXURE – D

C. SHORT CIRCUIT FORCES AND SPACER SPAN FOR 220 kV GANTRY STRUCTURE

Sl. No.	Max. Span	Conductor Configuration	Ph-Ph Spacing	Normal Tension	SCF per Phase	Spacer span
I.	**For Fault Level of 40 kA for 1 sec.**					
1.	54 mtr	QUAD ACSR	4.5 mtr	4 T	5.00 T	2.5 mtr
2.	54 mtr	TWIN ACSR	4.5 mtr	2 T	3.50 T	2.5 mtr
3.	74 mtr	TWIN ACSR	4.5 mtr	4 T	5.00 T	2.5 mtr
4.	54 mtr	QUAD ACSR	4.0 mtr	4 T	5.70 T	2.5 mtr
5.	54 mtr	TWIN ACSR	4.0 mtr	2 T	3.50 T	2.5 mtr
6.	74 mtr	TWIN ACSR	4.0 mtr	4 T	5.70 T	2.5 mtr
7.	48 mtr	QUAD ACSR	4.0 mtr	4 T	5.30 T	2.5 mtr
8.	52 mtr	QUAD ACSR	4.0 mtr	4 T	5.35 T	2.5 mtr
9.	68 mtr	TWIN ACSR	4.0 mtr	4 T	5.20 T	2.5 mtr
10.	56 mtr	QUAD ACSR	4.0 mtr	4 T	5.50 T	2.5 mtr
11.	72 mtr	TWIN ACSR	4.0 mtr	4 T	5.27 T	2.5 mtr
II.	**For Fault Level of 50 kA for 1 sec.**					
1.	48 mtr	QUAD ACSR	4.0 mtr	4 T	5.41 T	2.0 mtr
2.	52 mtr	QUAD ACSR	4.0 mtr	4 T	5.50 T	2.0 mtr
3.	36 mtr	TWIN ACSR	4.0 mtr	2 T	3.50 T	2.0 mtr

NOTE: ACSR conductor as mentioned above indicates that it is suitable for both ACSR MOOSE as well as ACSR BERSIMIS conductor.

D. SHORT CIRCUIT FORCES AND SPACER SPAN FOR 132 kV GANTRY STRUCTURE

Sl. No.	Max. Span	Conductor Configuration	Ph-Ph Spacing	Normal Tension	SCF per Phase	Spacer span
I.	**For Fault Level of 31.5kA for 1 sec.**					
1.	36 mtr	Twin Moose/ Zebra ACSR	3 mtr	1 T	2.15 T	2.5 mtr
2.	31.5 mtr	Twin Moose/ Zebra ACSR	2.7mtr	1 T	2.15 T	2.5 mtr
3.	48 mtr	Single Moose/ Zebra ACSR	3 mtr	1 T	2.05 T	NA
4.	42 mtr	Single Moose/ Zebra ACSR	2.7 mtr	1 T	2.03 T	NA

ANNEXURE-E

STANDARD TECHNICAL DATA SHEETS FOR AAC/ACSR CONDUCTORS, GS EARTHWIRE AND ALUMINIUM TUBE

1.0 GENERAL

Employer has stardardised the guaranteed technical particulars for the following AAC/ACSR conductors, Galvanised steel earthwire and aluminum tube. The contractor shall supply the conductors as per the standard GTP mentioned below. Any deviation to the following GTP shall be clearly brought out by the bidder in their bid.

1.1 Guaranteed Technical Particulars (GTP) for conductors:

A. **GTP of AAC BULL and AAC TARANTULA conductor:**

Sl.	Description	Unit	AAC BULL	AAC TARANTULA
1.0	**Applicable Standard**		IS:398	
2.0	**Raw Materials**			
2.1	Steel Wire / Rods			
2.1.1	Aluminium			
a)	Minimum purity of Aluminium	%	99.50	99.50
b)	Maximum copper content	%	0.04	0.04
3.0	**Aluminum strands after stranding**			
3.1	Diameter			
a)	Nominal	mm	4.25	5.23
b)	Maximum	mm	4.29	5.28
c)	Minimum	mm	4.21	5.18
3.2	Minimum breaking load of strand			
a)	Before stranding	KN	2.23	3.44
b)	After stranding	KN	2.12	3.27
c)	Maximum D.C. resistance of strand at 20 deg. Centigrade	Ohm /KM	3.651	3.627
3.3	Maximum resistance of 1 m length of strand at 20 deg. C	Ohm	0.00203	0.001341
4.0	**AAC Conductor**			
4.1. a)	Stranding		Al – 61/4.25 mm	Al – 37/ 5.23 mm
b)	Number of Strands			
i.	1st Aluminium Layer	Nos.	1	1
ii.	2nd Aluminium Layer	Nos.	6	6

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Sl.	Description	Unit	AAC BULL	AAC TARANTULA
iii.	3rd Aluminium Layer	Nos.	12	12
iv.	4th Aluminium Layer	Nos.	18	18
v.	5th Aluminium Layer	Nos.	24	-
4.2	Sectional Area of aluminium	Sq. mm	865.36	794.80
4.3	Total sectional area	Sq. mm	865.36	794.80
4.4	Approximate Weight	Kg/m	2.4	2.191
4.5	Diameter of the conductor	mm	38.25	36.60
4.6	UTS of the conductor	kN	139 (Min.)	120 (Min.)
4.7	Lay ratio of the conductor	mm	Max Min	Max Min
a)	6 wire Aluminium layer	mm	16 10	16 10
b)	12 wire Aluminium layer	mm	16 10	16 10
c)	18 wire Aluminium layer	mm	16 10	14 10
d)	24 wire Aluminium layer	mm	14 10	- -
4.8	DC resistance of the conductor at 20°C	ohm/ km	0.03340	0.03628
4.9	Standard length of the conductor	m	1000	1000
4.10	Tolerance on Standard length	%	(+/-) 5	(+/-) 5
4.11	Direction of lay of outer layer		Right Hand	Right Hand
4.12	Linear mass of the conductor			
a)	Standard	kg/ km	2400	2192
b)	Minimum	kg/ km	2355	2150
c)	Maximum	kg/ km	2445	2234
4.13	Modulus of Elasticity	Kg/sq .mm	4709 (Initial) 5869 (Final)	4709 (Initial) 5869 (Final)
4.14	Co-efficient of Linear Expansion	Per Deg. C	$23.0x10^{-6}$	$23.0x10^{-6}$
4.15	Minimum Corona Extinction Voltage	KV (rms)	508	320
4.16	RIV at 1 Mhz	Micro volts	Less than 1000 at 508 kV (rms)	Less than 1000 at 320 kV (rms)
5.0	**Drum Dimensions**		Generally conforms to IS:1778	

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Sl.	Description	Unit	AAC BULL	AAC TARANTULA
a)	Flange Diameter	mm	1855	1855
b)	Traverse width	mm	925	925
c)	Barrel Diameter	mm	850	850
d)	Flange thickness	mm	50x50	50x50

B. GTP of ACSR BERSIMIS and ACSR MOOSE conductor:

Sl.	Description	Unit	ACSR BERSIMIS	ACSR MOOSE
1.0	**Applicable Standard**		IS:398 / IEC - 61089	
2.0	**Raw Materials**			
2.1	Aluminium			
a)	Minimum purity of Aluminium	%	99.50	99.50
b)	Maximum copper content	%	0.04	0.04
2.2	Steel wires/ rods			
a)	Carbon	%	0.50 to 0.85	0.50 to 0.85
b)	Manganese	%	0.50 to 1.10	0.50 to 1.10
c)	Phosphorous	%	Not more than 0.035	Not more than 0.035
d)	Sulphur	%	Not more than 0.045	Not more than 0.045
e)	Silicon	%	0.10 to 0.35 (Max.)	0.10 to 0.35 (Max.)
2.3	Zinc			
a)	Minimum purity of Zinc	%	99.95	99.95
3.0	**Aluminum strands after stranding**			
3.1	Diameter			
a)	Nominal	mm	4.57	3.53
b)	Maximum	mm	4.61	3.55
c)	Minimum	mm	4.53	3.51
3.2	Minimum breaking load of strand			
a)	Before stranding	KN	2.64	1.57
b)	After stranding	KN	2.51	1.49
c)	Maximum D.C. resistance of strand at 20 deg. Centigrade	Ohm/ KM	1.738	2.921
3.3	Maximum resistance of 1 m length of strand at 20 deg. C	Ohm	0.001738	0.002921

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Sl.	Description	Unit	ACSR BERSIMIS	ACSR MOOSE
4.0	**Steel strand after stranding**			
4.1	Diameter			
a)	Nominal	mm	2.54	3.53
b)	Maximum	mm	2.57	3.60
c)	Minimum	mm	2.51	3.46
4.2	Minimum breaking load of strand			
a)	Before stranding	KN	6.87	12.86
b)	After stranding	KN	6.53	12.22
4.3	Galvanising			
a)	Minimum weight of zinc coating per sq.m.	gm	260	260
b)	Minimum number of dips that the galvanised strand can withstand in the standard preece test	Nos.	2 dips of one minute & 1 dip of half minute	2 dips of one minute & 1 dip of half minute
c)	Min. No. of twists in guage length equal 100 times the dia. of wire which the strand can withstand in the torsion test (after stranding)	Nos	16 (After stranding) 18 (Before stranding)	16 (After stranding) 18 (Before stranding)
5.0	**ACSR Conductor**			
5.1.a)	Stranding		Al -42/4.57 mm+ Steel-7/2.54 mm	Al -54/3.53 mm+ Steel-7/3.53 mm
b)	Number of Strands			
i.	Steel centre	Nos.	1	1
ii.	1st Steel Layer	Nos.	6	6
iii.	1st Aluminium Layer	Nos.	8	12
iv.	2nd Aluminium Layer	Nos.	14	18
v.	3rd Aluminium Layer	Nos.	20	24
5.2	Sectional Area of aluminium	Sq. mm	689.50	528.50
5.3	Total sectional area	Sq. mm	725.00	597.00
5.4	Approximate Weight	Kg/m	2.181	2.004
5.5	Diameter of the conductor	mm	35.05	31.77
5.6	UTS of the conductor	kN	154 (Min.)	161.20 (Min.)
5.7	Lay ratio of the conductor	mm	Max Min	Max Min

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Sl.	Description	Unit	ACSR BERSIMIS	ACSR MOOSE
a)	Outer Steel layer	mm	24 16	18 16
b)	8/12 wire Aluminium layer	mm	17 10	14 12
c)	14/ 18 wire Aluminium layer	mm	16 10	13 11
d)	20/24 wire Aluminium layer	mm	13 10	12 10
5.8	DC resistance of the conductor at 20°C	ohm/ km	0.04242	0.05552
5.9	Standard length of the conductor	m	1800	1800
5.10	Tolerance on Standard length	%	(+/-) 5	(+/-) 5
5.11	Direction of lay of outer layer	-	Right Hand	Right Hand
5.12	Linear mass of the conductor			
a)	Standard	kg/ km	2181	2004
b)	Minimum	kg/ km	2142	1965
c)	Maximum	kg/ km	2221	2045
5.13	Modulus of Elasticity (Final State)	Kg/sq .mm		6860
5.14	Co-efficient of Linear Expansion	Per Deg. C	$21.5x10^{-6}$	$19.3x10^{-6}$
5.15	Minimum Corona Extinction Voltage	KV (rms)	320	320
5.16	RIV at 1 Mhz under dry condition	Micro volts	Max. 1000 at 320 kV (rms)	Max. 1000 at 320 kV (rms)
6.0	**Drum Dimensions**		Generally conforms to IS:1778	
a)	Flange Diameter	mm	1800	1800
b)	Traverse width	mm	950	950
c)	Barrel Diameter	mm	650	650
d)	Flange thickness	mm	50x50	50x50

C. B. GTP of ACSR ZEBRA and ACSR PANTHER conductor:

Sl.	Description	Unit	ACSR ZEBRA	ACSR PANTHER
1.0	**Applicable Standard**		IS:398 / IEC-61089	
2.0	**Raw Materials**			
2.1	Aluminium			
a)	Minimum purity of Aluminium	%	99.50	99.50

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Sl.	Description	Unit	ACSR ZEBRA	ACSR PANTHER
b)	Maximum copper content	%	0.04	0.04
2.2	Steel wires/ rods			
a)	Carbon	%	0.50 to 0.85	0.50 to 0.85
b)	Manganese	%	0.50 to 1.10	0.50 to 1.10
c)	Phosphorous	%	Not more than 0.035	Not more than 0.035
d)	Sulphur	%	Not more than 0.045	Not more than 0.045
e)	Silicon	%	0.10 to 0.35 (Max.)	0.10 to 0.35 (Max.)
2.3	Zinc			
a)	Minimum purity of Zinc	%	99.95	99.95
3.0	**Aluminum strands after stranding**			
3.1	Diameter			
a)	Nominal	mm	3.18	3.00
b)	Maximum	mm	3.21	3.03
c)	Minimum	mm	3.15	2.97
3.2	Minimum breaking load of strand			
a)	Before stranding	KN	1.29	1.17
b)	After stranding	KN	1.23	1.11
3.3	Maximum resistance of 1 m length of strand at 20 deg. C	Ohm	0.003626	0.004107
4.0	**Steel strand after stranding**			
4.1	Diameter			
a)	Nominal	mm	3.18	3.00
b)	Maximum	mm	3.24	3.06
c)	Minimum	mm	3.12	2.94
4.2	Minimum breaking load of strand			
a)	Before stranding	KN	10.43	9.29
b)	After stranding	KN	9.91	8.85
4.3	Galvanising			
a)	Minimum weight of zinc coating per sq.m.	gm	260	260
b)	Minimum number of dips that the galvanised strand can withstand in the standard preece test	Nos.	2 dips of one minute & 1 dip of half minute	2 dips of one minute & 1 dip of half minute

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Sl.	Description	Unit	ACSR ZEBRA	ACSR PANTHER
c)	Min. No. of twists in guage length equal 100 times the dia. of wire which the strand can withstand in the torsion test (after stranding)	Nos	16 (After stranding) 18 (Before stranding)	16 (After stranding) 18 (Before stranding)
5.0	**ACSR Conductor**			
5.1.a)	Stranding		Al -54/3.18 mm+ Steel-7/3.18 mm	Al -30/3.00 mm+ Steel-7/3.00 mm
b)	Number of Strands			
i.	Steel centre	Nos.	1	1
ii.	1st Steel Layer	Nos.	6	6
iii.	1st Aluminium Layer	Nos.	12	12
iv.	2nd Aluminium Layer	Nos.	18	18
v.	3rd Aluminium Layer	Nos.	24	NA
5.2	Sectional Area of aluminium	Sq. mm	428.9	212.10
5.3	Total sectional area	Sq. mm	484.5	261.50
5.4	Approximate Weight	Kg/m	1.621	0.974
5.5	Diameter of the conductor	Mm	28.62	21.00
5.6	UTS of the conductor	kN	130.32 (Min.)	89.67 (Min.)
5.7	Lay ratio of the conductor	mm	Max Min	Max Min
a)	Outer Steel layer	mm	28 13	28 16
b)	12 wire Aluminium layer	mm	17 10	16 10
c)	18 wire Aluminium layer	mm	16 10	14 10
d)	24 wire Aluminium layer	mm	14 10	NA NA
5.8	DC resistance of the conductor at 20°C	ohm/ km	0.06868	0.140
5.9	Standard length of the conductor	m	1800	1800
5.10	Tolerance on Standard length	%	(+/-) 5	(+/-) 5
5.11	Direction of lay of outer layer		Right Hand	Right Hand
5.12	Linear mass of the conductor			
a)	Standard	kg/ km	1621	974
b)	Minimum	kg/	1589	954

ANNEXURE-E

Sl.	Description	Unit	ACSR ZEBRA	ACSR PANTHER
		km		
c)	Maximum	kg/ km	1653	993
5.13	Modulus of Elasticity	Kg/sq .mm		8158
5.14	Co-efficient of Linear Expansion	Per Deg. C	$19.3x10^{-6}$	$17.8x10^{-6}$
5.15	Minimum Corona Extinction Voltage	KV (rms)	154	92
5.16	RIV at 1 Mhz	Micro volts	Less than 1000 at 154 kV (rms)	Less than 500 at 92 kV (rms)
6.0	**Drum Dimensions**		Generally conforms to IS:1778	
a)	Flange Diameter	mm	1850	1850
b)	Traverse width	mm	925	925
c)	Barrel Diameter	mm	650	650
d)	Flange thickness	mm	50x50	50x50

1.2 Guaranteed technical particulars of Galvanised Steel Earthwire

	Description	Unit	Standard Values
1.0	**Raw Materials**		
1.1	**Steel wires / rods**		
a)	Carbon	%	Not more than 0.55
b)	Manganese	%	0.40 to 0.90
c)	Phosphorous	%	Not more than 0.04
d)	Sulphur	%	Not more than 0.04
e)	Silicon	%	0.15 to 0.35
1.2	**Zinc**		
a)	Minimum purity of Zinc	%	99.95
2.0	**Steel strands**		
2.1	**Diameter**		
a)	Nominal	mm	3.66
b)	Maximum	mm	3.74
c)	Minimum	mm	3.58
2.2.	**Minimum breaking load of strand**		
a)	After stranding	KN	10.58
2.3	**Galvanising**		
a)	Minimum weight of zinc coating per sq.m. after stranding	gms.	275
b)	Minimum number of dips that the galvanized strand can withstand	Nos.	3 dips of 1 minute and

	in the standard preece test		one dip of ½ minute
c)	Minimum number of twists in a gauge length equal to 100 times diameter of wire which the strand can withstand in the torsion test, after stranding	Nos.	18
3.0	**Stranded Earth wire**		
3.1	**UTS of Earth wire**	KN	68.4 (min.)
3.2	**Lay length of outer steel layer**		
a)	Standard	mm	181
b)	Maximum	mm	198
c)	Minimum	mm	165
3.3	**Maximum DC resistance of earth wire at 20^0 C**	Ohm/km	3.375
3.4	**Standard length of earth wire**	M	2000 or actual quantity whichever is less.
3.5	**Tolerance on standard length**	%	±5
3.6	**Direction of lay for outside layer**		Right hand
3.7	**Linear mass**		
a)	Standard	Kg/km	583
b)	Maximum	Kg/km	552
c)	Minimum	Kg/km	600
3.8	**Overall diameter**	mm	10.98

1.3 Guaranteed Technical Parameters of Aluminum Tube

A. GTP for 3" IPS & 4" IPS AL. TUBE

Sl. No.	Description	3" AL. TUBE	4" AL. TUBE
1.	Size	3" IPS (EH Type)	4" IPS (EH Type)
2.	Material	Aluminium Alloy 6101 T6 confirms to 63401 WP (range 2) of IS 5082 : 1998	
3.	Chemical Composition		
i)	Cu	0.05 Max	
ii)	Mg	0.4 to 0.9	
iii)	Si	0.3 to 0.7	
iv)	Fe	0.5 Max	
v)	Mn	0.03 Max	
Vi)	Al	Remainder	
4.	Outer diameter	88.90 mm	114.2 mm
5.	Tolerance on outer diameter	+2.2 mm, - 0.0 mm	+2.2 mm, - 0.0 mm
6.	Thickness	7.62 mm	8.51 mm
7.	Tolerance on thickness	+2.2 mm, - 0.0 mm	+2.2 mm, - 0.0 mm
8.	Cross-sectional area	1945.76 sq.mm	2825.61 sq.mm
9.	Weight	5.25 kg/m	7.7 kg/m
10.	Moment of Inertia	1621589.99 mm^4	3972577.97 mm^4
11.	Section Modulus	36481.21 mm^3	69572.29 mm^3

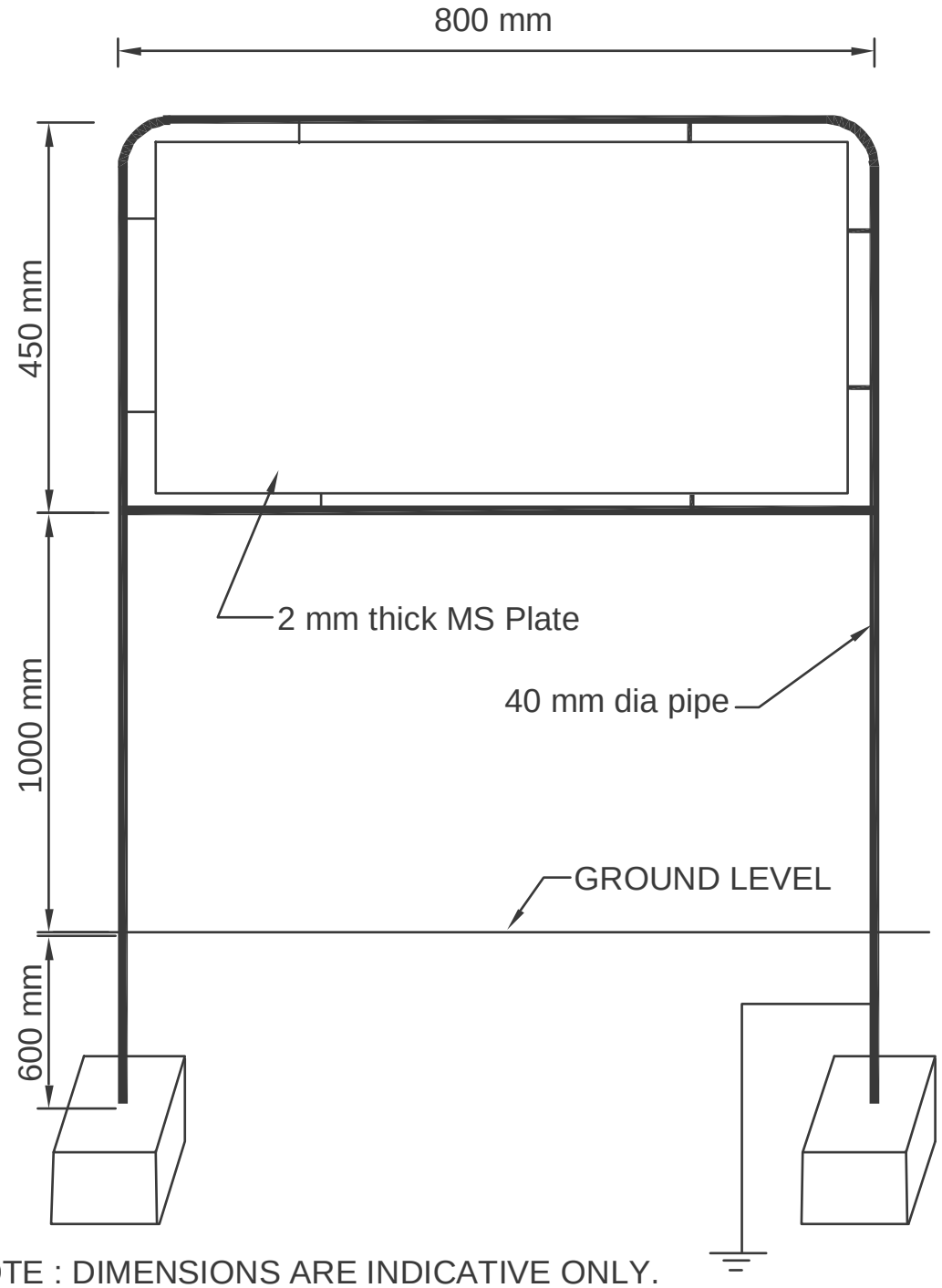
12.	Minimum Ultimate Tensile Strength	20.5 Kg/sq.mm	
13.	Temperature co-efficient of resistance	0.00364 per Deg.C	
14.	Minimum Electrical Conductivity at 20 deg.C	55% of IACS	
15.	Linear Temperature Co-efficient of Expansion (20 Deg.C -200 Deg.C)	0.000023	
16.	Modulus of Elasticity	6700 Kg/sq.mm	
17.	Minimum Elongation on 50 mm	10%	
18.	Thermal Conductivity at 100 Deg.C	0.43 Calories/sec/sq.mm/cm/deg.C	
19.	Minimum 0.2% proof stress	17.34 Kg/sq.mm	
20	Minimum Yield point	17.50 Kg/sq.mm	17.50 Kg/sq.mm
21	Minimum Breaking Strength	20.42 Kg/sq.mm	20.42 Kg/sq.mm

B. GTP for 4.5" IPS & 5" IPS AL. TUBE

Sl. No.	Description	4.5" AL. TUBE	5" AL. TUBE
1.	Size	4.5" IPS (EH Type)	5" IPS
2.	Material	Aluminium Alloy 6101 T6 confirms to 63401 WP (range 2) of IS 5082 : 1998	
3.	Chemical Composition		
i)	Cu	0.05 Max	
ii)	Mg	0.4 to 0.9	
iii)	Si	0.3 to 0.7	
iv)	Fe	0.5 Max	
v)	Mn	0.03 Max	
Vi)	Al	Remainder	
4.	Outer diameter	120.0 mm	141.3 mm
5.	Tolerance on outer diameter	+1.5 mm, - 0.0 mm	+2.8 mm, - 0.0 mm
6.	Thickness	12.0 mm	9.53 mm
7.	Tolerance on thickness	+1.0 mm, - 0.0 mm	+0.8 mm, - 0.0 mm
8.	Cross-sectional area	4071.50 sq.mm	3945.11 sq.mm
9.	Weight	10.993 kg/m	10.652 kg/m
10.	Moment of Inertia	6011958.58 mm^4	8610787.65 mm^4
11.	Section Modulus	100199.31 mm^3	121879.51 mm^3
12.	Minimum Ultimate Tensile Strength	20.5 Kg/sq.mm	
13.	Temperature co-efficient of resistance	0.00364 per Deg.C	
14.	Minimum Electrical Conductivity at 20 deg.C	55% of IACS	
15.	Linear Temperature Co-efficient of Expansion (20 Deg.C -200 Deg.C)	0.000023	
16.	Modulus of Elasticity	6700 Kg/sq.mm	
17.	Minimum Elongation on 50	10%	

ANNEXURE-E

	mm		
18.	Thermal Conductivity at 100 Deg.C	0.43 Calories/sec/sq.mm/cm/deg.C	
19.	Minimum 0.2% proof stress	17.34 Kg/sq.mm	
20	Minimum Yield point	14.50 Kg/sq.mm	17.50 Kg/sq.mm
21	Minimum Breaking Strength	17.50 Kg/sq.mm	20.42 Kg/sq.mm



NOTE : DIMENSIONS ARE INDICATIVE ONLY.
IT MAY VARY AS PER SITE REQUIREMENT.

POWER GRID CORPORATION OF INDIA LIMITED
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PROJECT :- STANDARD

TITLE:- STANDARD BAY NAME PLATE

KKParihar	KKParihar	18 / 02 / 2008	Drawing No.: C/ENG/STD/BAY NAME PLATE	Rev. 00
CKD BY	PRPD BY	Date		

GENERAL INSTRUCTION FOR EARTHING:

1. Location of earthing conductors / risers shown in the earthing drawing may change to suit the site condition.
2. Two different risers of one structure/equipment shall be connected to different conductors of main earthmat.
3. Earthing conductor around the building shall be burried at a minimum distance of 1500 mm from the outer boundary of the building.
4. Minimum distance of 6000 mm shall be maintained between two treated (pipe) electrode.
5. For surge arrester, earthing lead from surge counter to to main earthmat shall be shortest in length as pratically as possible. Earthing lead from surge arrester shall not be passed through any pipe.
6. No welding is allowed in the over ground earthing leads/risers if the length is less than 6m .

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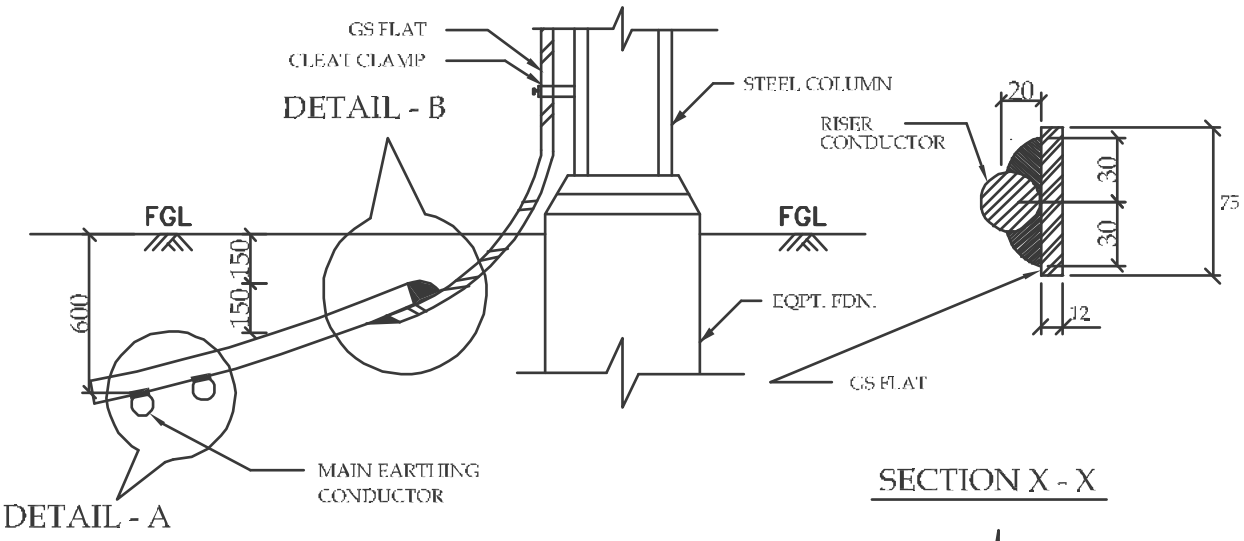
PROJECT :- TECHNICAL SPECIFICATION-SWITCHYARD ERECTION

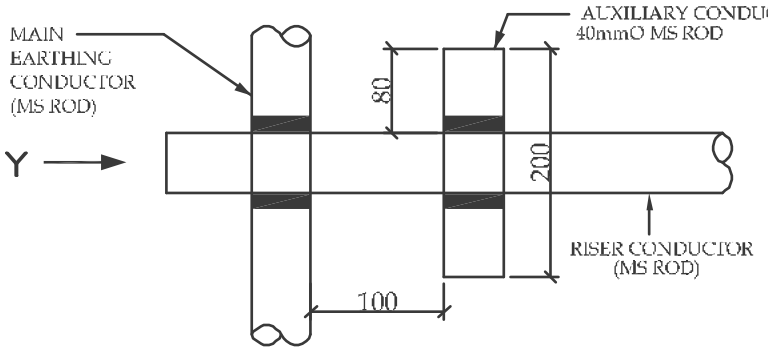
TITLE:- STANDARD EARTHING DETAILS

KKPashar	KKPashar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09
CKD BY	PRPD BY	Date	SHEET # 1

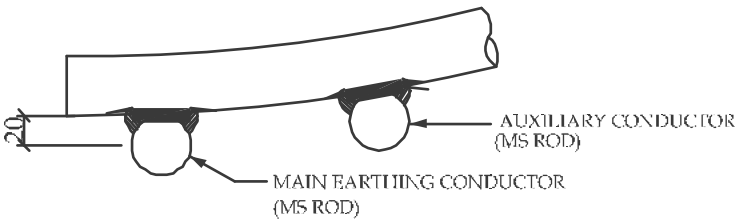


SECTION X - X

TYPICAL DETAILS OF RISER

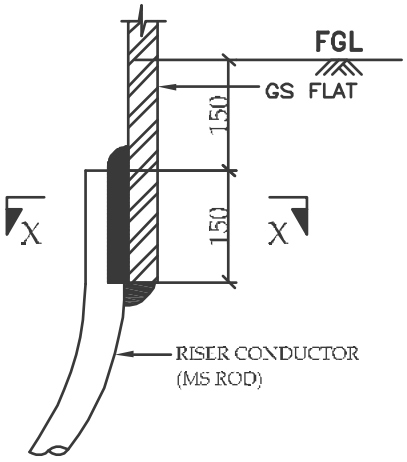


PLAN



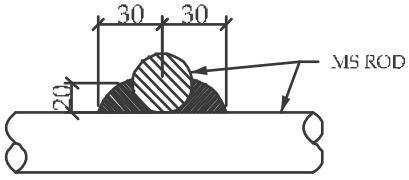
ELEVATION

DETAIL - A



ELEVATION

DETAIL - B



VIEW - Y

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POWER GRID CORPORATION OF INDIA LIMITED
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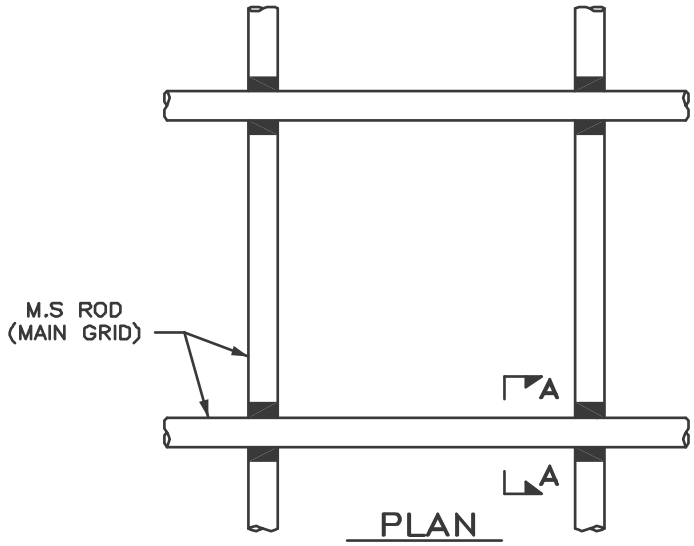
पावरग्रिड

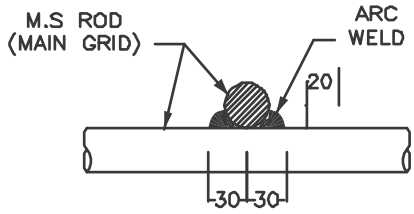
PROJECT :- TECHNICAL SPECIFICATION-SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

KKPashar	KKPashar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 2
CKD BY	PRPD BY	Date	

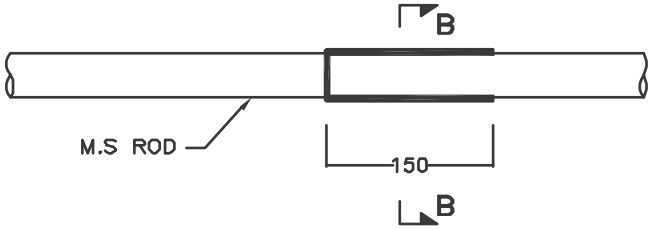


PLAN



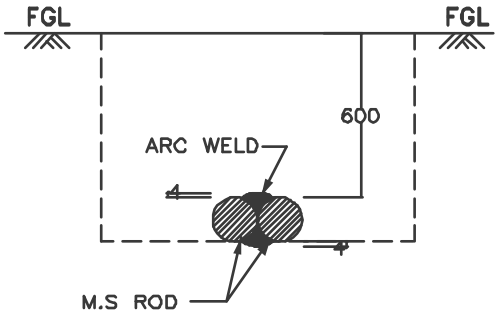
SECTION A – A

DETAIL OF CROSS JOINT

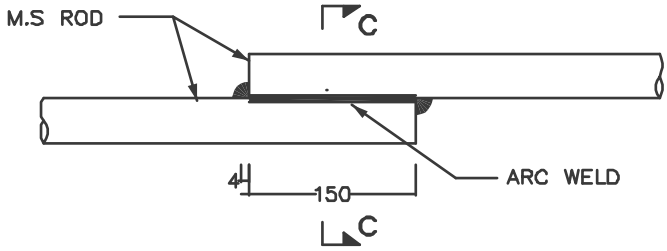


ELEVATION

(CONDUCTORS KEPT ON SIDES)

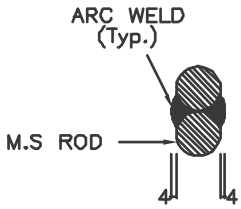


SECTION B – B



ELEVATION

(CONDUCTORS ONE ABOVE THE OTHER)



SECTION C – C

DETAIL OF LAP JOINT

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POWER GRID CORPORATION OF INDIA LIMITED
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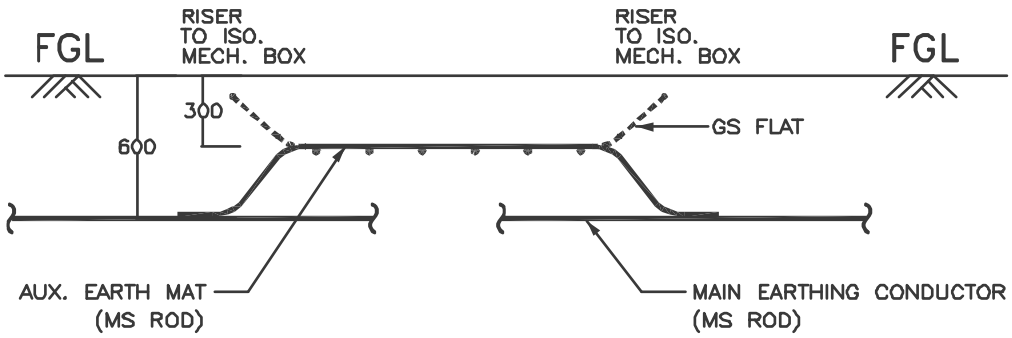
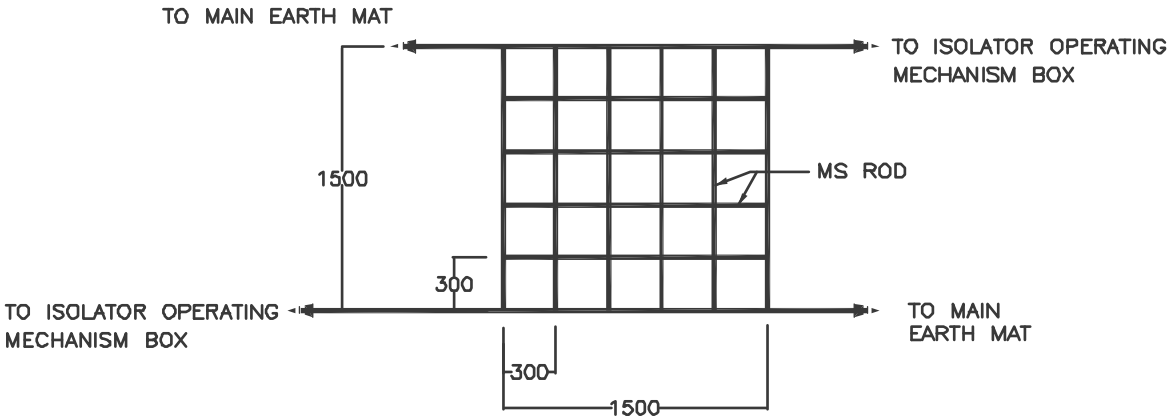
PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

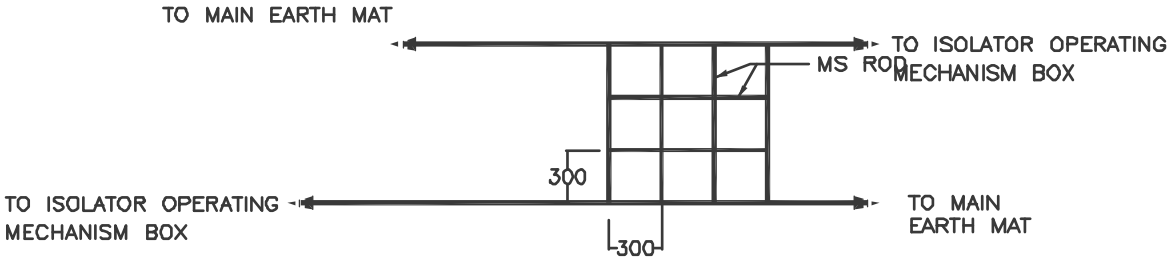
KKPashar	KKPashar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 3
CKD BY	PRPD BY	Date	



ELEVATION



PLAN (For 220kV & above class isolators)



PLAN (For 132kV & below class isolators)

RELEASED FOR CONTRUCTION

POWER GRID CORPORATION
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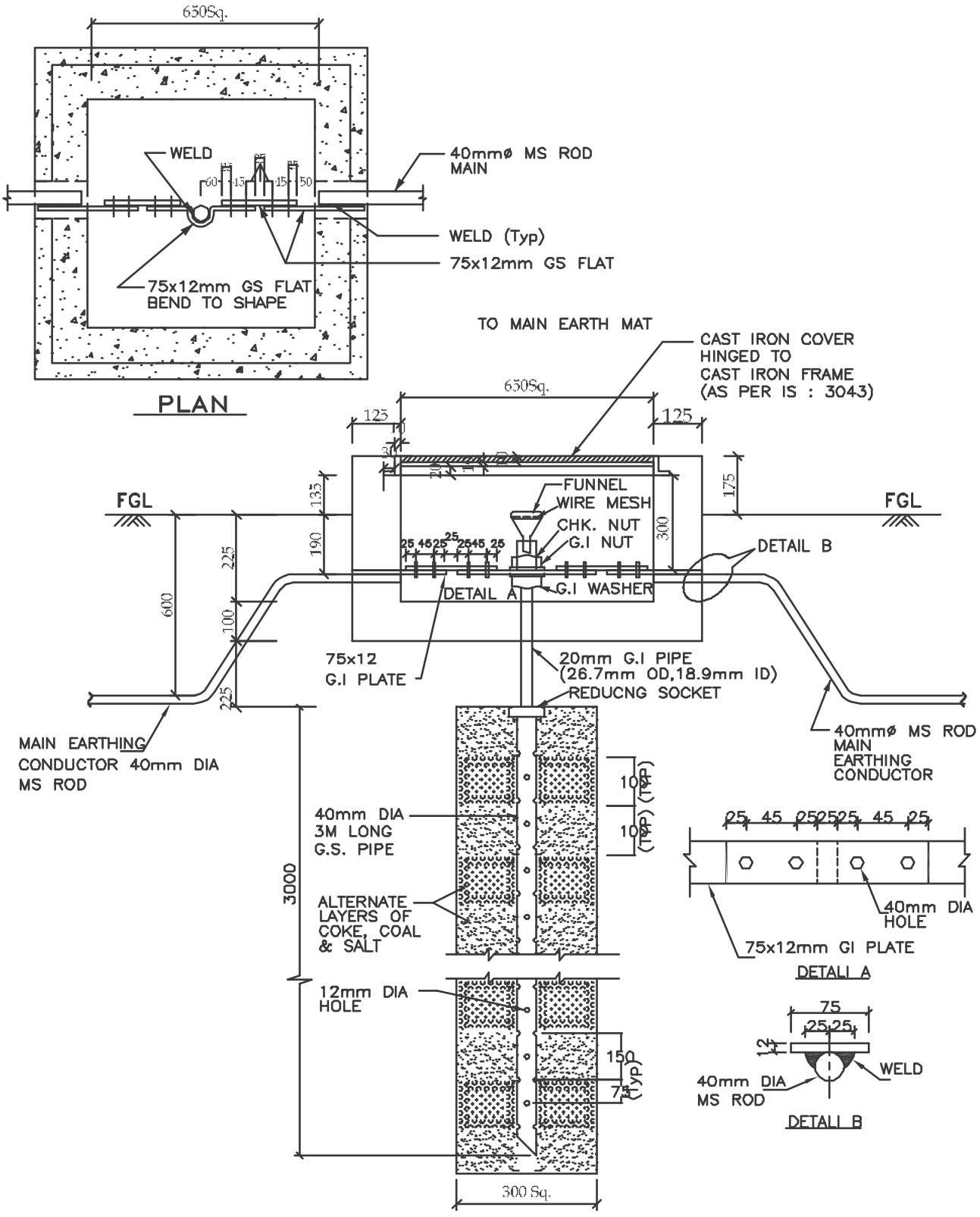
PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

K.K.Parkar	K.K.Parkar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 4
CKD BY	PRPD BY	Date	



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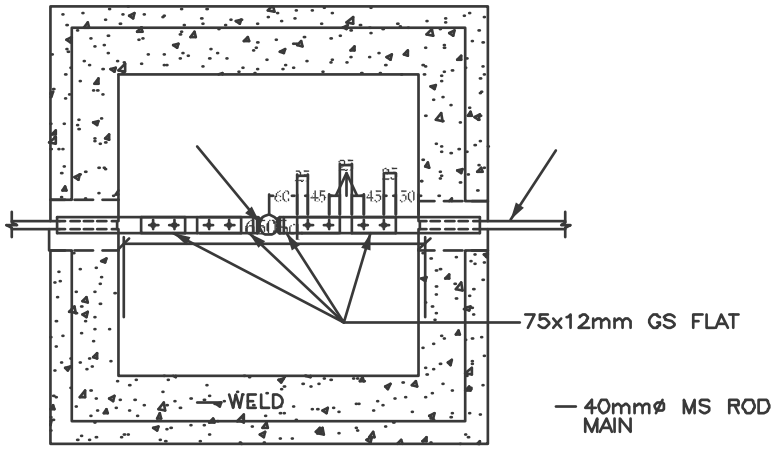
PROJECT :- TECHNICAL SPECIFICATION-SWITCHYARD ERECTION

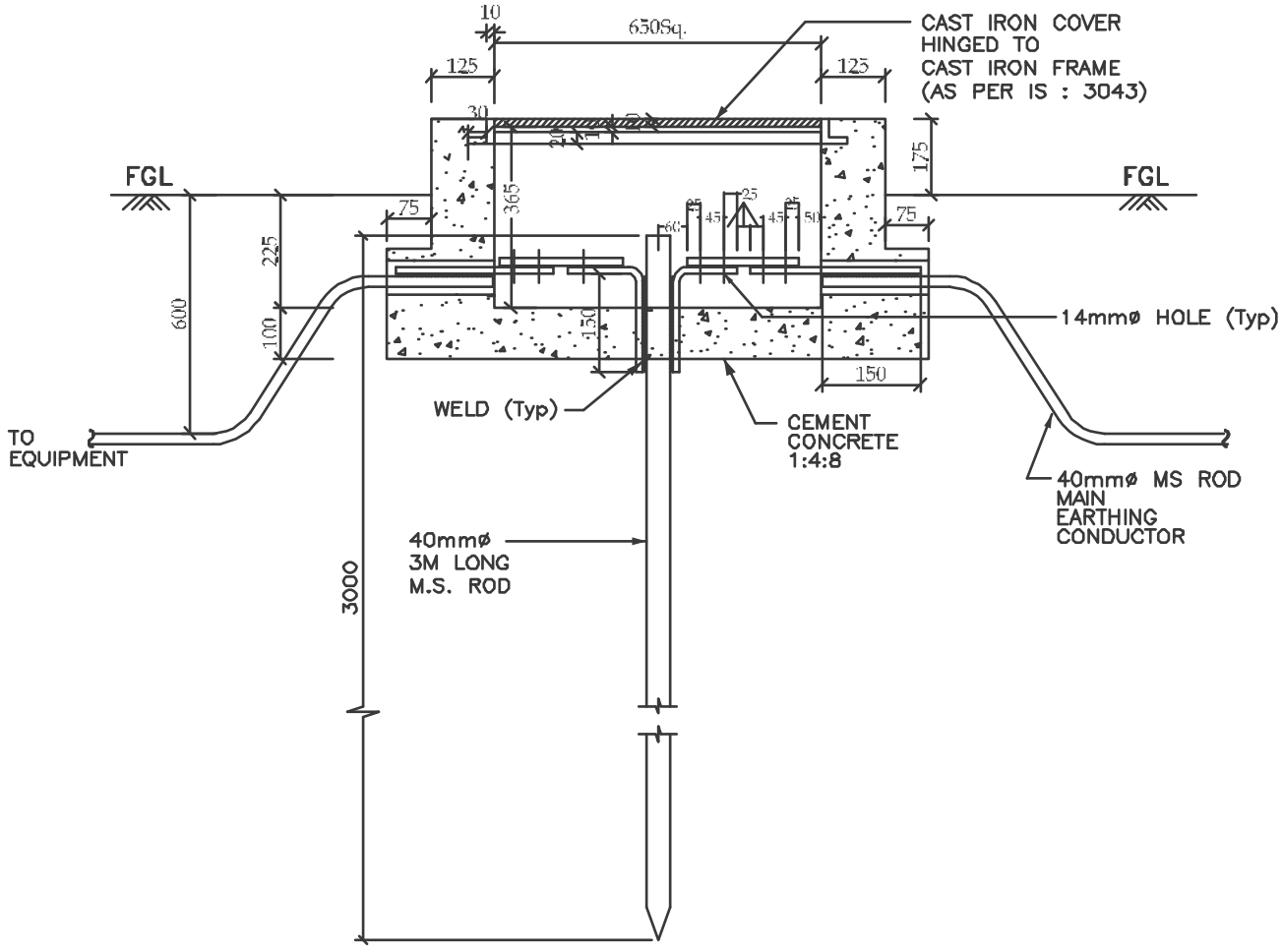
TITLE:- STANDARD EARTHING DETAILS

K.K.Parkar	K.K.Parkar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09
CKD BY	PRPD BY	Date	SHEET # 5

ROD ELECTRODE WITH TEST LINK FOR LM, TOWER WITH PEAK, CVT, LA



PLAN



ELEVATION

RELEASED FOR CONTRUCTION

POWER GRID CORPORATION OF INDIA LIMITED
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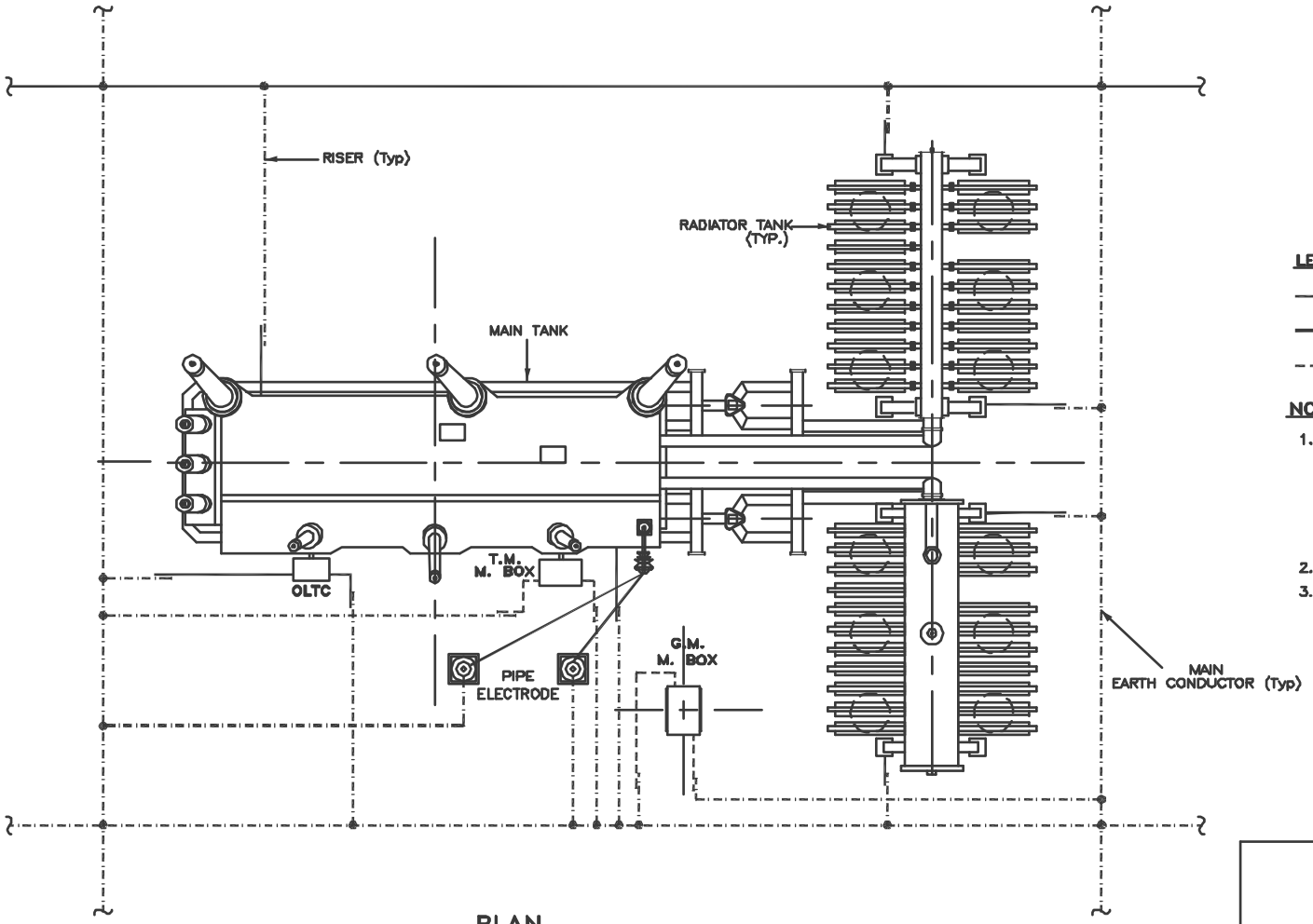
पावरग्रिड

PROJECT :- TECHNICAL SPECIFICATION-SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

KKPashar	KKPashar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09
CKD BY	PRPD BY	Date	SHEET # 6

EARTHING OF TRANSFORMER/ REACTOR



PLAN

LEGEND

— · — · —	40mmø MS ROD
———	75 x 12 mm GS FLAT
- - - - - - - - - -	50 x 6 mm GS FLAT

NOTES :-

1. No. OF RISERS :-

MAIN TANK	–	2 Nos.
RADIATOR TANK	–	4 Nos.
OLTC	–	2 Nos. (ICT only)
M. BOX	–	2 Nos./M. BOX
NEUTRAL EARTH ELECTRODE	–	2 Nos.

2. No. OF PIPE ELECTRODE REQUIRED = 2 Nos.
3. PYLON SUPPORTS SHALL BE EARTHED TO THE MAIN EARTHING CONDUCTOR BY GS FLAT.

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POWER GRID CORPORATION OF INDIA LIMITED
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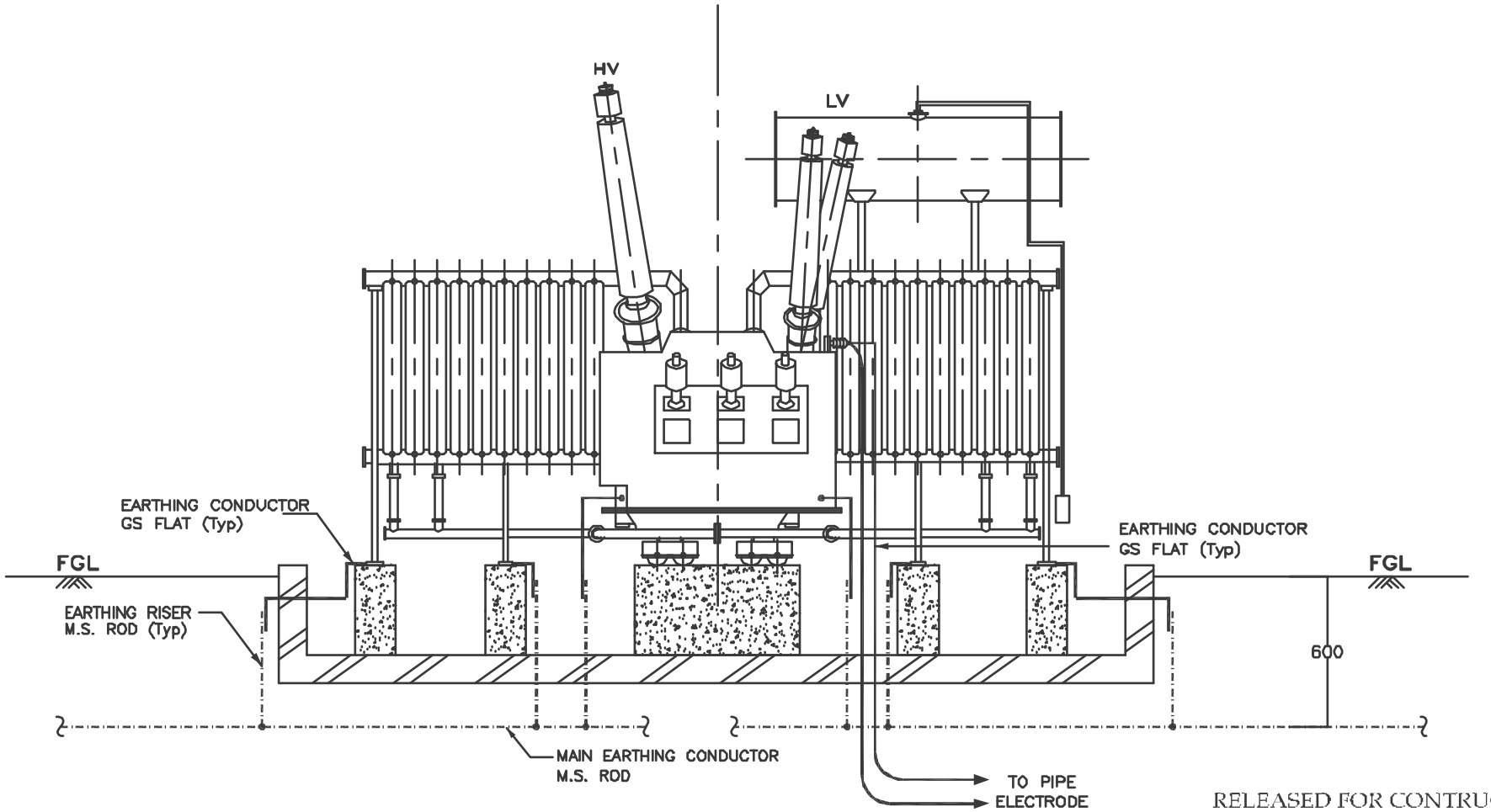
पावरग्रिड

PROJECT :- TECHNICAL SPECIFICATION-SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

K.K.Sinha	K.K.Sinha	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 7
CKD BY	PRPD BY	Date	

EARTHING OF TRANSFORMER/ REACTOR



RELEASED FOR CONTRUCTION

LEGEND

- 40mmø MS ROD
- 75 x 12 mm GS FLAT
- 50 x 6 mm GS FLAT

END VIEW

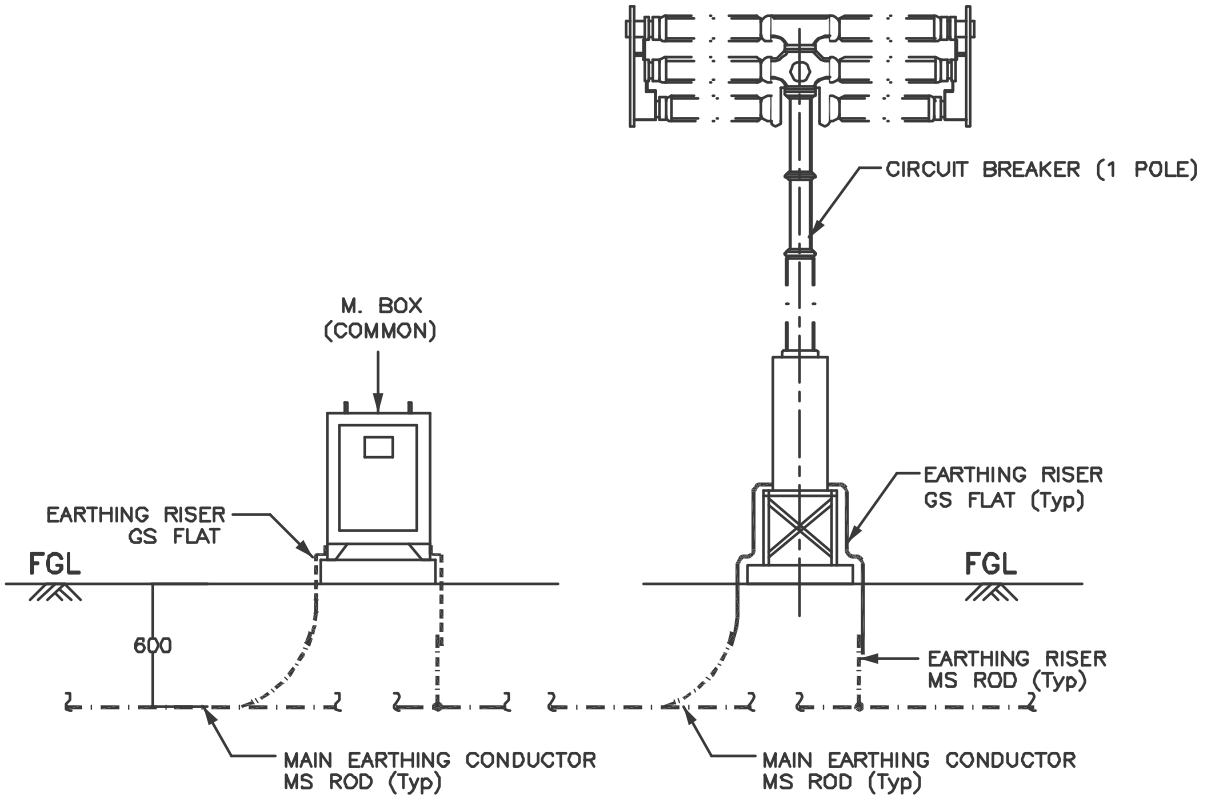
POWER GRID CORPORATION OF INDIA LIMITED
(A Government of India Enterprise)
पावरग्रिड

PROJECT :- TECHNICAL SPECIFICATION- SWITCHYARD ERECTION

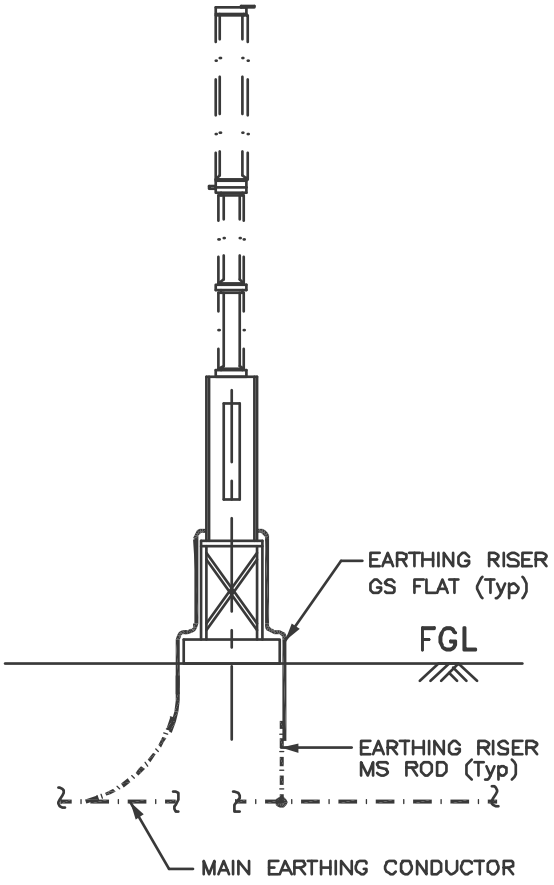
TITLE:- STANDARD EARTHING DETAILS

CKD BY	PRPD BY	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09
		Date	SHEET # 8

EARTHING OF CIRCUIT BREAKER



ELEVATION



NOTES :-

1. No. OF RISERS FOR CIRCUIT BREAKER = 2 Nos. / PHASE
1. No. OF RISERS FOR LADDER (IF Applicable) = 2 Nos.
2. No. OF RISERS FOR MAR. BOX = 2 Nos.
3. CLEAT CLAMP SHALL BE PROVIDED AT 1000mm INTERVAL.

LEGEND

— · — · —	40mmø MS ROD
———	75 x 12 mm GS FLAT
- - - - - - - - - - - - - - -	50 x 6 mm GS FLAT

RELEASED FOR CONTRUCTION

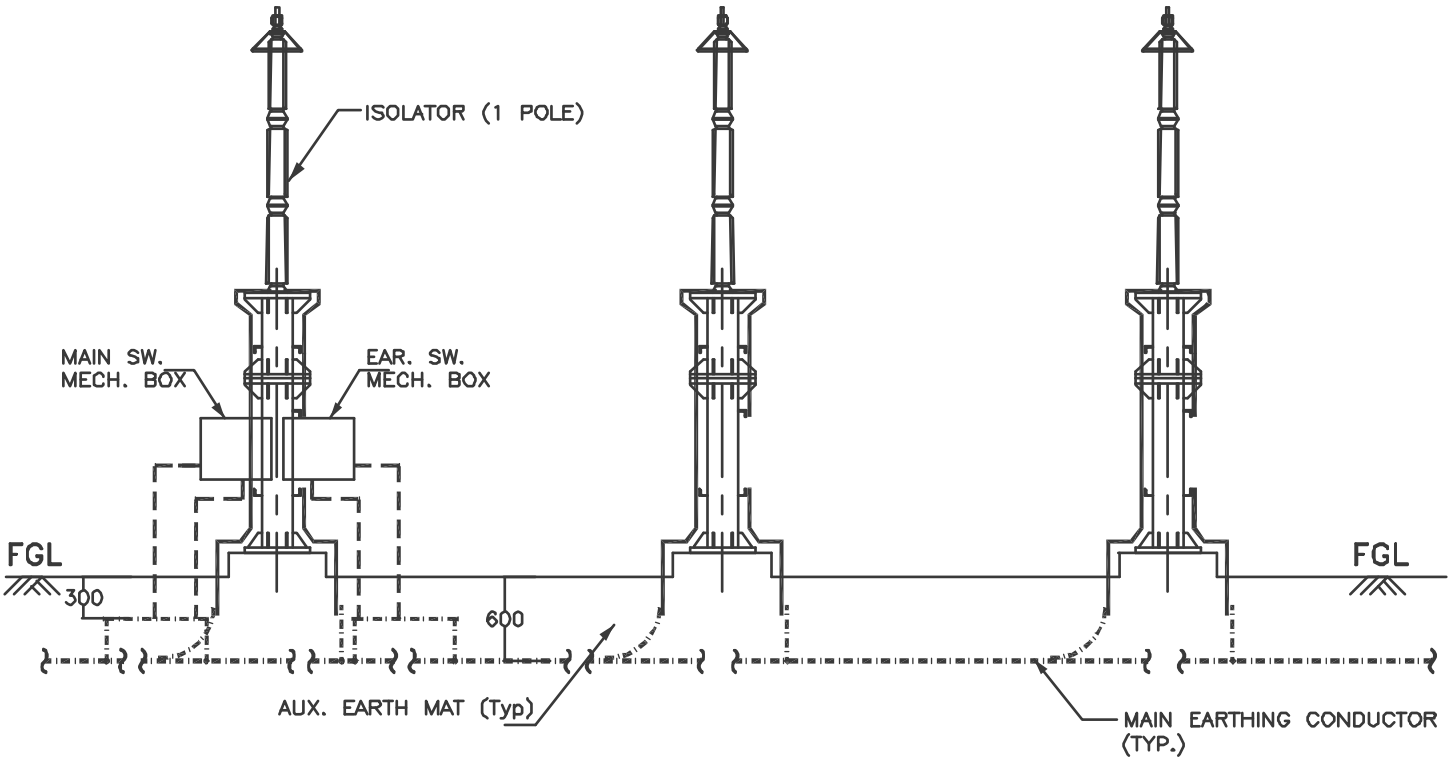
POWER GRID CORPORATION OF INDIA LIMITED
(A Government of India Enterprise)
पावरग्रिड

PROJECT :- TECHNICAL SPECIFICATION-SWITCHYARD ERECTION

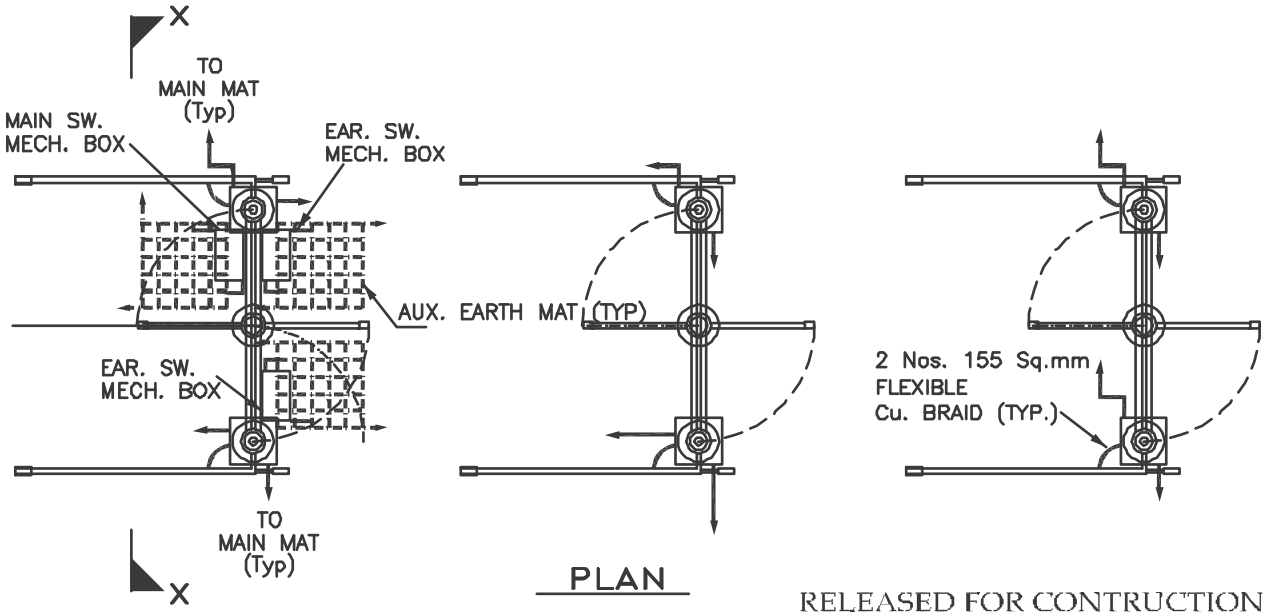
TITLE:- STANDARD EARTHING DETAILS

KKPashar	KKPashar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 9
CKD BY	PRPD BY	Date	

EARTHING OF ISOLATOR



ELEVATION



PLAN

RELEASED FOR CONTRUCTION

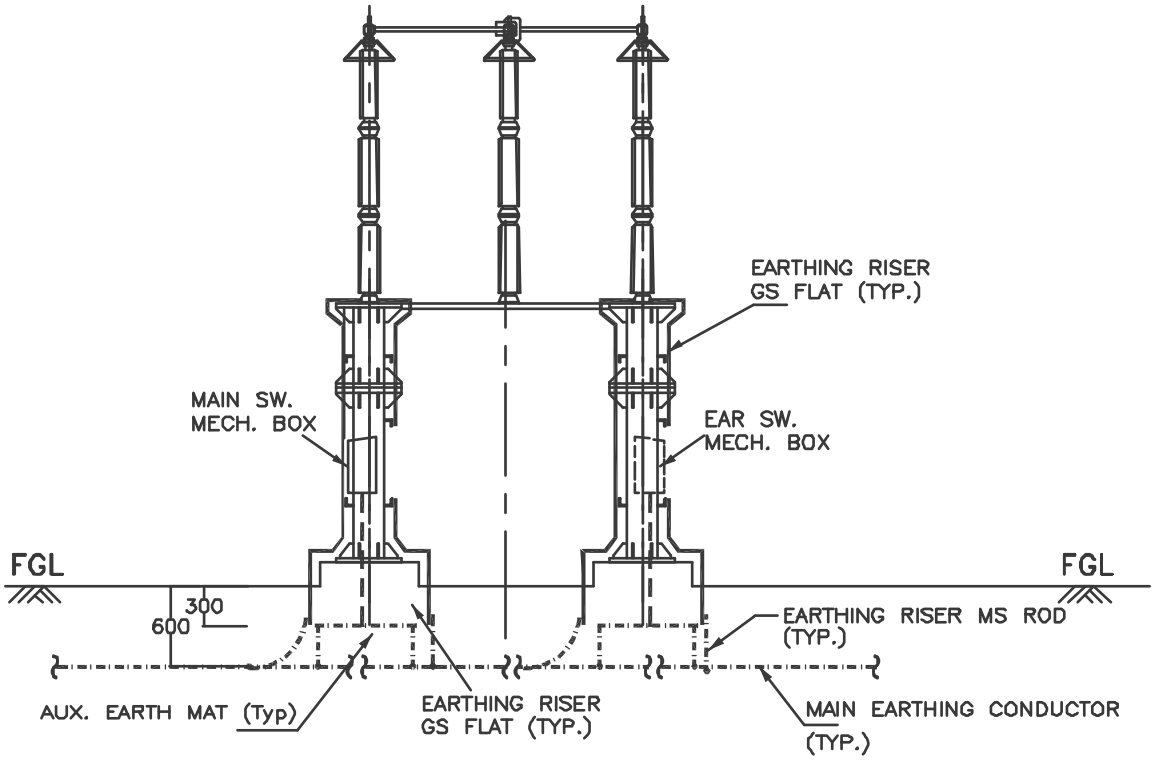
POWER GRID CORPORATION OF INDIA LIMITED
(A Government of India Enterprise)
पावरग्रिड

PROJECT :- TECHNICAL SPECIFICATION-SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

KKPashar	KKPashar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09
CKD BY	PRPD BY	Date	SHEET # 10

EARTHING OF ISOLATOR (1 PH)



VIEW – X X

LEGEND

—— · —— · ——	40mmø MS ROD
————————	75 x 12 mm GS FLAT
- - - - - - - - - - - - - - - -	50 x 6 mm GS FLAT

NOTES :–

1. No. OF RISERS FOR ISOLATOR = 4 Nos. / PHASE.
2. No. OF RISERS FOR MAIN MECH. BOX = 2 Nos.
3. No. OF RISERS FOR EARTH SW. MECH. BOX = 2 Nos. / BOX.
4. No. OF AUXILIARY EARTH MAT = 1 Nos. FOR EACH MB
5. CLEAT CLAMP SHALL BE PROVIDED AT 1000mm INTERVAL.
6. NO. OF AUX. EARTHMAT IS INDICATIVE ONLY. IT SHALL BE EXECUTED AS PER ACTUAL NUMBER/POSITION OF EARTH SWITCHES.

RELEASED FOR CONTRUCTION

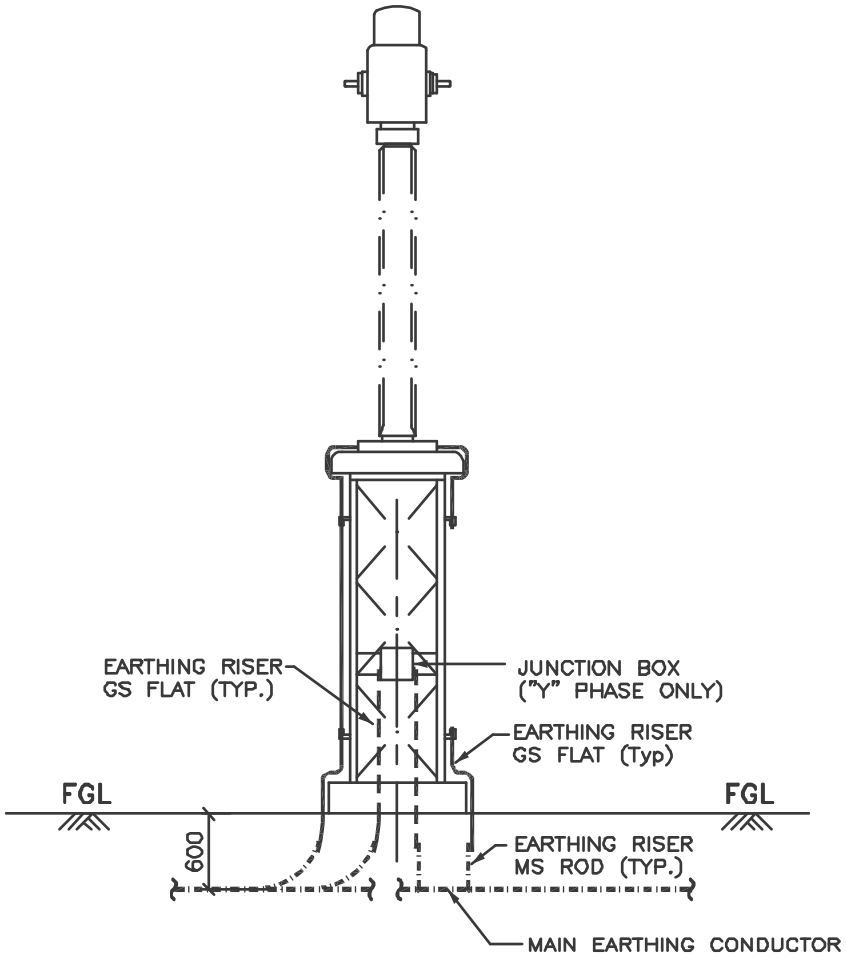
POWER GRID CORPORATION OF INDIA LIMITED
(A Government of India Enterprise) पावरग्रिड

PROJECT :- TECHNICAL SPECIFICATION-SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

KKPashar	KKPashar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 11
CKD BY	PRPD BY	Date	

EARTHING OF CURRENT TRANSFORMER (1 PH)



ELEVATION

LEGEND

——— · ——— · ———	40mmø MS ROD
———————————	75 x 12 mm GS FLAT
- - - - - - - - - - - - - - - -	50 x 6 mm GS FLAT

NOTES :–

1. No. OF RISERS = 2 Nos. / PHASE.
2. No. OF RISERS FOR JUN. BOX = 2 Nos.
3. CLEAT CLAMP SHALL BE PROVIDED AT 1000mm INTERVAL.

RELEASED FOR CONTRUCTION

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

PROJECT :- TECHNICAL SPECIFICATION-SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

K.K.Parkar	K.K.Parkar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 12
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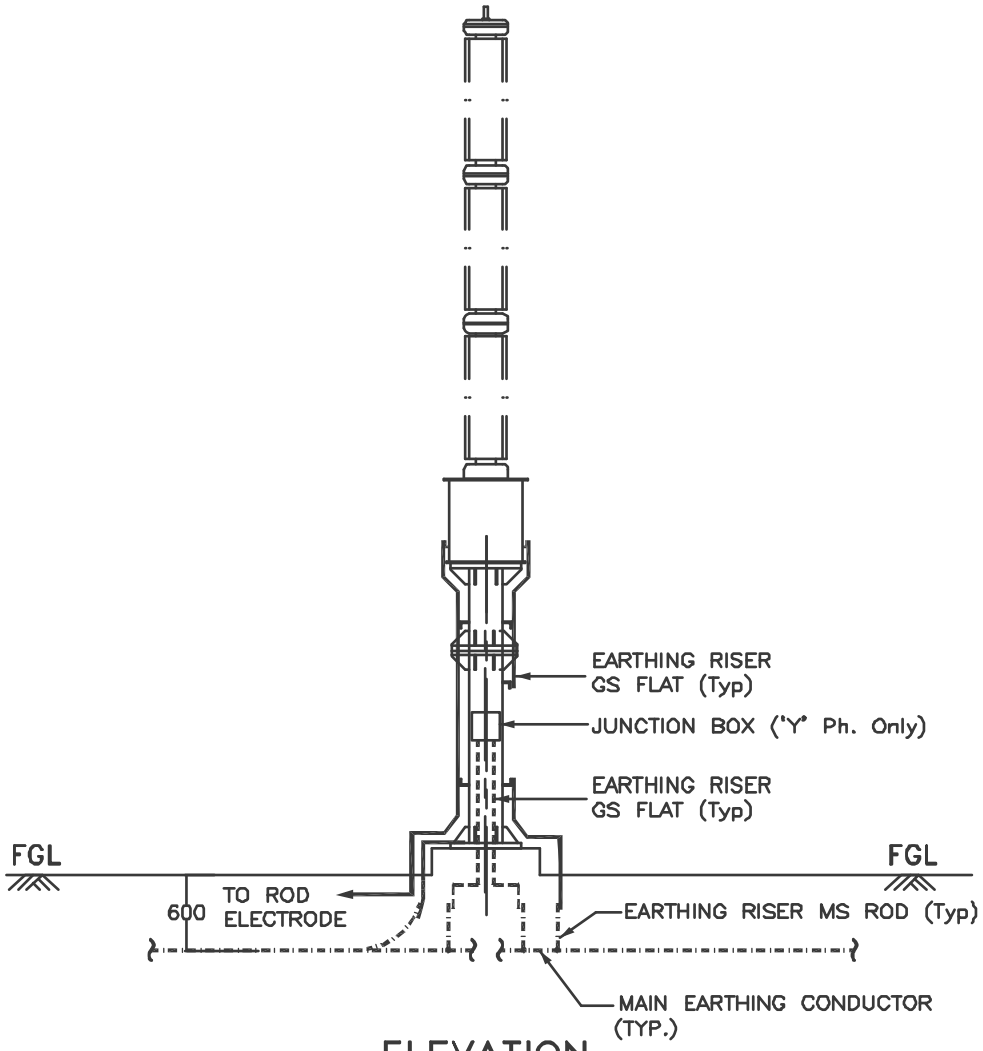
EARTHING OF CAPACITIVE VOLTAGE TRANSFORMER (1 PH)



ELEVATION

LEGEND

— · — · —	40mmø MS ROD
———	75 x 12 mm GS FLAT
- - - - - - - - - - - - - - -	50 x 6 mm GS FLAT

NOTES :–

1. No. OF RISERS = 3 Nos. / PHASE.
2. No. OF RISERS FOR J. BOX = 2 Nos.
3. No. OF ROD ELECTRODE REQUIRED = 1 No. / PHASE.
4. CLEAT CLAMP SHALL BE PROVIDED AT 1000mm INTERVAL.

RELEASED FOR CONTRUCTION

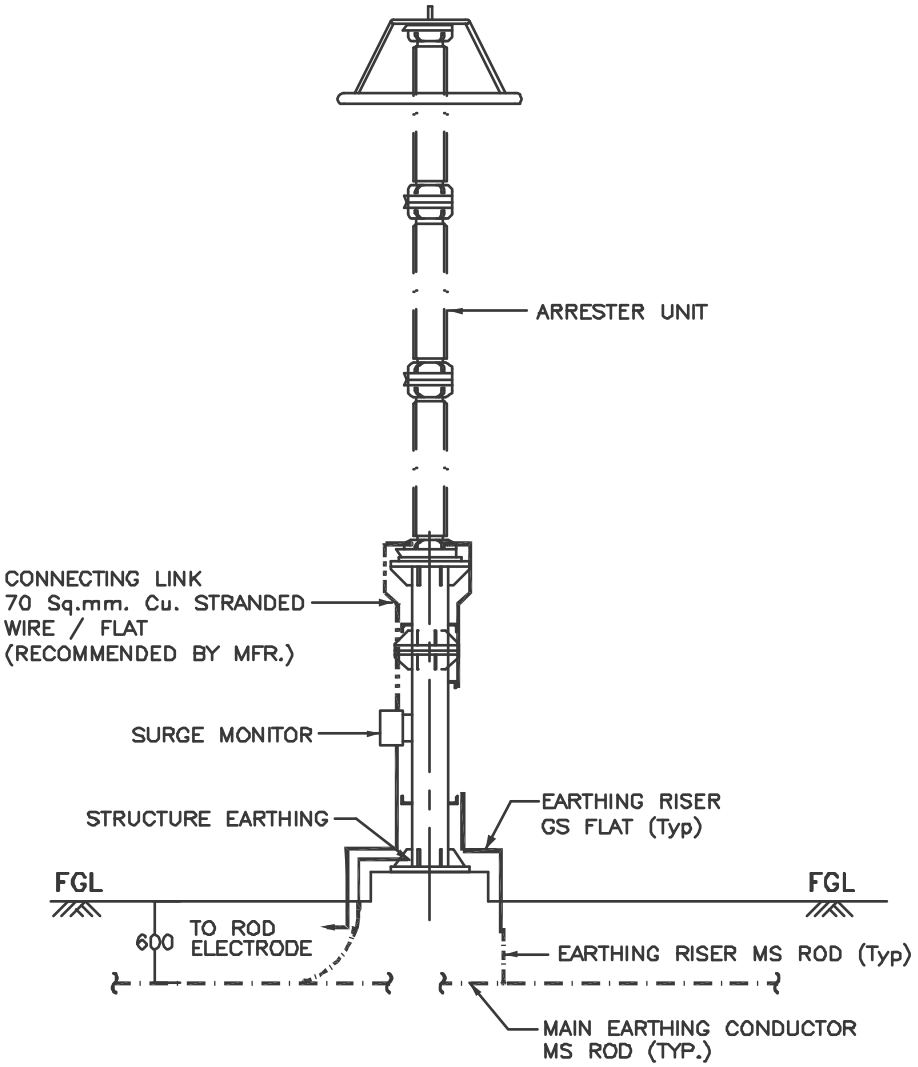
POWER GRID CORPORATION OF INDIA LIMITED
(A Government of India Enterprise)
पावरग्रिड

PROJECT :- TECHNICAL SPECIFICATION-SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

KKPashar	KKPashar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 13
CKD BY	PRPD BY	Date	

EARTHING OF SURGE ARRESTER (1PH)



ELEVATION

LEGEND

— · — · — 40mmø MS ROD

——— 75 x 12 mm GS FLAT

NOTES :–

1 . No. OF RISERS = 3 Nos. / PHASE.
2 . No. OF ROD ELECTRODE REQUIRED = 1 No. / PHASE.
3 . CLEAT CLAMP SHALL BE PROVIDED AT 1000mm INTERVAL.

RELEASED FOR CONTRUCTION

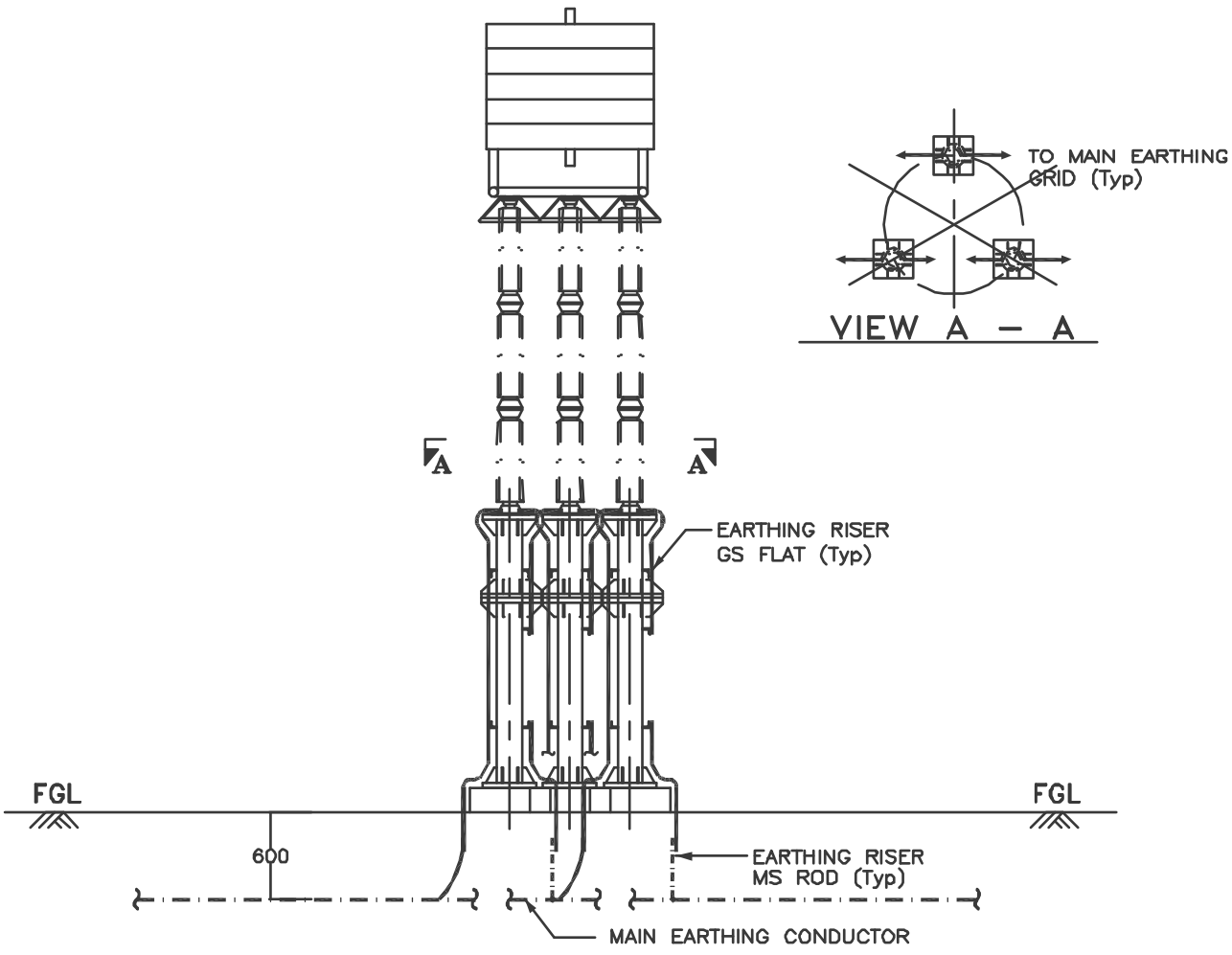
POWER GRID CORPORATION OF INDIA LIMITED
(A Government of India Enterprise)
पावरग्रिड

PROJECT :- TECHNICAL SPECIFICATION-SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

K.K.Parkar	K.K.Parkar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 14
CKD BY	PRPD BY	Date	

EARTHING OF WAVE TRAP (1PH)



ELEVATION

LEGEND

— · — · — 40mmø MS ROD

——————— 75 x 12 mm GS FLAT

NOTE :–

1. No. OF RISERS = 6 Nos. / PHASE.
2. CLEAT CLAMP SHALL BE PROVIDED AT 1000mm INTERVAL.

RELEASED FOR CONTRUCTION

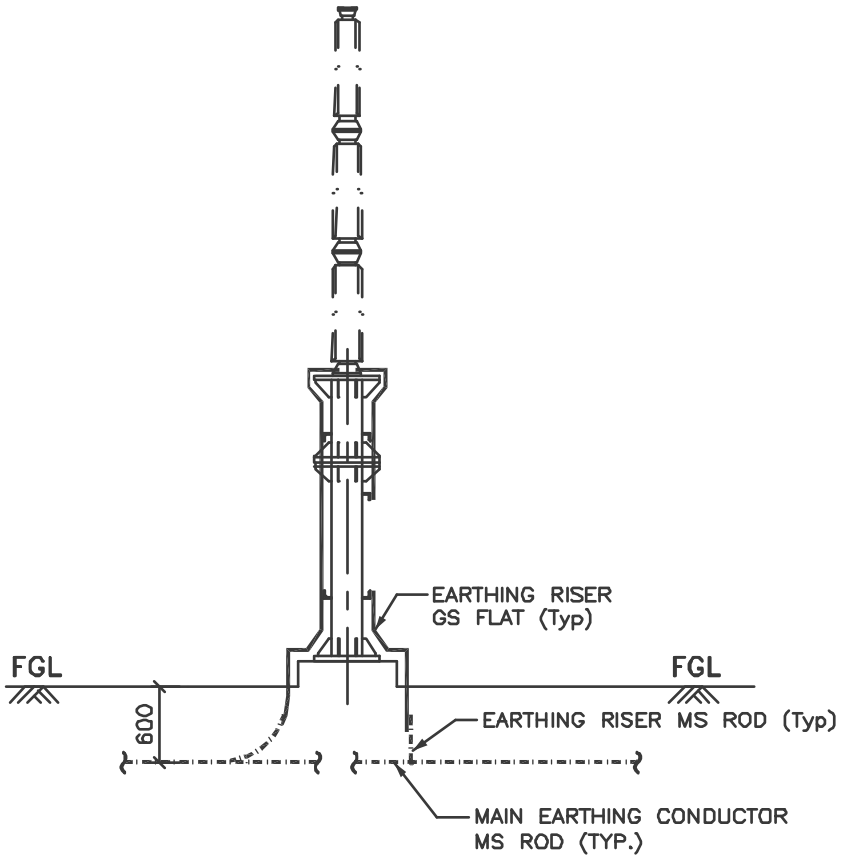
POWER GRID CORPORATION OF INDIA LIMITED
(A Government of India Enterprise) पावरग्रिड

PROJECT :- TECHNICAL SPECIFICATION-SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

KKPashar	KKPashar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 15
CKD BY	PRPD BY	Date	

EARTHING OF POST INSULATOR (1PH)



ELEVATION

LEGEND

40mmø MS ROD

75 x 12 mm GS FLAT

NOTES :-

1. No. OF RISERS = 2 Nos. / PHASE.
2. CLEAT CLAMP SHALL BE PROVIDED AT 1000mm INTERVAL.

RELEASED FOR CONTRUCTION

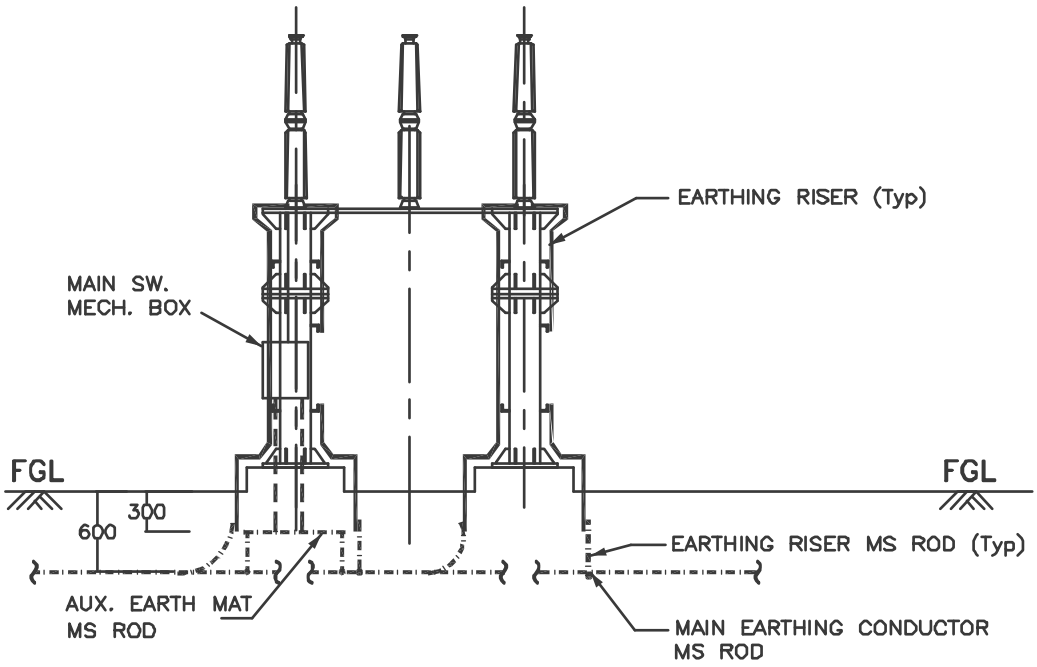
POWER GRID CORPORATION OF INDIA LIMITED
(A Government of India Enterprise) पावरग्रिड

PROJECT :- TECHNICAL SPECIFICATION-SWITCHYARD ERECTION

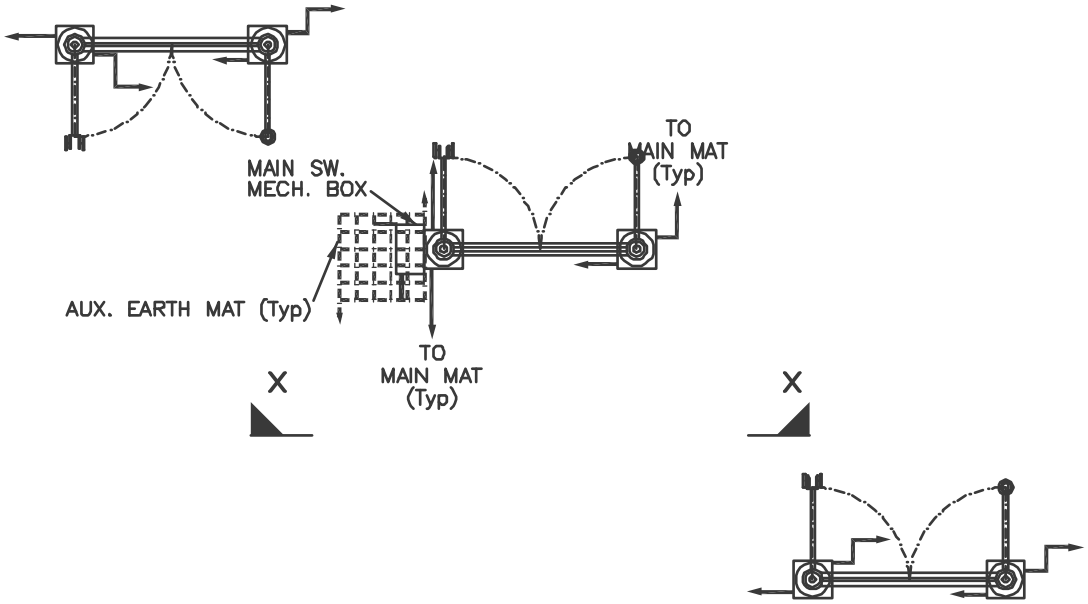
TITLE:- STANDARD EARTHING DETAILS

KK Parkar	KK Parkar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 16
CKD BY	PRPD BY	Date	

TANDEM ISOLATOR



VIEW – X X

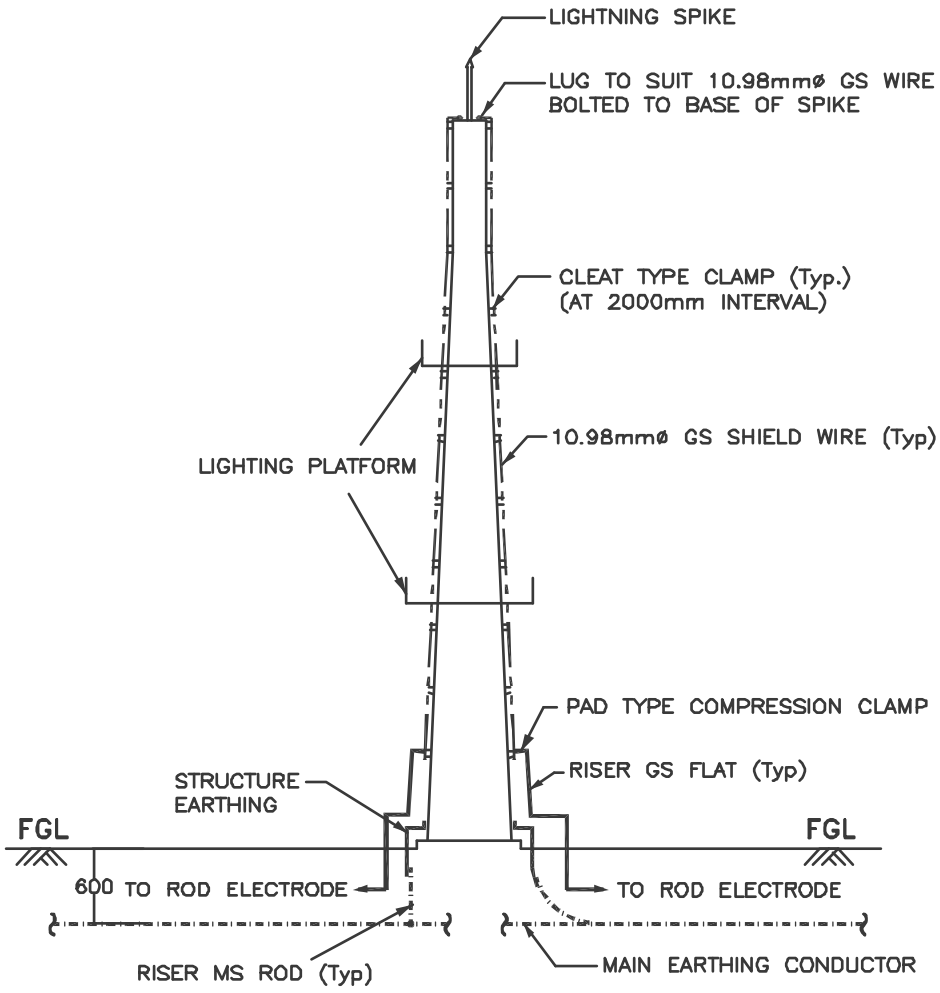


PLAN

RELEASED FOR CONTRUCTION

POWER GRID CORPORATION OF INDIA LIMITED (A Government of India Enterprise) पावरग्रिड			
PROJECT :- TECHNICAL SPECIFICATION- SWITCHYARD ERECTION			
TITLE:- STANDARD EARTHING DETAILS			
K.K.Sarkar	K.K.Sarkar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 17
CKD BY	PRPD BY	Date	

EARTHING OF LIGHTNING MAST



ELEVATION

NOTES :–

1. No. OF RISERS = 4 Nos.
2. No. OF ROD ELECTRODE REQUIRED = 2 Nos.
3. No. OF PAD TYPE CLAMP = 2 Nos.

LEGEND

— · — · — 40mmø MS ROD

——— 75 x 12 mm GS FLAT

RELEASED FOR CONTRUCTION

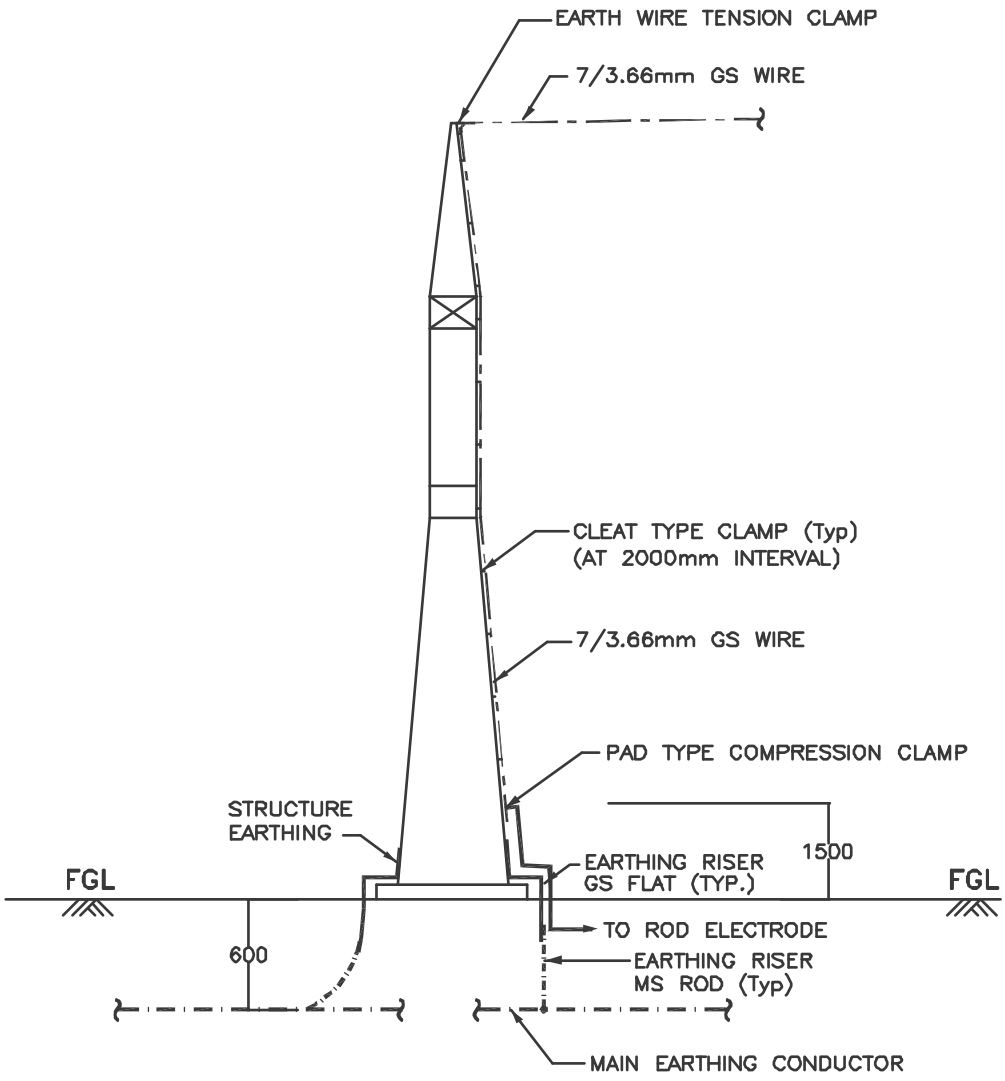
POWER GRID CORPORATION OF INDIA LIMITED
(A Government of India Enterprise) पावरग्रिड

PROJECT :- TECHNICAL SPECIFICATION- SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

K.K.Parkar	K.K.Parkar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 18
CKD BY	PRPD BY	Date	

EARTHING OF TOWER WITH PEAK



ELEVATION

NOTES :-

1. No. OF RISERS = 3 Nos.
2. No. OF ROD ELECTRODE REQUIRED = 1 No.
3. No. OF PAD TYPE CLAMP = 1 No.

LEGEND

- 40mmø MS ROD
- 75 x 12 mm GS FLAT

RELEASED FOR CONTRUCTION

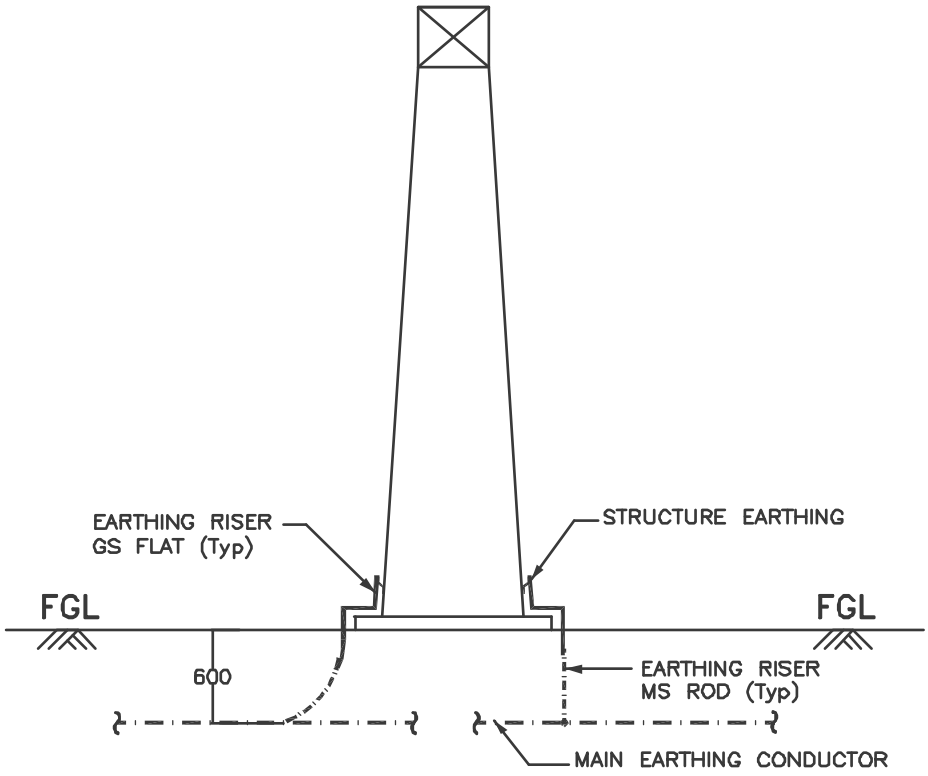
POWER GRID CORPORATION OF INDIA LIMITED
(A Government of India Enterprise) पावरग्रिड

PROJECT :- TECHNICAL SPECIFICATION-SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

KKPashar	KKPashar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 19
CKD BY	PRPD BY	Date	

EARTHING OF TOWER WITHOUT PEAK



ELEVATION

LEGEND

— · — · — 40mmø MS ROD

——— 75 x 12 mm GS FLAT

NOTES :-

1. No. OF RISERS = 2 Nos.

RELEASED FOR CONTRUCTION

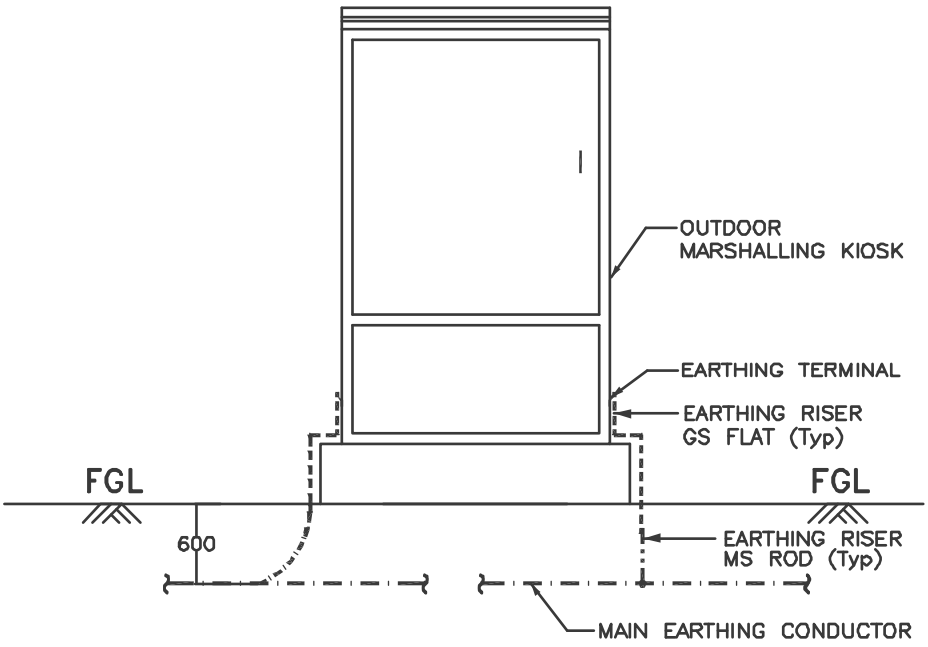
POWER GRID CORPORATION OF INDIA LIMITED
(A Government of India Enterprise) पावरग्रिड

PROJECT :- TECHNICAL SPECIFICATION-SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

K.K.Parkar	K.K.Parkar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 20
CKD BY	PRPD BY	Date	

EARTHING OF BAY MARSHALLING BOX



ELEVATION

LEGEND

—— · —— · ——	40mmø MS ROD
————————	75 x 12 mm GS FLAT
----------	50 x 6 mm GS FLAT

NOTE :–

1. No. OF RISERS = 2 Nos.

RELEASED FOR CONTRUCTION

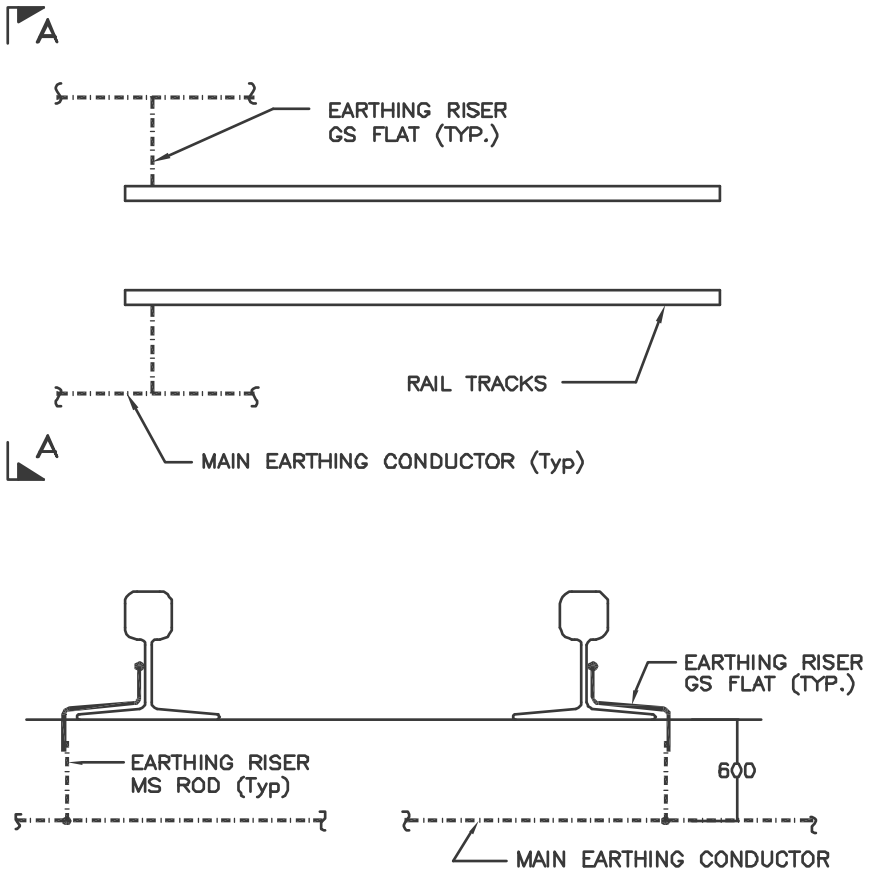
POWER GRID CORPORATION
OF INDIA LIMITED
(A Government of India Enterprise) पावरग्रिड

PROJECT :- TECHNICAL SPECIFICATION-
SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

KK Parkar	KK Parkar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 21
CKD BY	PRPD BY	Date	

EARTHING OF RAIL TRACK



SECTION A – A

LEGEND

40mmø MS ROD

75 x 12 mm GS FLAT

NOTES :–

1. EACH RAIL SHALL BE EARTHED AT 30M INTERVAL AND ALSO AT BOTH ENDS.

RELEASED FOR CONTRUCTION

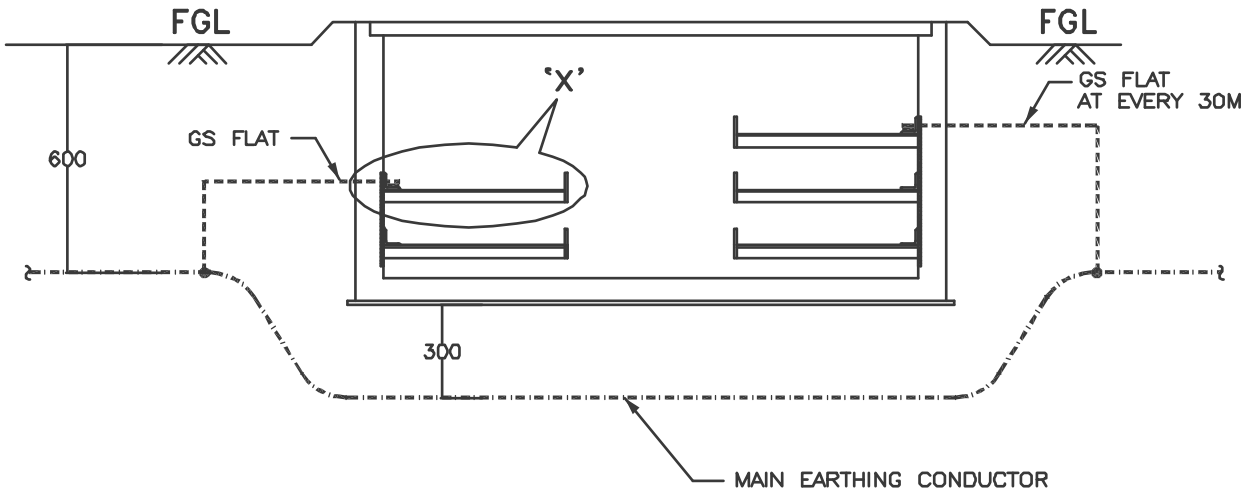
POWER GRID CORPORATION OF INDIA LIMITED
(A Government of India Enterprise)
पावरग्रिड

PROJECT :- TECHNICAL SPECIFICATION-SWITCHYARD ERECTION

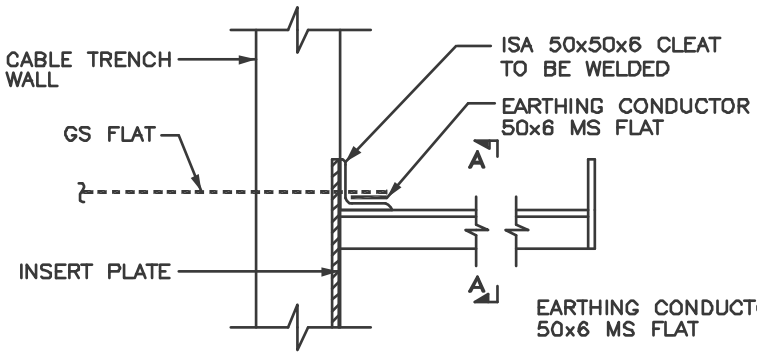
TITLE:- STANDARD EARTHING DETAILS

CKD BY	PRPD BY	Date	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 22
KKPashar	KKPashar	Dec-2013	

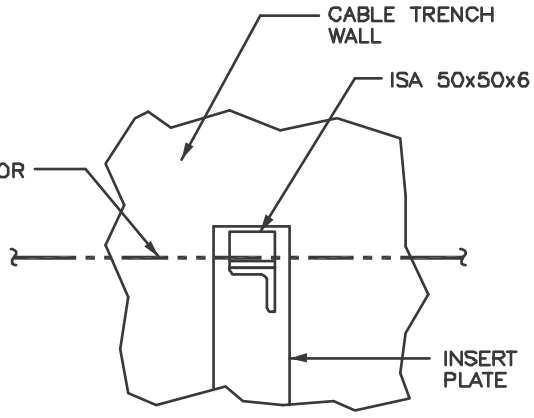
EARTHING OF CABLE TRENCH



TYPICAL CROSS SECTION OF CABLE TRENCH



DETAIL – X



SECTION A – A

NOTES :–

1. MS FLAT SHALL RUN ON TOP TIER ALL ALONG THE CABLE TRENCHES & WELDED TO EACH OF THE RACKS.
2. MS FLAT SHALL BE EARTHED AT 30M INTERVAL AND ALSO AT BOTH ENDS.

RELEASED FOR CONTRUCTION

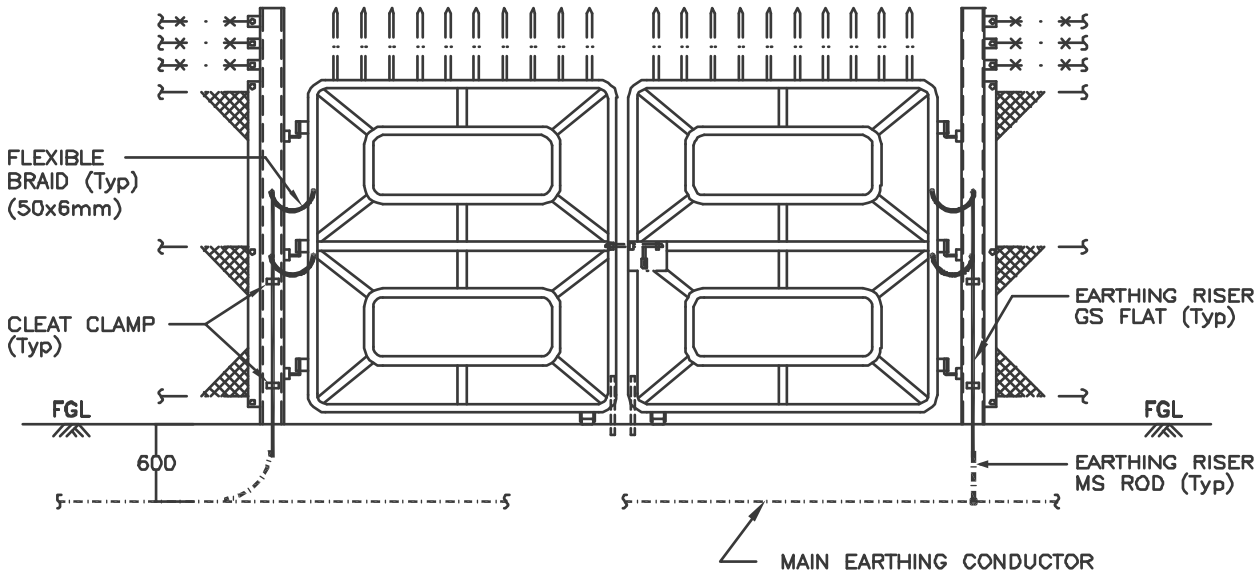
POWER GRID CORPORATION OF INDIA LIMITED
(A Government of India Enterprise)
पावरग्रिड

PROJECT :- TECHNICAL SPECIFICATION-SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

KKPashar	KKPashar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 23
CKD BY	PRPD BY	Date	

EARTHING OF GATES



MAIN GATE

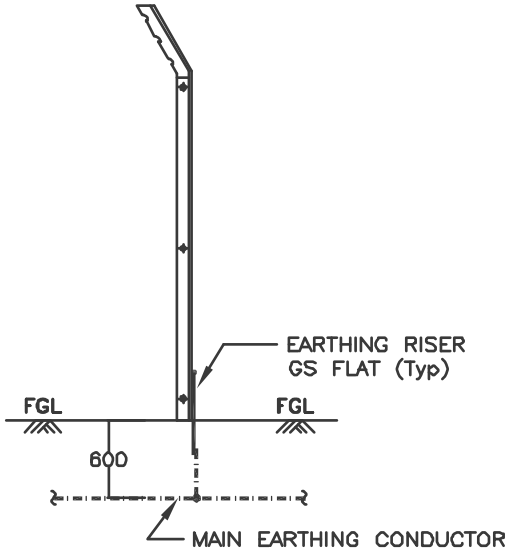
LEGEND

—— · —— · ——	40mmø MS ROD
————————	75 x 12 mm GS FLAT
—— - - —— - - ——	50 x 6 mm MS FLAT

NOTES :-

	FENCE POST	MAIN GATE
1 . No. OF RISERS REQUIRED	1	2
2 . No. OF FLEXIBLE BRAID	—	4

3. ALL GATES & EVERY ALTERNATE FENCE SHALL BE CONNECTED TO EARTHING GRID.



FENCE POST
(ALTERNATE FENCE POST)

RELEASED FOR CONTRUCTION

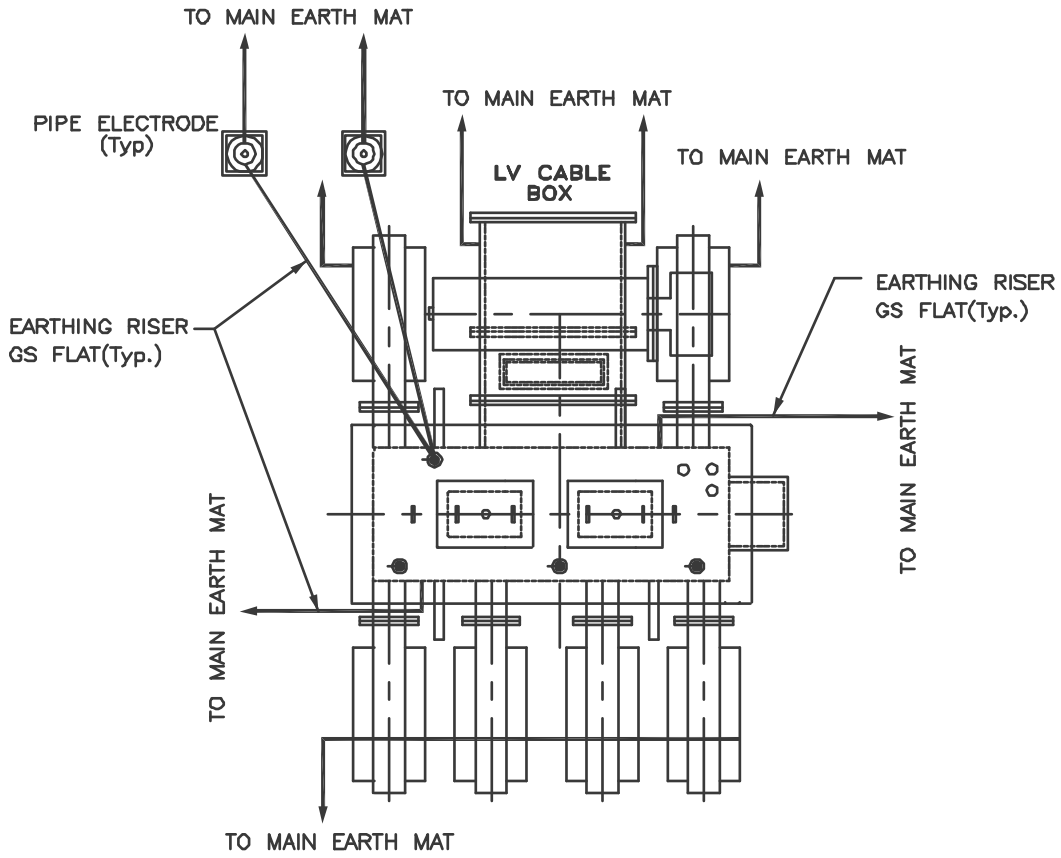
POWER GRID CORPORATION OF INDIA LIMITED
(A Government of India Enterprise) पावरग्रिड

PROJECT :- TECHNICAL SPECIFICATION-SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

KKPashar	KKPashar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 24
CKD BY	PRPD BY	Date	

EARTHING OF LT TRANSFORMER



PLAN

LEGEND

- 40mmø MS ROD
- 75 x 12 mm GS FLAT
- 50 x 6 mm GS FLAT

NOTES :-

1. No. OF RISERS FOR MAIN TANK & T.M. MAR. BOX = 4 Nos.
2. No. OF RISERS FOR LV CABLE BOX & RADIATOR = 4 Nos.
3. No. OF RISERS FOR PIPE ELECTRODE = 2 Nos.
4. No. OF PIPE ELECTRODES REQUIRED = 2 Nos.

RELEASED FOR CONTRUCTION

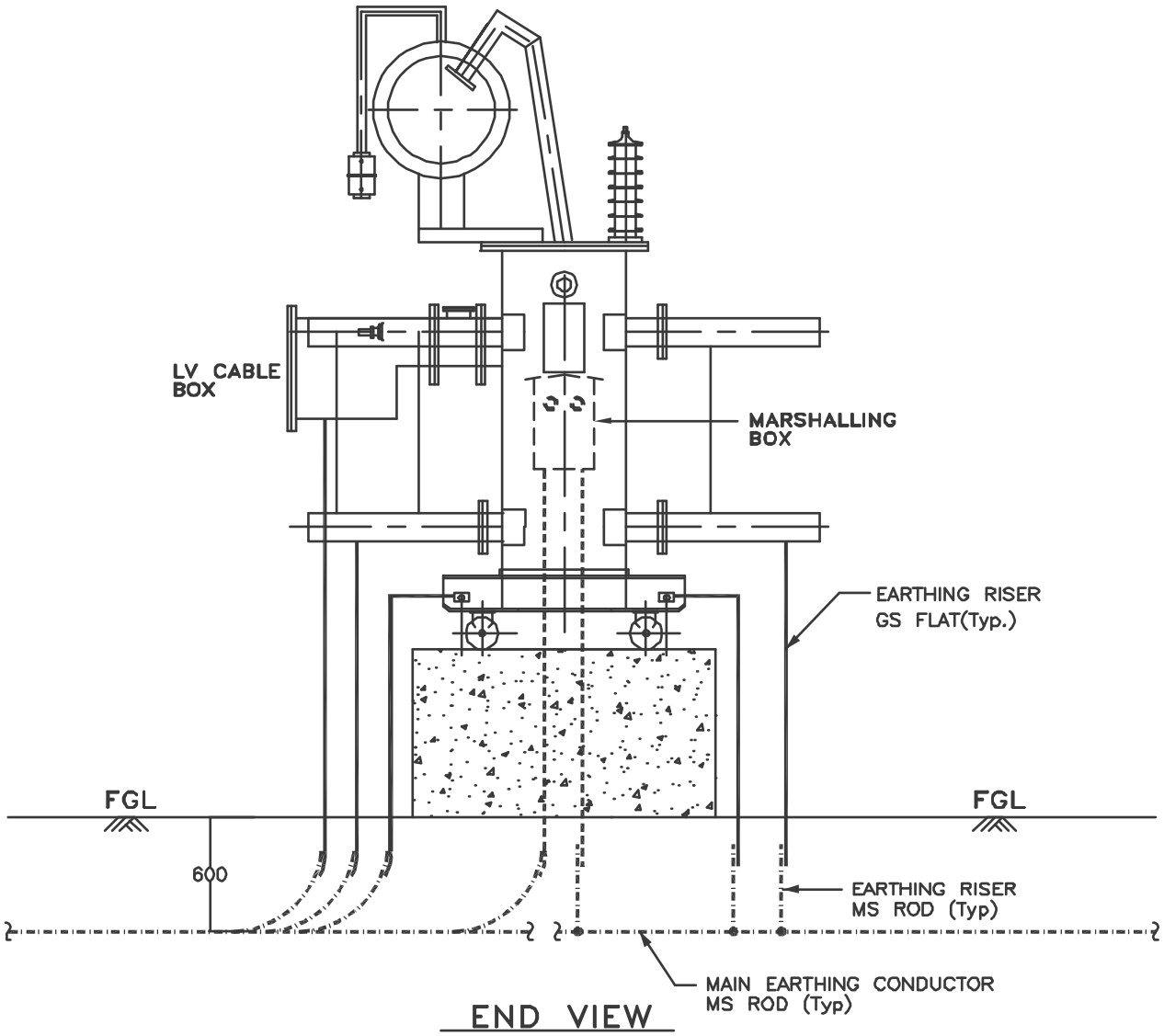
POWER GRID CORPORATION OF INDIA LIMITED
(A Government of India Enterprise) पावरग्रिड

PROJECT :- TECHNICAL SPECIFICATION-SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

KKPashar	KKPashar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 25
CKD BY	PRPD BY	Date	

EARTHING OF LT TRANSFORMER



END VIEW

RELEASED FOR CONTRUCTION

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

PROJECT :- TECHNICAL SPECIFICATION-SWITCHYARD ERECTION

TITLE:- STANDARD EARTHING DETAILS

K.K.Parkar	K.K.Parkar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 26
CKD BY	PRPD BY	Date	

EARTHING OF PYLON SUPPORTS

Pylon supports shall be grounded through 50x6mm GI flat to the ring around the Pylon supports of 75x12mm GI flat which in turn is connected to the main grid (40 mm dia MS rod) at 2 to3 points as available.

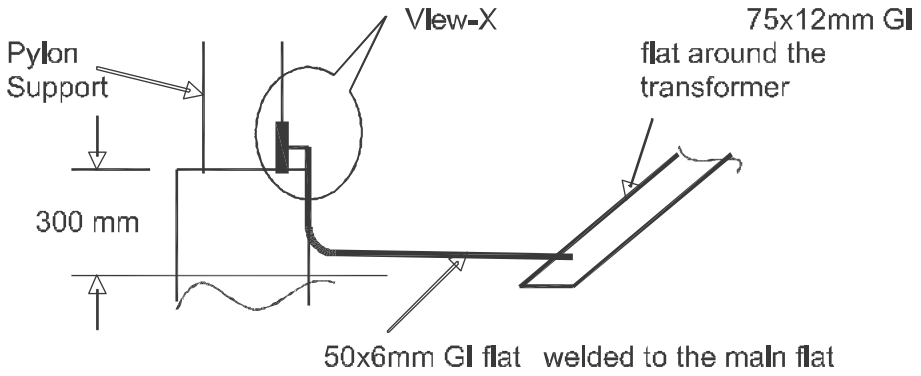


Fig.- Elevation (Earthing of Pylon Supports)

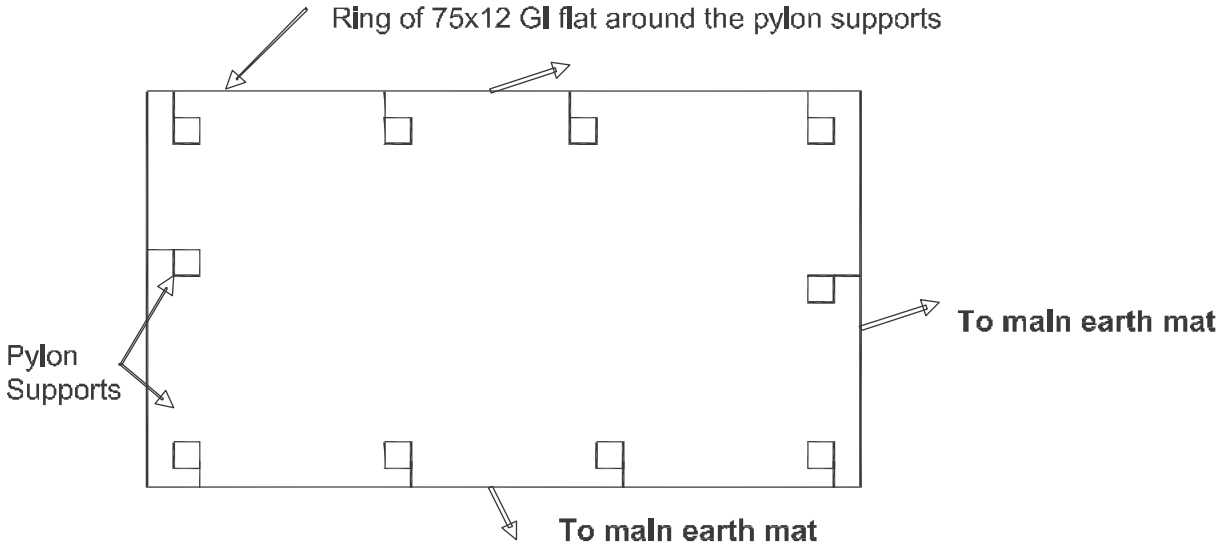


Fig.- Layout (Earthing of Pylon Supports)

RELEASED FOR CONTRUCTION

POWER GRID CORPORATION OF INDIA LIMITED (A Government of India Enterprise)			
PROJECT :- TECHNICAL SPECIFICATION- SWITCHYARD ERECTION			
TITLE:- STANDARD EARTHING DETAILS			
K.K.Sarkar	K.K.Sarkar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 27
CKD BY	PRPD BY	Date	

EARTHING OFHYDRANT/ HVW SPRAY PIPING

These pipes shall be grounded at pump house through 50x6mm GI flat connected to the main flat, 75x12mm running around the room.

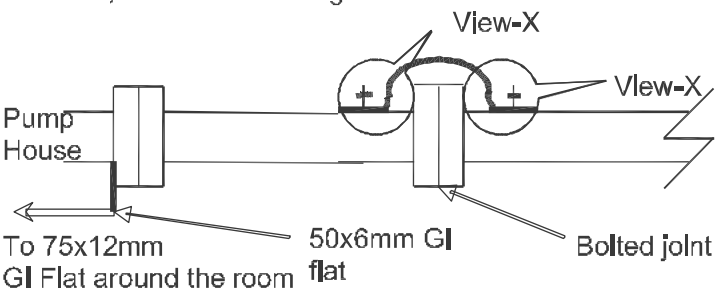


Fig.-Earthing of Hydrant / HVW Spray Piping

EARTHING OFHYDRANT POST/ HOSE BOX

A bolt shall be welded to these structures at the time of installation which can be used to connect them to the nearest riser or main 75x12mm GI flat through 50x6mm GI flat.

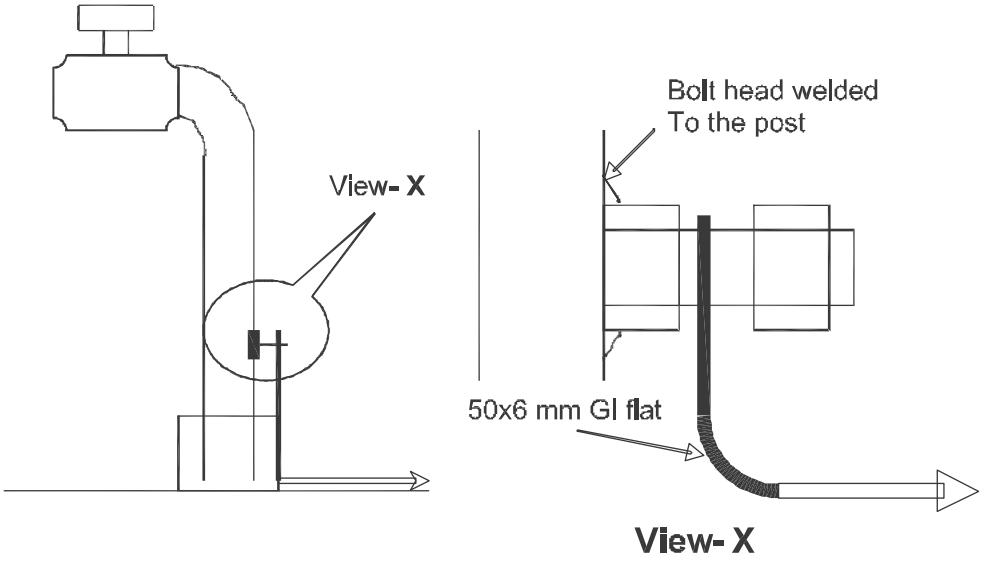


Fig.- Earthing of hydrant box / hose box

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POWER GRID CORPORATION OF INDIA LIMITED (A Government of India Enterprise)			
PROJECT :- TECHNICAL SPECIFICATION- SWITCHYARD ERECTION			
TITLE:- STANDARD EARTHING DETAILS			
K.K.Sarkar	K.K.Sarkar	Dec-2013	Drawing No.: C/ENG/STD/EARTHINGS/09 SHEET # 28
CKD BY	PRPD BY	Date	

SECTION: STRUCTURE

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1.0	GENERAL	1
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3.0	DESIGN DRAWINGS, BILL OF MATETRIALS AND DOCUMENTS	4
4.0	FABRICATION AND ERECTION	5
5.0	BOLTING	5
6.0	WELDING	5
7.0	FOUNDATION BOLTS	6
8.0	STABILITY OF STRUCTURE	6
9.0	GROUTING	6
10.0	GALVANISING	6
11.0	TOUCH-UP PAINTING	6
12.0	INSPECTION BEFORE DISPATCH	7
13.0	TEST CERTIFICATE	7
14.0	SAFETY PRECAUTIONS	7

SECTION: STRUCTURES

1.0 GENERAL

The scope of specification covers fabrication, proto-assembly, supply and erection of galvanised steel structures for towers, beams, lightning masts and equipment support structures. If specified in section – Project, design of steel structure shall also be in the scope of contractor. The structures shall be of pipe type or lattice type as per Bid Proposa Sheet. Lattice structures shall be fabricated from structural steel conforming to IS: 2062 (latest). All pipe structures shall be fabricated from GI pipe conforming to YST 22 or of higher grade as per IS 806.

Line diagrams of Towers, beams, Lightning masts, equipment support structures are enclosed with the tender document. The fabrication drawings along with BOMs for these structures shall be provided to the successful bidder after the award. However structure, which are to be designed at detailed engineering stage by the employer, only line diagram shall be provided by POWERGRID and fabrication drawing shall be prepared by the Contractor. Support structure for circuit breaker shall be designed by the Manufacturer. Any other structure necessary to suit the layout for a particular substation to complete the work in all respect shall be designed by the employer / contractor at detailed Engineering stage.

Equipment support structure standardization has been carried out by the employer with the provision of stool to facilitate interchangeability of equipments at a later stage. Stools shall be provided by the Contractor between the equipment and its support structure to match the bus bar height. The top of stool shall be connected to the equipment and the bottom of the stool shall be connected to the Base support structure.

The scope shall include supply and erection of all types of structures including bolts, nuts, washers, step bolts, inserts in concrete, gusset plates, equipment mounting bolts, structure earthing bolts, foundation bolts, spring washers, fixing plates and any other items as required to complete the job.

The connection of all structures to their foundations shall be with base plates and embedded anchor/foundation bolts. All steel structures including anchor/foundation bolts shall be fully galvanized. The weight of the zinc coating shall be at least 610 gm/sq.m. Zinc coating for costal areas, if defined in section – Project shall not be less than 900gm/sq.m

Suitable modification shall be carried out in the drawings of equipment support structures by the Contractor in order to suit fixation of accessories such as marshalling boxes, MOM boxes, Control Cabinets, Junction box,

surge counter, etc. in the standard structure fabrication drawings. Nothing extra shall be payable or recoverable from the contractor on account of modification in support structures.

2.0 DESIGN REQUIREMENTS FOR STRUCTURES (To be referred only for structures to be designed by the Contractor)

2.1 For design of steel structures loads such as dead loads, live loads, wind loads etc. shall be based on IS:875,Parts I to V.

2.2 For materials and permissible stresses IS: 802, Part-I, Section-2 shall be followed in general. However, additional requirements given in following paragraphs shall also be considered.

2.3 Minimum thickness of galvanized tower member shall be as follows:

Members	**Minimum thickness (mm)**
Leg members, Ground wire Peak members/Main members	5
Other members	4
Redundant members	4

Size and thickness of gusset plate, pack washer and pack plate shall be as per requirement.

2.4 Maximum slenderness ratios for leg members, other stressed members and redundant members for compression force shall be as per IS-802.

2.5 Minimum distance from hole center to edge shall be 1.5 x bolt diameter. Minimum distance between center to center of holes shall be 2.5 x bolt diameter.

2.6 All bolts shall be M16 or higher as per design requirement.

2.7 Step Bolts

In order to facilitate inspection and maintenance, the structures shall be provided with climbing devices. Each tower shall be provided with M16 step bolts 175mm long spaced not more than 450mm apart, staggered on faces on one leg extending from about 0.5 meters above plinth level to the top of the tower. The step bolt shall conform to IS: 10238.

2.8 **Design Criteria**

a) All structures shall be designed for the worst combination of dead loads, live loads, wind loads as per code IS:875, seismic forces as per code IS:1893, loads due to deviation of conductor, load due to unbalanced tension in conductor, torsional load due to unbalanced vertical and horizontal forces, erection loads, short circuit forces including "snatch" in the case of bundled conductors etc. Short circuit forces shall be calculated considering a fault level of 40 kA, 50kA, 63kA or as applicable. IEC-60865 may be followed for evaluation of short circuit forces.

b) Switchyard gantry structures shall be designed for the two conditions i.e. normal condition and short circuit condition. In both conditions the design of all structures shall be based on the assumption that stringing is done only on one side i.e. all the three (phase) conductors broken on the other side.
Factor of safety of 2.0 under normal conditions and 1.5 under short circuit condition shall be considered for the design of switchyard structures.

c) Vertical load of half the span of conductors/string and the earth wires on either side of the beam shall be taken into account for the purpose of design. Weight of man with tools shall be considered as 150 kgs. for the design of structures.

d) Terminal/line take off gantries shall be designed for a minimum conductor tension of 9 metric tonnes per phase for 765kV, 4 metric tonnes per phase for 400kV, 2 metric tonnes per phase for 220kV and 1 metric tonne per phase for 132 kV or as per requirements whichever is higher . The distance between terminal gantry and dead end tower shall be taken as 200 metres for 765/400/220kV and 100m for 132KV. The design of these terminal gantries shall also be checked considering +/- 30 deg deviation of conductor in both vertical and horizontal planes. For other gantries the structural layout requirements shall be adopted in design.

e) The beams shall be connected with towers/ columns by bolted joints.

f) All Pipe support structures used for supporting equipments shall be designed for the worst combination of dead loads, erection load. Wind load/seismic forces, short circuit forces and operating forces acting on the equipment and associated bus bars as per IS:806. The material specification shall be as per IS: 1161 read in conjunction with IS: 806.

g) If luminaries are proposed to be fixed on gantries, then the proper loading for the same shall be considered while designing. Also holes for fixing the brackets for luminaries should be provided wherever required.

h) Foundation bolts shall be designed for the loads for which the structures are designed.

i) Height of Lightning masts shall be as per approved structure layout and designed for diagonal wind condition. Lightning masts shall be provided with plateforms for mounting lighting fixtures and a structural steel ladder within its base up to the level of plateform. The ladder shall be provided with protection rings. The platforms shall also have protection railing. The details of lighting fixtures would be as per the approved drawings.

3.0 DESIGN DRAWINGS, BILL OF MATETRIALS AND DOCUMENTS

3.1 Structures, for which line diagram has already been provided along with tender documents, fabrication drawings (structure assembly drawing) along with Bill of Material shall be provided to the successful bidder after award based on which structures shall be supplied. Fabrication drawings issued to the contractor for any project shall be valid for other projects also if wind speed of the area is same. These drawings are also available on the POWERGRID web site and can be downloaded from the web site. Hard copies, if needed, can be obtained from employer. These drawings shall be good for fabrication and inspection of steel structures for any substation. Release for construction stamp for particular substation is not required. Replacing MS section with higher section or replacing MS section with HT section of same size due to non availability of particular section shall not require employer's approval and this can be done without any additional financial implication to the employer.

3.2 STRUCTURES DESIGNED DURING DETAILED ENGINEERING:

3.2.1 In case deisign of structure is to be done by employer, only line diagram of the structure shall be provided to the contractor and fabrication drawing shall be prepared by contractor based on line diagram and submitted for approval.

3.2.2 In case design of structure is covered in the scope of contract, the contractor shall submit design alongwith line diagram for approval and based on approved line diagram, fabrication drawing shall be prepared and submitted for employers'approval. The line diagram should indicate not only profile, but section, numbers and sizes of bolts and details of typical joints.

3.2.3 The fabrication drawings to be prepared and furnished by the Contractor shall be based on line diagram provided by employer or the design approved by the employer. These fabrication drawings shall indicate complete details of fabrication and erection including all erection splicing details and typical fabrication splicing details, lacing details, weld sizes and lengths. Bolt details and all customary details in accordance with standard structural engineering practice whether or not given by the employer. The fabrication drawings and bill of material based on fabrication drawing shall be submitted to the employer for approval. Approved bill of material prepared based on fabrication drawing shall be the basis for payment.

3.3 Such approval shall, however, not relieve the Contractor of his responsibility for the safety and durability of the structure and good connections and any loss or damage occurring due to defective fabrication, design or workmanship shall be borne by the Contractor.

4.0 FABRICATION AND ERECTION

4.1 The fabrication and erection works shall be carried out generally in accordance with IS 802. A reference however may be made to IS 800 in case of non-stipulation of some particular provisions in IS 802. All materials shall be completely shop fabricated and finished with proper connection material and erection marks for ready assembly in the field.

4.2 The component parts shall be assembled in such a manner that they are neither twisted nor otherwise damaged and shall be so prepared that the specified camber, if any, is provided. In order to minimize distortion in member the component parts shall be positioned by using the clamps, clips, dogs, jigs and other suitable means and fasteners (bolts and welds) shall be placed in a balanced pattern. If the individual components are to be bolted, paralleled and tapered drifts shall be used to align the part so that the bolts can be accurately positioned.

4.3 Sample towers, beams, lightning masts and equipment support structures may be trial assembled in fabrication shop in order to ensure fitment of various members and to avoid problems during erection.

4.4 The Contractor should arrange on his own all plant and equipment, welding set, tools and tackles, scaffolding, trestles equipments and all other accessories and ancillaries required for carrying out erection without causing any stresses in the members which may cause deformation and permanent damage. Minor modification, if any, required during erection shall be done at site with the approval of Engineer – in- charge.

5.0 BOLTING

i) Every bolt shall be provided with a washer under the nut so that no part of the threaded portion of the bolt is within the thickness of the parts bolted together.
ii) In case of fasteners, the galvanizing shall confirm to IS-1367(Part 13). The spring washer shall be electro galvanized as per Grade IV of IS-1573.

6.0 WELDING

The work shall be done as per approved fabrication drawings which shall clearly indicate various details of joints to be welded, type of weld, length and size of weld, Symbols for welding on erection and shop drawings shall be

according to IS:813. Welding shall be carried out in accordance with IS:816.

7.0 FOUNDATION BOLTS

7.1 Foundation bolts for the towers and equipment supporting structures shall be embedded in first stage concrete while the foundation is cast. The Contractor shall ensure the proper alignment of these bolts to match the holes in the base plate.

7.2 The Contractor shall be responsible for the correct alignment and leveling of all steel work on site to ensure that the towers/structures are plumb.

7.3 All foundation bolts for lattice structure, pipe structure are to be supplied by the Contractor.

7.4 All foundation bolts shall be provided with two no. standard nuts of class 5 confirming to IS:1363/1367/6639, one check nut of class 4 confirming to IS:1364, one anchore plate at the bottom of foundation bolt and one plain washer.

7.5 All foundation bolts shall conform to IS 5624, however, the material, shall be MS conforming to IS:2062/ SAE:1018.

8.0 STABILITY OF STRUCTURE

The Contractor shall be responsible for the stability of the structure at all stages of its erection at site and shall take all necessary measures by the additions of temporary bracings and guying to ensure adequate resistance to wind and also to loads due to erection equipment and their operations.

9.0 GROUTING

The method of grouting the column bases shall be subject to approval of employer and shall be such as to ensure a complete uniformity of contact over the whole area of the steel base plate. No additional payment for grouting shall be admissible.

10.0 GALVANISING

All structural steel works, equipment support structures and foundation bolts shall be galvanized after fabrication. The galvanization shall be done as per requirement of IS 4579. Purity of zinc to be used shall be 99.95% as per IS:209.

11.0 TOUCH-UP PAINTING

Minor defects in hot dip galvanized members shall be repaired by applying

zinc rich primer and two coats of enamel paint to the satisfaction the employer before erection.

12.0 INSPECTION BEFORE DISPATCH

Each part of the fabricated steel work shall be inspected as per approved quality plans and certified by the employer or his authorized representative as satisfactory before it is dispatched to the erection site. Such certification shall not relieve the Contractor of his responsibility regarding adequacy and completeness of fabrication.

13.0 TEST CERTIFICATE

Copies of all test certificates relating to material procured by the Contractor for the works shall be submitted during inspection.

14.0 SAFETY PRECAUTIONS

The Contractor shall strictly follow at all stages of fabrication, transportation and erection of steel structures, raw materials and other tools and tackles, the stipulations contained in Indian Standard Code for Safety during erection of structural steel work-IS:7205.

15.0 All tests mentioned in standard field quality plans shall have to be carried out and conformity of materials and workmanship shall be ascertained.

Employer has standardized its Specific Requirement for various equipment and works for different voltage levels. Items or clauses, which are not applicable for the scope of this package as per schedule of quantities described in BPS or as per scope defined elsewhere in Section Project, the technical specification/clauses for the items specified below should not be referred to.

S.No.	Clause No.	Amended As (As per Specific Requirement Rev 07)
A.	**Section: GTR Rev 15**	
1.	Section GTR, Rev-15 Clause 2.1 (a)	"All equipment/materials/items, as per **Annexure-K (Rev 01),** as applicable under present scope of works, shall be procured and supplied from domestic manufacturers only with Minimum Local Content for individual items as listed in the above annexure. 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.	**New Clause No. 4.7**	**Planning and Designing in purview of Vulnerability Atlas of India** Vulnerability Atlas of India (VAI) is a comprehensive document which provides existing hazard scenario for the entire country and presents the digitized State/UT wise hazard, maps with respect to earthquakes, winds and floods for district wise identification of vulnerable areas. It also includes additional digitized maps for thunderstorms, cyclones and landslides. The main purpose of this Atlas is its use for disaster preparedness and mitigation at policy planning and project formulation stage. This Atlas is one of its kind single point source for the various stakeholders including policy makers, administrators, municipal commissioners, urban managers, engineers, architects, planners, public etc. to ascertain proneness of any city/ location/ site to multi-hazard which includes earthquakes, winds, floods thunderstorms, cyclones and landslides. While project formulation, approvals and implementation of various urban housing, buildings and infrastructures schemes, this Atlas provides necessary information for risk analysis and hazard assessment. The Vulnerability Atlas of India has been prepared by Building Materials and Technology Promotion Council under Ministry of Housing and Urban Affairs, Government of India and available at their website https://www.bmtpc.org/. It is mandatory for the bidders to refer Vulnerability Atlas of India for multi-hazard risk assessment and include the relevant hazard proneness specific to project location while planning and designing the project in terms of: i) Seismic zone for earthquakes, ii) Wind velocity iii) Area liable to floods and Probable max. surge height iv) Thunderstorms history v) Number of cyclonic storms/ severe cyclonic storms and max sustained wind specific to coastal Region vi) Landslides incidences with Annual rainfall normal vii) District wise Probable Max. Precipitation

3.	**New Para under Clause no. 8.3.2**	Wherever references to SFQP is made in Technical Specifications, it shall be the latest edition/revision of the same uploaded up to seven (7) days prior to the actual date of bid opening.
4.	Section GTR Rev 15 Clause No 24.1	Technical requirements for 765/400/220/132kV* Air Insulated Switchgear (AIS) Equipment*: **A)** Circuit Breaker (i) The manufacturer(s) whose 765/400/220/132kV* Circuit Breaker(s) are offered, must have, manufactured, type tested (as per IEC/IS or equivalent standard) and supplied 715/345/220/132kV* or higher voltage class Circuit Breaker(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 Circuit Breaker and not meeting the requirement stipulated in (i) above, can also be considered provided that a) 715/345/220/132kV* or higher Voltage class Circuit Breaker(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 Circuit Breaker(s) to be supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 3% of the ex-works cost of the Circuit Breaker(s)* for the additional warranty period in addition to the contract performance guarantee to be submitted by the contractor. **B)** Isolator, Current Transformer, Capacitive Voltage transformer, Inductive Voltage transformer, Surge Arrester and Wave Trap) (i) The manufacturer whose 765/400/220/132kV* equipment(s) are offered, must have manufactured, type tested (as per IS/IEC or equivalent standard) and supplied 715/345/220/132kV* or higher voltage class equipment(s), which are in satisfactory operation# for at least two (2) years as on the date of NOA. OR (ii) The manufacturer, who have established manufacturing and testing facilities in India for the offered equipment(s) and not meeting the requirement stipulated in (i) above, can also be considered provided that: a) 715/345/220/132kV* or higher Voltage class equipment(s) must have been manufactured in the above Indian works & type

		tested (as per IS/IEC standard) as on the date of NOA b) Manufacturer has manufactured, type tested (as per IS/IEC or equivalent standard) and supplied equipment(s) of 345kV or above voltage class (applicable for 765kV* Equipment)/220kV or above voltage class (applicable for 400kV* equipment) /132kV or above voltage class (applicable for 220kV* equipment) / 66kV or higher voltage class (applicable for 132kV* equipment), which are in satisfactory operation# for at least two (2) years as on the date of NOA. c) 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(s) to be supplied under the contract. Further, contractor shall furnish performance guarantee for an amount of 3% of the ex-works cost of the equipment(s)* for the additional warranty period in addition to the contract Performance guarantee to be submitted by the contractor. OR (iii) The manufacturer, who have established manufacturing and testing facilities in India for the offered equipment(s) based on technological support of a parent company or collaborator and not meeting the requirement stipulated in (i) above, can also be considered provided that: a) 715/345/220/132kV* or higher Voltage class equipment(s) must have been manufactured in the above Indian works & type tested (as per IS/IEC standard) as on the date of NOA. b) The parent company or collaborator meets the qualifying requirements stipulated under (i) given above. A valid collaboration agreement for technology transfer / license to design, manufacture, test and supply the 765/400/220/132kV* Air Insulated Switchgear (AIS) Equipment(s)* in India, shall be submitted. c) The parent company/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 Legends: * : voltage class of respective equipment as applicable. # : satisfactory operation means certificate issued by the Employer/Utility certifying the operation without any adverse remark.

		NOA: Notification Of Award
5.	**Clause No. 24.16(ii)(b)**	Contractor shall furnish performance guarantee for an amount of 3% of the ex-works cost of the equipment (s)* and this performance guarantee shall be in addition to the contract performance guarantee to be submitted by the contractor.
6.	**New Clause Clause No. 24.21**	**Technical Requirement for 220/132/66 kV* level GIS/Hybrid GIS/MTS Equipment:** (i) The manufacturer whose 220/132/66 kV* level GIS/Hybrid GIS/MTS 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 220/110/66kV* 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. (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. 220/110/66kV* or above voltage level 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 GIS 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 220/110/66*kV 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:** 1. (*) voltage class of respective equipment as applicable *2.* (@) 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 disconnector and three nos. of single phase CTs / Bushing CTs. GIS means SF6 Gas insulated Switchgear. 3. Experience with combination of GIS CB bay/Hybrid GIS CB Bay/MTS CB Bay is also acceptable if supply of only Hybrid/MTS equipment is envisaged. Hybrid GIS means outdoor SF6 Gas insulated switchgear connected to outdoor Air insulated bus-bar System (AIS bus-bars System), MTS means outdoor SF6 Gas insulated Mixed Technology Switchgear connected to outdoor AIS bus bar system.

		4. (**) Type test reports of the collaborator/ parent company/ subsidiary company/ group company shall also be acceptable
B.	**Section GIS Rev 5A**	
1.	**New Para under Clause no.1**	GIS of all voltage levels above 52kV class envisaged under a single package, shall be supplied from one GIS manufacturer who shall be responsible for design, manufacturing, erection, testing and commissioning of complete GIS switchyard under the Contract and any other responsibilities stipulated in the contract with respect to GIS portion
2.	**New Clause no. 5.41(10)**	The price of Bus-duct inside the GIS hall shall be integral part of the respective bay module and it will not be paid separately. However, the payment of bus-duct for outside the GIS hall along with support structure shall be paid as per running meters in line with provision of Bid Price schedule.
3.	**Clause no. 6.8.2**	The CSD shall be provided in following circuit breakers: a) 765kV • Main and Tie bay for Auto Transformer • Main and Tie bay of Bus Reactor • Switchable Line Reactor bay b) 400kV • Main and Tie bay for 765/400kV Auto Transformer • Main and Tie bay of Bus Reactor • Switchable Line Reactor bay c) 220 & 132kV • Bay for operation of Shunt reactor The requirement of CSD shall be explicitly specified in price schedule.
4.	**New Clause 6.8.3 (n)**	For Circuit breaker with CSD controlling a Transformer following is applicable "The limit for inrush current for switching of Transformer by CSD shall be 1.0 p.u. of rated current of transformer after fine tuning of CSD settings during pre-commissioning checks. For site acceptance of CSD, during online CSD test after fine tuning inrush current should be less than 1.0 P.U. of rated current in five consecutive operations".
5.	**New Clause no. 10.1.3(n)**	For 400kV & above voltage class GIS bay module, CT cores shall be duly distributed on both side of circuit breaker. For 220 kV and below voltage level GIS bay module, CT on one side of the circuit breaker is also acceptable.
6.	**New Clause no. 15.2.14**	All 765kV & 400kV Circuit Breaker control schematics shall be finalized in such a way, that it may operate with or without CSD by using a suitable selector switch irrespective of whether circuit breakers to be supplied are envisaged along with CSD or not as per bid price schedules.
7.	**New Para added under Clause no. 20**	During detailed engineering, the type test reports of GIS equipment of the parent company/subsidiary company/group company shall also be acceptable provided that the design of offered GIS is same as that of type tested GIS equipment.
8.	Clause no 20, Sl. no. 14 of Table	14 | Reactor current switching test for Inductive Current switching capability as per IEC 62271-110. Further, the manufacturer whose circuit breakers tested with smaller current w.r.t current limits specified for Reactor current switching test duty-2, 3 & 4 in IEC 62271-110 shall also be acceptable.

<table>
<tr><td>9.</td><td>Annexure-1
S.No. 20 (i)</td><td>
<table>
<tr><th>Parameter</th><th>765kV system</th><th>400kV system</th><th>220kV system</th><th>132 kV system</th></tr>
<tr><td>Pre-insertion resistor requirement</td><td>As per BPS</td><td>As per BPS</td><td>NA</td><td>NA</td></tr>
<tr><td>Rating (ohms)</td><td>Approx. 450 with tolerance as applicable</td><td>Approx. 400 with tolerance as applicable</td><td>NA</td><td>NA</td></tr>
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</td></tr>
<tr><td>10.</td><td>New Para under Clause no 26.</td><td>Requirement for Mandatory spares for GIS
a. Any equipment which is not supplied as main equipment or part of main equipment, mandatory spare for that is not applicable.
b. It is recognized that the GIS manufacturer may have standardized the GIS design/equipment rating based on the manufacturer's standard practice. Alternate proposals, offering higher rating equipment (without additional cost implication), will also be considered provided such equipment meets the specified minimum designs rating, standard and performance requirements.
c. In case contractor offers circuit breaker, dis-connector, current transformer, SF6/Air Bushing etc. under main equipment of higher rating than equipment rating specified in the specifications, the mandatory spare of same higher rating offered by contractor identical to main equipment offered in the package shall be required to be supplied against spares without any cost implication to POWERGRID.</td></tr>
<tr><td>11.</td><td>Annexure-10 Rev-1</td><td>Annexure-10 Rev-1 (Standard Mandatory Spares for Gas Insulated Switchgear) of stands deleted.</td></tr>
<tr><td>C.</td><td colspan="2">Section Switchgear – CB Rev 11</td></tr>
<tr><td>1.</td><td>Clause no. 2.6 Para 2</td><td>The CSD shall be provided in following circuit breakers:
d) 765kV
• Main and Tie bay for Auto Transformer
• Main and Tie bay of Bus Reactor
• Switchable Line Reactor bay
e) 400kV
• Main and Tie bay for 765/400kV Auto Transformer
• Main and Tie bay of Bus Reactor
• Switchable Line Reactor bay
f) 220 & 132kV
• Bay for operation of Shunt reactor
The requirement of CSD shall be explicitly specified in price schedule.</td></tr>
<tr><td>2.</td><td>New Clause no. 2.6.1(n)</td><td>For Circuit breaker with CSD controlling a Transformer following is applicable

"The limit for inrush current for switching of Transformer by CSD shall be 1.0 p.u. of rated current of transformer after fine tuning of CSD settings during pre-commissioning checks. For site acceptance of CSD, during online CSD test after fine tuning inrush current should be less than 1.0 P.U. of rated current in five consecutive operations".</td></tr>
<tr><td>3.</td><td>Clause No. 11.4</td><td>Separate cables shall be used for AC, DC-I, DC-II and selected DC. Each control cable shall include minimum 10% spare cores (subject to minimum 1 no. of spare core).</td></tr>
<tr><td>4.</td><td>Clause No. 11.5</td><td>Requirement of Plug-In type connector for Inter-pole cabling is deleted</td></tr>
<tr><td>5.</td><td>Clause No. 11.6</td><td>Vertical run of cables to the operating mechanism box shall be properly supported by providing the perforated closed type galvanized cable tray (Cable tray also to be supplied along with the Circuit Breaker) to be fixed as an integral part of the</td></tr>
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<tr><td></td><td></td><td>structures. The load of the cable shall not be transferred to the mechanism box/terminal arrangement in any circumstances. Hanging or loose run of cable is not permitted. The drawing of cable tray including fixing arrangement shall be incorporated in the GA drawing of CB also.</td></tr>
<tr><td>6.</td><td>Clause No. 16.0 S.No. 20 (i)</td><td>
<table>
<tr><th>Parameter</th><th>765kV system</th><th>400kV system</th><th>220kV system</th><th>132 kV system</th><th>66kV System</th></tr>
<tr><td>Pre-insertion resistor requirement</td><td>As per BPS</td><td>As per BPS</td><td>NA</td><td>NA</td><td>NA</td></tr>
<tr><td>Rating (ohms)</td><td>Approx. 450 with tolerance as applicable</td><td>Approx. 400 with tolerance as applicable</td><td>NA</td><td>NA</td><td>NA</td></tr>
</table>
</td></tr>
<tr><td>D.</td><td colspan="2">Section Switchgear-INST Rev 11</td></tr>
<tr><td>1.</td><td>Clause No. 6.2 (a)(iii)</td><td>Seismic withstand test as per Annexure-B of Section-GTR or IEC62271-2 (with Seismic acceleration requirement as per Annexure-I of this specification/Section-Project) for 400kV and above voltage rating.</td></tr>
<tr><td>2.</td><td>Clause No. 6.2 (b)(iii) & (c)(iii)</td><td>Seismic withstand test (as per Annexure-B of Section-GTR) or IEC-62271-2 (with Seismic acceleration requirement as per Annexure-II of this specification/Section-Project) for 400kV and above voltage class.</td></tr>
<tr><td>3.</td><td>Clause No. 9.2 Para 3 & 4</td><td>CTs must have adequate provision for taking oil samples from the bottom of the CT 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. 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.

Manufacturer/Contractor shall supply 2 nos. of oil sampling device for every 20 nos. of oil filled CT supplied with a minimum of 2 nos. of oil sampling device for each substation. The price of the above sampling bottles is deemed to be included in cost of equipment.</td></tr>
<tr><td>4.</td><td>Clause No. 9.3</td><td>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
g) DGA of oil (for IVT/PT)

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.

IVTs/PTs must have adequate provision for taking oil samples from the bottom of the IVT/PT 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. Manufacturer should also indicate the total quantity of oil which can be withdrawn from IVT/PT for gas analysis before refilling or further treatment of IVT becomes necessary.</td></tr>
</table>

<table>
<tr><td></td><td></td><td>Manufacturer/Contractor shall supply 2 nos. of oil sampling device for every 20 nos. of oil filled IVT/PT supplied with a minimum of 2 nos. of oil sampling device for each substation. The price of the above sampling bottles is deemed to be included in cost of equipment.</td></tr>
<tr><td>5.</td><td>Clause No. 10.0</td><td>Defect Liability
The actions required to be taken by contractor in case of defects observed in CT/CVT/IVT/PT of ratings 145kV & above during the warranty period (defect liability period) shall be as per enclosed <u>Annexure-V (Revised)</u>of this specification. Further, the replaced/repaired/refurbished equipment (or part of equipment) shall have Two (2) years warranty without prejudice to contractual warranty period (defect liability period).</td></tr>
<tr><td>E.</td><td colspan="2">Section Switchgear-Surge Arrester Rev 12</td></tr>
<tr><td>1.</td><td>New Clause No. 4.5</td><td>The Surge Arresters shall be provided with a common Junction box suitably for a set of three (3) Surge Arresters of each bay for extending the contact information of surge counter to SAS</td></tr>
<tr><td>F.</td><td colspan="2">Section: Lighting System Rev 07</td></tr>
<tr><td>1.</td><td>New Para under Clause No. 2.1</td><td>Wherever, Indoor Illumination of building is specified as LS/Lot/SET item in BPS, illumination shall be provided using fixture types as specified in Annexure-I of Section: Lighting System. However, contractor shall submit lighting design calculation for deciding the number of fixtures in each building/room. Following Average lux (at working plane of height 1.2 Mtrs from floor level) levels to be maintained for design of illumination system:
<table>
<tr><td>S.No.</td><td>Building/Room Type</td><td>Average Lux Level to be maintained</td></tr>
<tr><td>1</td><td>Control Room /Station-In charge Room /Administrative Room/Conference Room / Switchyard Panel Room/ GIS Relay Panel Room</td><td>300 Lux</td></tr>
<tr><td>2</td><td>Electronic Test Lab</td><td>250 Lux</td></tr>
<tr><td>3</td><td>GIS Hall/ Battery Room/ACDC & DCDB Room</td><td>200 Lux</td></tr>
<tr><td>4</td><td>AHU Room/GIS Store Room/ Pantry /Reception/ FFPH Building</td><td>150 Lux</td></tr>
<tr><td>5</td><td>Corridor/ Toilets</td><td>100 Lux</td></tr>
<tr><td>6</td><td>Periphery of the Building</td><td>50 Lux</td></tr>
<tr><td>7</td><td>Any other room/building</td><td>200 Lux</td></tr>
</table>
The minimum lux level to average lux level ratio should not be less than 0.6 (i.e Emin/Eav> 0.6). The maintenance factor for indoor illumination design shall be considered as 0.8.</td></tr>
</table>

<table>
<tr><td></td><td></td><td>All required items /equipment /fixtures/ panels/ receptacles/ switches/ switchboards/ fans etc. for Illumination of Control Room Building, GIS Building, FFPH, SPR, Security Hut etc. (as applicable) are deemed to be included under corresponding LS/Lot/SET item of BPS.</td></tr>
<tr><td>2.</td><td>Clause no. 6.2.1(ii)</td><td>All Outdoor Lighting Panels shall be Stainless sheet steel of Grade 304 and shall be dust, weather and vermin proof. Panels shall be of thickness not less than 1.5 mm smoothly finished, leveled and free from flaws. Stiffeners shall be provided wherever necessary.
Alternatively, outdoor lighting panels of Aluminum shall also be acceptable as per provisions stipulated in Section GTR.</td></tr>
<tr><td>3.</td><td>Clause no. 6.6(i) (b)</td><td>The outdoor junction boxes shall be complete with conduit knockouts/threaded nuts and provided with terminal strips. The junction boxes shall be suitable for termination of Cable glands of required size. The junction boxes shall be provided with 4 way knockouts suitable for street lighting/switchyard lighting terminals suitable for 2 numbers 4C x 16 Sq.mm Al. cable or as per requirement. All Outdoor Junction boxes shall be of Stainless Steel of thickness 1.5mm of grade 304. Outdoor Junction Boxes shall be suitable for mounting on columns, structures etc for Outdoor Lighting. The outdoor Junction shall have IP 55 protection. Alternatively, outdoor junction boxes of Aluminum shall also be acceptable as per provisions stipulated in Section GTR.</td></tr>
<tr><td>G.</td><td colspan="2">Section: LT Switchgear Rev 05</td></tr>
<tr><td>1.</td><td>Clause no. 1.21.2</td><td>Contractor shall submit type test reports for the Lighting transformers as per IS:2026 for which test conducted once are acceptable (i.e. The requirement of test conducted within last ten years shall not be applicable)</td></tr>
<tr><td>2.</td><td>Clause no. 1.6.1</td><td>MCCB shall in general conform to IS: 13947 Part-2. All MCCB offered shall have Ics = 100% Icu rating.</td></tr>
<tr><td>H.</td><td colspan="2">Section DG Set Rev 05</td></tr>
<tr><td>1.</td><td>New para added under Clause no. 7.1(a)</td><td>Alternatively, AMF Panel for DG Set may be installed outside the acoustic enclosure near the DG Set. In such cases, AMF panel with or without additional enclosure shall meet IP-55 degree of protection.</td></tr>
<tr><td>I.</td><td colspan="2">Section: Battery and Battery Charger Rev 06</td></tr>
<tr><td>1.</td><td>Clause no. 1.2.12</td><td>The battery shall be capable of giving 1200 or more charge/discharge cycles at 80% Depth of discharge (DOD) at an average temperature of 27º Celsius.
DOD (Depth of Discharge) is defined as the ratio of the quantity of electricity (in Ampere-hour) removed from a cell or battery on discharge to its rated capacity.</td></tr>
<tr><td>2.</td><td>Clause no 1.1.4 table -2 (48V)</td><td>Bidder shall select number of cells, float and Boost voltage to achieve following system requirement:-
……..
……..
<table>
<tr><td rowspan="3">220V DC system</td><td>Load</td><td>Duration</td><td>Type Of Loads</td></tr>
<tr><td>…..</td><td>…..</td><td>……</td></tr>
<tr><td>…..</td><td>……</td><td>……</td></tr>
<tr><td></td><td>…….</td><td>…….</td><td>……</td></tr>
<tr><td rowspan="2">48V DC System</td><td>Continuous Load</td><td>10 hours Continuous</td><td>load associated with PLCs.(when speech is not working)</td></tr>
<tr><td>Momentary Load</td><td>15 minute</td><td>Loads associated with PLCs (when speech is working)</td></tr>
</table></td></tr>
<tr><td>J.</td><td colspan="2">Section Fire Protection Rev 06</td></tr>
<tr><td>1.</td><td>New para added at Clause no.2.03.00</td><td>Fire detection and alarm system shall also be provided in the GIS Hall using beam type smoke detectors to be installed at suitable mounting height, and in the Relay Panel room with ionization/optical type smoke detectors to be installed on the</td></tr>
</table>

<table>
<tr><td></td><td></td><td>ceiling.</td></tr>
<tr><td>2.</td><td>New Clause no.2.01.02</td><td>Hydrant posts and Fire extinguishers (CO2 and DCP type) shall also be provided for GIS Building also.</td></tr>
<tr><td>3.</td><td>Clause No. 2.04.02 & 10.00.00</td><td>Mechanical foam type fire extinguishers wherever specified as 50 litre capacity, conforming to IS:13386, shall be read as 60 litre capacity conforming to IS 16018

Further in case of non-availability of any type of fire extinguisher (i.e. water, CO2, DPC, foam type) of a particular size as specified in BPS or technical specification, next available higher size conforming to IS shall be supplied.</td></tr>
<tr><td>4.</td><td>New Clause No. 2.06.05</td><td>For new substation, Fire Fighting LT Boards (AC & DC) and Annunciation panels (for FFPH & Control Room Building), shall have number of feeders, annunciation windows, zone-alarm modules (as applicable) required for entire present & specified future scope of the substation.</td></tr>
<tr><td>5.</td><td>Clause No.9.01.00(c) & Appendix-V</td><td>Deleted</td></tr>
<tr><td>6.</td><td>Appendix-I</td><td>Appendix-I (Rev 4) stand replaced by following <u>Appendix-I (Rev 5)</u></td></tr>
<tr><td>7.</td><td>Appendix-IV</td><td>Revised Appendix-IV Page1 of 13 is replaced by <u>Annexure-IV rev 01</u> Page1 of 13.</td></tr>
<tr><td>K.</td><td colspan="2">Section: Power & Control Cable Rev 06</td></tr>
<tr><td>1.</td><td>Section: Power & Control Cable Rev 06

Clause No. 4.2</td><td>Standard lengths for each size of power and control cables shall be 500/1000 meters. However, to avoid cable wastage and cable jointing at site, non-standard lengths of each size of Power & Control cable may also be acceptable subject to maximum length of 1000meters (+ 5% tolerance)</td></tr>
<tr><td>2.</td><td>Clause no 1.1.4</td><td>Refer <u>Annexure-S1</u> for METHODOLOGY FOR SUPPLY, INSTALLATION & SIZING OF CABLES</td></tr>
<tr><td>L.</td><td colspan="2">Section-Air Conditioning Rev-04</td></tr>
<tr><td>1.</td><td>Clause No. 2.3.2.3</td><td>Cooling capacity of 3TR AC units shall not be less than 36000btu/hr. and shall have energy efficiency rating of 5 star as on the date of NOA.</td></tr>
<tr><td>2.</td><td>Clause No. 2.3.3.4</td><td>Cooling capacity of 2TR AC units shall not be less than 22000btu/hr. and shall have energy efficiency rating of 5 star as on the date of NOA</td></tr>
<tr><td>3.</td><td>Clause no. 2.4</td><td>Clause no. 2.4 of Section-Air Conditioning Rev-04 of Technical Specification Void</td></tr>
<tr><td>4.</td><td>New Annexure-S2</td><td><u>Annexure S2</u> – Air Conditioning & Ventilation System for GIS Building</td></tr>
<tr><td>M.</td><td colspan="2">Section Switchyard Erection Rev 10</td></tr>
<tr><td>1.</td><td>New Clause No. 2.5</td><td>Transmission line side insulator string along with hardware for line termination shall be in the scope of substation contractor. The erection of same shall be done by associated TL contactor.</td></tr>
<tr><td>2.</td><td>Clause No. 9.4(j) & (k)</td><td>
<table>
<tr><th>S.No</th><th>Item</th><th>Size</th><th>Material</th></tr>
<tr><td>j)</td><td>Isolator MOM Box</td><td>50X6 mm GS flat & Flexible copper braid</td><td>Galvanised steel and copper Braid</td></tr>
<tr><td>k)</td><td>Insulator Guy Arrangement</td><td>75x12mm G.S. flat</td><td>Galvanised Steel</td></tr>
</table>
</td></tr>
<tr><td>3.</td><td>New Clause No. 9.5.8</td><td>For estimation of riser of new substation/switchyard, maximum spacing of Main Earthmat shall be considered as 30 M x 30 M, 24 M x 24 M, 16 M x 16 M & 12 M x 12 M for 765kV, 400kV, 220kV & 132kV switchyard respectively.

Actual spacing for main earthmat shall be finalized during detailed engineering</td></tr>
</table>

<table>
<tr><td></td><td></td><td>based on soil resistivity data and payment shall be made as per actual executed quantity at site. However, no cost compensation shall be considered in case of actual spacing of main earthmat finalized during detailed engineering is less than that mentioned above.

For switchyard extensions, main earthmat spacing shall be considered same as that in the existing switchyard.</td></tr>
<tr><td>4.</td><td>Clause no 9.10.3</td><td>Auxiliary earthing mat comprising of minimum 32mm dia M.S. rods closely spaced (300 mm x 300 mm) conductors shall be provided at depth of 300mm from ground level below the operating handles of the M.O.M. Box of the isolators. M.O.M. boxes shall be directly connected to the auxiliary earthing mat. Flexible copper
braid connection to be provided between MOM box and GI flat to take care of soil sagging. The size of auxiliary earthing mat shall be of 1500mmx1500mm size for 220kV and above voltage class isolators and 900mmx900mm size for 132kV and below voltage class isolators. Factory welded auxiliary earthmat is preferable</td></tr>
<tr><td>5.</td><td>New Clause No. 10.2</td><td>Following type of conductor for Flexible or Rigid Bus bars/Switchyard Equipment Jumpers/Interconnections shall be provided subject to suitability of conductor as per specified/applicable current ratings:

<table>
<tr><th>Voltage Level</th><th>Conductor / Al .Tube Type</th></tr>
<tr><td>Voltage Level: 765kV</td><td>AAC Bull / 4.5" IPS Al. Tube</td></tr>
<tr><td>Voltage Level: 400kV</td><td>ACSR Bersimis / 4.5" IPS Al. Tube</td></tr>
<tr><td>Voltage Level: 220kV</td><td>ACSR Moose / 4.0" IPS Al. Tube</td></tr>
<tr><td>Voltage Level: 132kV</td><td>ACSR Moose / 3.0" IPS Al. Tube</td></tr>
</table>

For substation extension works, suitable clamps & connectors for interconnection with existing buses as per drawings shall be provided by the contractor under present scope.

Conductor type with higher current rating than that specified above shall also be acceptable without any additional price implication.
Note: - For existing Substation, existing conductor configuration may preferably be adopted in extn. S/s package.</td></tr>
<tr><td>6.</td><td>New Clause no. 20.1</td><td><u>Neutral formation for Transformer(s), DELTA formation and making connection arrangement to connect spare unit in place of any unit of the bank without physical shifting and Earthing Arrangement :</u>

For Spare Unit connection to form 3-ph bank of 765kV Class Transformers with isolator based switching arrangement without physical shifting of spare unit along with necessary Neutral Formation, Earthing Arrangement & Tertiary (DELTA) formation for 3-ph bank formation with 1-ph units shall be under present scope as per the details mentioned below:

i. <u>Neutral Formation including Neutral auxiliary bus and Earthing Arrangement</u>

The contractor shall connect the neutrals of three (3) 1-phase transformers by overhead connection using 3" IPS Al tube. The neutral formation shall be such that neutral winding of single-phase spare transformer can be disconnected or connected to the three phase banks. The connection from the neutral bushing to neutral bus shall be through 3" IPS Al tube and wherever flexible jumper needs to be provided, same shall be through twin conductor. All material like Bus post insulator, Aluminium tube, conductor, clamps & connectors, earthing materials, support structure, foundation bolts, hardware etc. required for neutral formation and connection with neutral CT and earthing of neutral shall be provided by</td></tr>
</table>

		contractor. **ii. <u>Tertiary Delta Formation including Tertiary auxiliary bus(Insulation level 52 kV) .</u>** The contractor shall connect 33kV tertiary of single-phase auto-transformers in DELTA configuration by overhead connection to operate in 3-Ph Bank. The Delta shall be formed by 3" IPS Al tube, which shall be insulated with heat shrinkage insulating sleeve of at least 52kV class and shall be supported by structure mounted bus post insulators at suitable intervals. Jumpers (twin conductors) wherever provided shall also be insulated using suitable insulation tape or sleeve at least 52kV class at site. The minimum phase to phase horizontal spacing for delta formation shall be 1.5meter. All associated materials like bus post insulators, Aluminium tube, conductor, clamps & connectors, support structures, **foundation bolts,** hardware, earthing materials etc. required for tertiary delta formation shall be provided by the contractor. **iii. <u>HV & IV Auxiliary Buses (Applicable for AIS Substation)</u>** Formation of HV & IV auxiliary buses for connection of transformer 3-Phase bank with 1-Phase Spare transformer unit is under the present scope of the bidder. All associated materials like Bus post insulators, Aluminium tube, conductors, clamps & connectors, insulator strings, hardware, earthing materials, support structures, **foundation bolts,** required for the above-mentioned arrangement shall be provided by the contractor.
7.	**New Clause no. 20.2**	**<u>Neutral formation for Reactor banks, connection to neutral grounding reactor through 132kV Surge arrester, connection to ground through neutral CTs and connection arrangement to connect spare reactor unit in place of any other units of the bank without physical shifting and Earthing Arrangement :</u>** For Spare Unit connection to 3-ph bank of 765kV Class Reactors with isolator based switching arrangement without physical shifting of spare unit along with necessary Neutral Formation, Earthing Arrangement for 3-ph bank formation with 1-ph units shall be under present scope as per the details mentioned below: **i. <u>Neutral Formation including Neutral auxiliary bus and Earthing Arrangement</u>** The contractor shall connect the neutrals of three (3) 1-phase reactors by overhead connection using 3" IPS Al tube. The neutral formation shall be such that neutral winding of single-phase spare reactor can be disconnected or connected to the three phase banks. Neutral Connections of spare unit shall be extended upto the other unit(s) by forming Neutral auxiliary bus. The connection from the neutral bushing to neutral bus shall be through 3" IPS Al tube and wherever flexible jumper needs to be provided, same shall be through twin conductor. All material like Bus post insulator, Aluminum tube, conductor, clamps & connectors, earthing materials, support structure, **foundation bolts,** hardware etc. required for neutral formation and connection with neutral CT and earthing of neutral shall be provided by contractor. Required Insulation level is 145 kV from individual reactor neutral to point of neutral formation. However after neutral formation, the insulation level is 36kV. Connection of each Line reactor bank formed under present scope to Neutral grounding reactor through 132kV Surge Arrester including NGR by passing arrangement is also under present scope.

		ii. HV Auxiliary Bus (Applicable for AIS Substation) Formation of HV auxiliary bus for connection of reactor 3-Phase bank with 1-Phase Spare reactor unit is under the present scope of the bidder. All associated materials like Bus post insulators, Aluminium tube, conductors, clamps & connectors, insulator strings, hardware, earthing materials, support structures, **foundation bolts** , etc. required for the above-mentioned arrangement shall be provided by the contractor.
8.	**New Clause no. 20.3**	Supply & Laying of Power, Control Cables & Special Cables (if any) (including all cabling works for spare unit of transformer/reactor) along with accessories for power supply, alarm, trip, control & indication, status and monitoring signals & contacts made available at MB/CMB of Transformers/Reactors upto Control & Relay Panels and BCUs located in the Switchyard Panel Room/Control Room and successful integration of same with Station Control, Protection & SAS System is in the scope of the contractor.
9.	**New Clause no. 20.4**	3½Cx300 Sq. mm XLPE power cable for oil filtration units of reactors & transformers shall be provided. The cable shall be terminated at 250A receptacle near Reactor & Transformer in the switchyard. XLPE Power cables shall be looped in & out for 250A Power receptacles.
10.	**New Clause no. 20.5**	Neutral of spare transformer/reactor is to be connected to station grounding system through a jumper/copper flat. This shall be applicable for single phase transformer/reactor wherever spare unit have been provided.
11.	**New Clause no. 20.6**	Tertiary connections made for tertiary loading of LT Transformer shall be insulated using suitable insulation tape or sleeve of at least 52kV class at site
12.	**New Clause no. 20.7**	The earthing risers from terminal of Neutral Current Transformer (NCT) of bank of 1-Phase Transformer/Reactor (as applicable) shall be brought down for connection with pipe electrodes by providing suitable insulators mounted on NCT support structure (minimum 2 nos. per support). Necessary provisions on NCT support structure for mounting of insulator shall be provided. These insulators shall deemed to be included in corresponding Erection Hardware item for Transformer/Reactor bay (as applicable) of BPS
13.	**New Clause No. 21**	Connection arrangement of 765kV equipment's shall be done as per the conceptual drawing (Drawing No. C/ENGG/SS/CONCEPTUAL 765KV BAY CONNECTIONS, Rev-01) enclosed as **Annexure-S3** of this Section.
14.	**New Clause No. 22**	For connection to HV bushing of tertiary loaded LT Transformer, insulated copper rod/strip of at least 75 sq.mm cross sectional area shall be used.
15.	New annexure	Refer **Annexure-S4** for SHORT CIRCUIT FORCES & SPACER SPAN FOR 765kV & 400kV GANTRY STRUCTURE
N.	**Section: Structure Rev 06**	
1.	**New Clause No. 3.2.4 Added**	POWERGRID will issue the fabrication drawings of the standard structures to the successful bidder. The contractor shall do the proto assembly of the structures as per the issued fabricated drawings. Employer may opt to witness such proto assembly. The bidder shall follow the fabrication drawing for preparing the proto assembly and do the minor adjustments if necessary, without affecting the strength of the structure. In case of equipment support structure the attachment of stool and fixing of MOM box etc. shall be taken care by the contractor as per the requirement of the equipment. The proto to be witnessed and Proto corrected drawings along with BOM shall be certified by the contractor. Certified drawings and BOM shall be submitted to POWERGRID for information only. The arrangement shall however not

		absolve the contractor from the responsibility of supply and erection of safe sound and durable structure.
2.	**New Clause no. 3.4**	Nuts, Bolts and washers for all non standard structures shall be payable as per BPS.
O.	**Section Civil Works Rev 11A**	
1.	**New Clause No. 21.0**	The dewatering pump shall be Portable, Self Priming, Non clog, horizontal type monobloc pump. The Pump shall be driven by electric motor suitable for outdoor application with IP-55 degree of protection. Following are the major technical parameters for the pumps to be supplied as per BPS: (A) Pump Rating : 2 HP Flow Rate : 200-400 LPM Minimum Total Head : 12 Mtrs Voltage Range : 415 ± 10% Volts (Three Phase) (B) Pump Rating : 5 HP Flow Rate : 1000-1400 LPM Minimum Total Head : 10 Mtrs Voltage Range : 415 ± 10% Volts (Three Phase)
2.	**Clause 10.5.3 of Section-Civil works Rev 11A** **&** **Clause 2.8 (b) of Section-Structures Rev 06**	**Factor of safety for design of tower and equipment structures and foundations:** a. Factor of safety for design of tower, equipment structures shall be 1.5 under normal condition and 1.2 under short-circuit condition. b. Factor of safety for design of tower, equipment foundation shall be 1.5 in both normal and short circuit condition as per IS 456. c. Factor of safety for stability of tower, equipment foundation like overturning shall be 2 (without wind or seismic), 1.5 (with wind or seismic) for normal and short circuit condition as per IS 1904.
3.	**New Clause No. 22.0**	**Slope Protection Works & Retaining Walls**: Design & Drawings pertaining to slope protection works & retaining walls (if required) shall be developed by the contractor during detailed engineering for Employer's approval. The work shall be measured under respective line items of BPS.
4.	New Clause of Copy right in Civil Rev 11A & Structure Rev 06	a. The copyright in all drawings, documents and other materials containing data and information for such design(s) to be developed by the Contractor or through any third party under this Contract shall remain vested in the Employer for a period of 5 years from the date of Completion of the Contract. In case the Contractor intends to use these design(s) for any purpose other than for project(s) to be executed by POWERGRID prior to the period of 5 years as above, the Contractor shall obtain a written permission from POWERGRID to this effect. The permission shall be granted or otherwise by POWERGRID keeping in view the specifics of the case and POWERGRID shall be sole judge in this regard. In case any breach of the aforesaid provisions of copyright during the copyright retention period comes to the notice, POWERGRID shall take the action as deemed fit keeping inter-alia under the provisions of the Integrity Pact.

		b. The Contractor may also use previous structure designs and associated foundation designs meeting specification requirements, which have been designed by them for any other project of POWERGRID, having copyright retained thereof with POWERGRID, without any financial implication and without any written permission from POWERGRID as per para (a) above. c. In case the Contractor uses previously designed structure and associated foundation designs meeting specification requirements, developed by the Contractor for any other utility/developer, POWERGRID shall be free to use designs and reproduce all drawings, documents and other material for the purpose of the Contract including, if required, in its any other project and for operation and maintenance, without any financial implication. The contractor shall ensure to submit only those documents for which they hold copyright. d. Also, all the drawings indicated at (a) & (b) above shall carry the following statement and shall be displayed conspicuously on the drawing: "WARNING: THIS IS PROPRIETORY ITEM AND DESIGN RIGHT IS STRICTLY RESERVED WITH POWERGRID UNDER NO CIRCUMSTANCES THIS DRAWING SHALL BE USED BY ANYBODY WITHOUT PRIOR PERMISSION FROM POWERGRID IN WRITING"
P.	**Section CRP Rev 09**	
1.	**New Para added under Clause No.5.1**	Requirement of Shrouding shall not be applicable to TB's where live parts are concealed.
2.	**New para added under Clause no.18.8**	Line Differential relays used as both Main –I & Main-II protection of a line, shall be of either different make & model or shall be on different hardware platform.
3.	**New para added under Clause no.18.9(s)**	Directional Earth Fault Relay/Function provided shall have Carrier Aided scheme feature which shall be suitable for single phase auto re-closure schemes
4.	Clause no. 19.1. (a), (b) and (d)	(a) have single phase & 3 phase reclosing facilities. (b) have a continuously variable dead time range of 0.1-2 seconds. (d) Auto reclose scheme shall have provision of selection of the following modes:- i. Single phase. ii. Three Phase. iii. Single & three phase. iv. Non-Auto The necessary provision in the scheme shall be provided to select the A/R mode from both **local and remote**.
5.	**New Para added under Clause No. 20.4**	Wherever, scope for NGR by passing is envisaged, necessary equipment, wiring etc. required for control & monitoring of 145kV Circuit Breaker for NGR by-passing arrangement shall be under contractor's scope of work. The same may be located in respective line/reactor protection panel.
6.	**Clause No. 21.1 (e)**	be suitable for individual input from associated CTs with rated CT secondary current of 1 Amp.
7.	**New Clause No. 21.8**	Back-up Impedance protection function shall be provided for 765kV & 400kV sides of 765/400/33kV ICT and for 400kV side of 400kV class ICT. This protection function can be clubbed with any other protection IED's except of Differential Protection IDC.
8.		The equipment offered shall have six (6) output ports. Various combinations of

<table>
<tr><td></td><td>Clause No. 32.9</td><td>output ports shall be selected by the customer, during detailed engineering, from the following :
• Potential free contact (Minimum pulse duration of 50 milli seconds.)
• IRIG-B
• RS232C
• SNTP Port (at least 4 ports)
• IEEE 1588 PTP (Applicable only for Process bus automation station)</td></tr>
<tr><td>9.</td><td>Clause no 37. IV Breaker Relay Panel</td><td>BREAKER RELAY PANEL: The breaker relay panel shall consist of the following:
<table>
<tr><th>Sl. No.</th><th>Description</th><th>Qty</th></tr>
<tr><td>1.</td><td>Breaker failure Protection Scheme*</td><td>1no.</td></tr>
<tr><td>2.</td><td>DC supply Supervision relay</td><td>2nos.</td></tr>
<tr><td>3.</td><td>Trip Circuit supervision relays#</td><td>6nos.</td></tr>
<tr><td>4.</td><td>Auto-reclose scheme (##)</td><td>1No.</td></tr>
<tr><td>5.</td><td>Flag relays, aux relays, timers, trip relays as per scheme requirements</td><td>As required</td></tr>
<tr><td>Note-1)</td><td colspan="2"># Trip supervision relays shall be 2 or 6 numbers as per no. of trip coils for each 132KV Circuit breaker</td></tr>
<tr><td>Note- 2)</td><td colspan="2">Equipment/relays to be provided under CB Relay Panel may be accommodated in the Protection Panels to be provided for Transmission Line/Transformer/Reactor as applicable</td></tr>
<tr><td>Note- 3)</td><td colspan="2">* In case of bay extension in existing half diameter, breaker failure relay for main CB / Tie CB shall be supplied only if BFR built-in Bus Bar protection bay unit is not available or Tie CB standalone BFR relay is not available in the existing protection scheme.</td></tr>
<tr><td>Note-4)</td><td colspan="2">## Auto reclose scheme shall also be acceptable as a part of BCU. All Circuit Breaker Relay Panel shall be provided with Auto-reclose function. However, during execution stage Auto-reclose function shall be enabled/ disabled based on requirement.</td></tr>
</table></td></tr>
<tr><td>Q.</td><td colspan="2">Section SAS Rev 04</td></tr>
<tr><td>1.</td><td>Typical Architectural Drawing of SAS (Without Process Bus)</td><td>TYPICAL ARCHITECTURAL DRAWING OF SUBSTATION AUTOMATION SYSTEM (Without Process Bus) stands replaced by <u>Annexure-S5</u></td></tr>
<tr><td>2.</td><td>Para 2 under Clause No. 3.3.1</td><td>The Substation Automation System shall have communication ports on each gateway (two gateways per station) as follows:

(a) Three ports for Remote Control Centres on Secure IEC60870-5-104 protocol.
(b) Two port on IEC 60870-5-104 for Regional System Coordination Centre (RSCC)</td></tr>
<tr><td>3.</td><td>New Para Added Under Clause No.4.1.5</td><td>The bidder shall also provide 2 Nos. managed Ethernet switches with at least 16 copper RJ45 ports on each switch to form managed "Redundant System LAN" for connecting different NTAMC sub-systems devices (SCADA Gateways, VMS, VOIP etc.) as per revised system architecture <u>(attached as Annexure S5)</u>. The specification of the switches is enclosed at <u>Annexure-S6.</u></td></tr>
<tr><td>4.</td><td>Para 2 Under Clause No.4.1.6</td><td>Contractor shall provide 2 nos. Next Generation Firewalls (NGFW); one No. Main & one No. Standby having electrical ethernet interfaces/ports and placed between FOTE & SAS gateways, NTAMC switch etc. at the substation. All ethernet based applications (e.g. PMU, AMR, VOIP, SAS/SCADA etc.) shall be terminated in the firewall ports directly. Each port of firewall shall work as a separate zone. Firewall shall be hardware based with functionality of Block/Allow/drop and IPSec VPN (network encryption). Minimum 16 Nos. of ports/interfaces shall be provided in</td></tr>
</table>

		each firewall (i.e. Main & Standby) Contractor can use either single firewall or multiple firewalls to meet this interfaces requirement, each for main as well as standby firewall. Minimum throughput of firewall shall be 300 Mbps. The Firewall shall be managed/ configured as standalone at present and shall also have compatibility to manage/configure through Centralized Management Console (CMC) remotely in future. OEM Support on 24x7 basis for 7 years shall be provided for all the functions & features of the Firewall. Firewall shall be tested and certified for ISO15408 Common Criteria for least EAL4+. Further, the OEM must certify that it conforms to Secure Product Development Life Cycle requirements as per IEC62443-4-1. The firewall shall generate reports for NERC-CIP Compliance. The specifications for the firewalls are attached at **Annexure-S7.**
5.	**Para 3 Under Clause No.4.1.6**	The substation routers shall have the following features: - Routing protocols such as OSPF and support for IPv4 and IPv6 **- 8 Ethernet interfaces of 10/100 Mbps** - 2 E1 interfaces - Hot standby operation with a similar router - Support IEEE 802.3u, 802.1p, 802.1Q, 802.1d, 802.1w, - Traffic prioritization for routed IP flows/ports
6.	**Bullet no.4 under Clause No. 4.2.1**	Each BCU shall be equipped with Local HMI (display) facilities, enabling control of each particular bay from BCU whenever required. The Local HMI facilities shall be accomplished by means of Graphical LCD display embedded into the front panel of the BCU. Display will show the SLD (with device identification number) showing status of bay switching equipment (such as circuit breaker, isolators, earth switches) and enabling issuance of switching controls. Other display type will be multiple displays of analog values readings / reports, displays for controls other than switching, Alarm panel displays, Diagnostic/ online configuration displays etc. **Bay control unit shall have inbuilt metering CVT supervision function. It shall have feature to give alarm in case of CVT/PT metering core fuse fail.**
7.	Clause 4.2.2 New bullet	Bay Control Units for Main System and Auxiliary system at a station shall be classified as below based on it's application and Contractor shall supply following types of BCU applicable under the subject package: Bay control Unit (IED) of Main System (a). Main Bay BCU (b). Tie Bay BCU (c). Switchable Line Reactor Bay BCU Bay control Unit (IED) of Auxiliary System (a) Auxiliary BCU
8.	**New Clause 15.4**	Mandatory spares: a. Mandatory Spares for Substation Automation shall be supplied as per BPS. b. The offered "Bay control Unit (IED) of Main System" as spare, shall be sufficient to replace all types of Bay control Units supplied under Main system without addition of any hardware/module etc. Further any additional I/O module and/or hardware supplied under Main system to meet the functional requirement of Bay control Unit in any bay, shall be considered part of Bay control Unit (IED) of Main System. The offered "Bay control Unit (IED) of Auxiliary System" as spare, shall be sufficient to replace all types of Auxiliary BCU supplied under Auxiliary system without addition of any hardware/module etc.

<table>
<tr><td></td><td></td><td>Further any additional I/O module and/or hardware supplied under Auxiliary system to meet the functional requirement of Bay control Unit shall be considered part of Bay control Unit (IED) of Auxiliary System</td></tr>
<tr><td>9.</td><td>Clause No. 16.0 (v)</td><td><u>LIST OF EQUIPMENTS</u>
v) Two nos. Disturbance Recorder/Engineering Work Station where atleast one workstation shall have Linux based operating system.</td></tr>
<tr><td>R.</td><td colspan="2">Section PLCC Rev 05</td></tr>
<tr><td>1.</td><td>New Clause No. 6.12.4</td><td>For 765 kV Wave Trap, cantilever strength of BPIs used for Wave Trap shall be 10kN.</td></tr>
<tr><td>2.</td><td>New Clause no. 10.4.13</td><td>All protection couplers (Analog protection coupler, digital protection coupler) shall be equipped with direct reading type counter facility for all the codes (Tx & Rx).</td></tr>
<tr><td>3.</td><td>New Clause no.10.5</td><td>Digital protection coupler (DPC) shall be used as one of the two tele-protection channel on the lines between the stations having Optical Fiber link alongwith SDH Equipment. Specification of digital protection coupler is enclosed as <u>Annexure-S8.</u> The DPC can be housed either in offered Control & Protection Panel / PLCC Panel or in separate panel. Generally SDH Equipment are placed in communication room of Control room where as DPC is placed in panel room. The connection between SDH equipment and each DPC shall be through Optical fiber. Necessary cables, converter(s) for converting E1 signal to optical fiber at both ends (at Panel Room as well as at Control room) along with FODP shall be in the scope of the contractor. Further sharing of additional spare ports of converter for DPC placed in other Panel Room or in same Panel Room is also permitted. Necessary optical fiber for interconnection of DPC is to be provided by the contractor. Further any copper wiring for ensuring the protection signaling/data/speech shall be in the scope of the contractor.</td></tr>
<tr><td>S.</td><td colspan="2">VISUAL MONITORING SYSTEM (if specified in BPS)</td></tr>
<tr><td>1.</td><td></td><td>Technical Specification for Visual Monitoring System for watch and ward of substation premises is attached at <u>Annexure-S9</u></td></tr>
<tr><td>T.</td><td colspan="2">Section –400KV Transformer Rev 13</td></tr>
<tr><td>1.</td><td>Clause 4(b)</td><td>The concentration of any fault gas is more than respective values as per Table-1 of IEEE-C57.104-2019, which are as detailed below.
<table>
<tr><th>FAULT GAS</th><th>O2/N2 Ratio ≤ 0.2</th><th>O2/N2 Ratio > 0.2</th></tr>
<tr><td>Hydrogen (H2)</td><td>75</td><td>40</td></tr>
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<tr><td>Acetylene (C2H2)</td><td>01</td><td>02</td></tr>
<tr><td>Carbon monoxide (CO)</td><td>900</td><td>500</td></tr>
<tr><td>Carbon dioxide (CO2)</td><td>5000</td><td>3500</td></tr>
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<tr><td>2.</td><td>Clause No. 6.5.1</td><td>Conservator shall have air cell type constant oil pressure system to prevent oxidation and contamination of oil due to contact with moisture.
Conservator Protection Relay (CPR)/Air cell puncture detection relay shall be installed to give alarm in the event of lowering of oil in the conservator due to puncture of air cell in service.

Conservator shall be fitted with magnetic oil level gauge (Plug & socket type arrangement) with potential free high and low oil level alarm contacts and prismatic oil level gauge and Conservator Protection Relay.</td></tr>
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<tr><td></td><td></td><td>Plug & socket type arrangement with factory fitted cable of adequate length shall be supplied by OEM. Connection of plug and socket with cable at site is not acceptable.</td></tr>
<tr><td>3.</td><td>Annexure-H</td><td>ANNEXURE - H
1.1 KV GRADE POWER & CONTROL CABLES
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– VOID (Parameters of Standard Technical Data Sheet shall not be referred to)

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<tr><td>4.</td><td>Clause 9.1</td><td>Particles in the oil
The particle analysis shall be carried out in an oil sample taken before carrying out FAT at manufacturer's works and after completion of the oil filtration at site. The procedure and interpretation shall be in accordance with the recommendation of CIGRE report WG-12.17- "Effect of particles on transformer dielectric strength". Particle limit as shown below shall be ensured by manufacturer, implying low contamination, as per CIGRE Brochure 157, Table 8.

Limiting value for the particle count are 1000 particle/100 ml with size ≥ 5 µm; 130 particle/100 ml with size ≥ 15 µm.</td></tr>
<tr><td>U.</td><td colspan="2">Section 400kV Shunt Reactor Rev. 11</td></tr>
<tr><td>1.</td><td>Clause No. 7.5.1</td><td>Conservator shall have air cell type constant oil pressure system to prevent oxidation and contamination of oil due to contact with moisture.
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Conservator shall be fitted with magnetic oil level gauge (Plug & socket type arrangement) with potential free high and low oil level alarm contacts and prismatic oil level gauge and Conservator Protection Relay.

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Limiting value for the particle count are 1000 particle/100 ml with size ≥ 5 µm; 130 particle/100 ml with size ≥ 15 µm.</td></tr>
<tr><td>V.</td><td colspan="2">Section- 765kV Auto-transformer Rev 08</td></tr>
<tr><td>1.</td><td>Clause 4(b)</td><td>The concentration of any fault gas is more than respective values as per Table-1 of IEEE-C57.104-2019, which are as detailed below.
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Conservator Protection Relay (CPR)/Air cell puncture detection relay shall be installed to give alarm in the event of lowering of oil in the conservator due to puncture of air cell in service.

Conservator shall be fitted with magnetic oil level gauge (Plug & socket type arrangement) with potential free high and low oil level alarm contacts and prismatic oil level gauge and Conservator Protection Relay.

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Limiting value for the particle count are 1000 particle/100 ml with size ≥ 5 µm; 130 particle/100 ml with size ≥ 15 µm.</td></tr>
<tr><td>W.</td><td colspan="2">Section-765kV Shunt Reactor, Rev. 08</td></tr>
<tr><td>1.</td><td>Clause 5(b)</td><td>The concentration of any fault gas is more than respective values as per Table-1 of IEEE-C57.104-2019, which are as detailed below.
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X.	**LT transformer Rev-5**	
1.	Clause no 5.2.5 b)	**Clause no 5.2.5 b) Stand Deleted.**

Sl. No.	Power System Equipment	Minimum Local Content (%)
1	Power Transformers (up to 765 kV, including Generator Transformers)	60
2	Instrument Transformer (up to 765 kV)	60
3	Transformer Oil Dry Out System (TODOS)	60
4	Reactors up to 765 kV	60
5	Oil Impregnated Bushing (Up to 400kV)	60
6	Resin Insulated Paper (RIP) bushings (up to 145 kV)	50
7	Circuit Breakers (up to 765kV AC-Alternating Current)	60
8	Disconnectors, Isolators (up to 765kV AC)	60
9	Wave Trap (up to 765kV AC)	60
10	Oil Filled Distribution Transformers up to & including 33kV [Cold Rolled Grain Oriented (CRGO)/Amorphous, Aluminium/Copper wound]	60
11	Dry type Distribution Transformers up to & including 33kV (CRGO/Amorphous, Aluminium/Copper wound)	60
12	Conventional conductor	60
13	Accessories for conventional conductors	60
14	High Temperature/High Temperature Low Sag (HTLS) conductors (such as Composite core, GAP, ACSS, INVAR, AL59) and accessories	60
15	Optical ground wire (OPGW)- all designs	60
16	Fiber Optic Terminal Equipment (FOTE) for OPGW	50
17	OPGW related Hardware and accessories	60
18	Remote Terminal Unit (RTU)	50
19	Power Cables and accessories up to 33kV	60
20	Control cables including accessories	60
21	XLPE cables up to 220kV	60
22	Substation Structures	60
23	Transmission Line Towers	60
24	Porcelain (Disc/Long Rod) Insulators	60
25	Bus Post Insulators (Porcelain)	60
26	Porcelain Disc Insulators with Room Temperature Vulcanisation (RTV) coating	50
27	Porcelain Long Rod Insulators with Room temperature Vulcanisation (RTV) coating	50
28	Hardware Fittings for porcelain Insulators	60
29	Composite/Polymeric Long Rod Insulators	60
30	Hardware Fittings for Polymer Insulators	60
31	Bird Flight Diverter (BFD)	60
32	Power Line Carrier Communication (PLCC) system (up to 800kV)	60
33	Gas Insulated Switchgear (up to 400kV AC)	60
34	Gas Insulated Switchgear (above 400kV AC)	50
35	Surge/Lightning Arrester (up to 765kV AC)	60
36	Power Capacitors	60
37	Packaged Sub-station (6.6kV to 33kV)	60
38	Ring Main Unit (RMU) (up to 33kV)	60

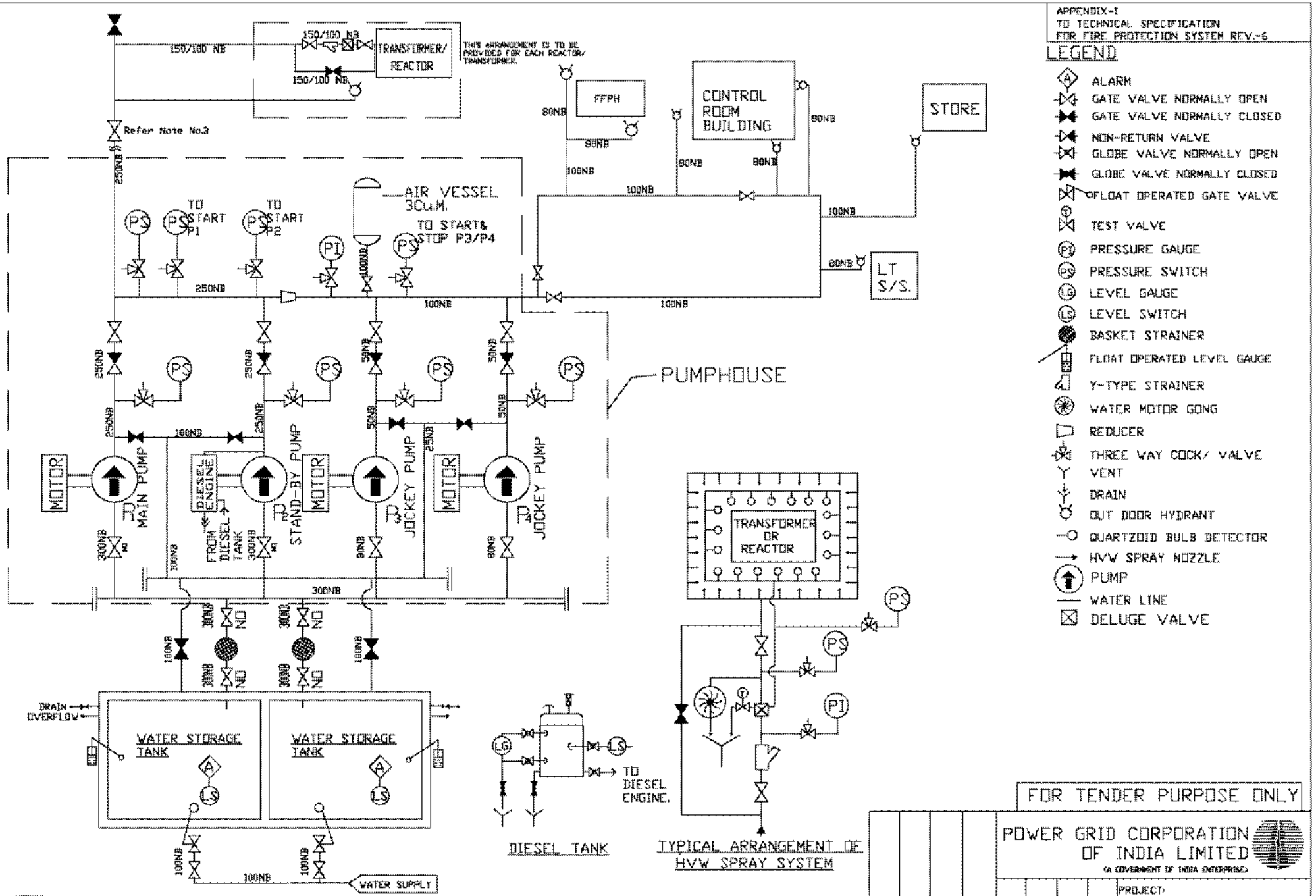
39	Medium Voltage (MV) GIS panels (up to 33kV)	60
40	Automation and Control system/Supervisory Control and Data Acquisition (SCADA) system in Power system	50
41	Control and Relay panel (including Digital/Numerical relays)	50
42	Electrical motors 0.37kW to 1MW	60
43	Energy meters excluding smart meters	50
44	Control and Power cables and accessories (up to 1.1kV)	60
45	Diesel Generating (DG) set	60
46	DC system (DC Battery & Battery Charger)	60
47	AC and DC Distribution board	60
48	Indoor Air Insulated Switchgear (AIS) up to 33kV	60
49	Poles (PCC, PSCC, Rolled Steel Joist, Rail Pole, Spun, Steel Tubular)	60
50	Material for Grounding/earthing system	60
51	Illumination system	60
52	Overhead Fault Sensing Indicator (FSI)	50
53	Power Quality Meters	50
54	Auxiliary Relays	50
55	Load Break Switch	50
56	Cranes, EOT cranes, gantry crane & chain pulley blocks, etc	60
57	Elevator	60
Fire Protection and Detection system		
58	Motor driven fire water pumps	60
59	Diesel engine driven fire water pumps	60
60	Hydrant system	60
61	High velocity water spray system	60
62	Medium velocity water spray system	60
63	Foam Protection system	60
64	Inert gas flooding system	60
65	Fire tenders	60
66	Portable fire-extinguishers	60

Annexure-V (Revised): Actions required in case of defects observed during warrantee period

Equipment	Nature of problem	Corrective measures to be taken by contractor
CT/IVT/PT (Oil filled)	**DGA Violation** H2 > 300 ppm C2H2> 2 ppm	Refurbished or replaced
CT/IVT/PT (SF_6 filled)	a) SF6 gas leakage b) High Dew point of SF6 gas (> -36 deg C at atm press)	a)Repair/ replacement b)Re-processing of gas and replacement of Gas in case of no improvement
CT/IVT/PT (Oil filled)	**Violation of Tan delta** Tan Delta: >0.5%(during pre-commisioning) >0.7% (in operation) or change w.r.t. to previous year value > 0.1%	Replacement
CT, IVT/PT & CVT	- Oil leakage - Low Oil level -Sec winding problem leading to open/ short circuit, saturation etc	Replacement or repair as per repair procedure approved by QA.
CVT	Secondary voltage drift: Upto ± 0.5 volts Healthy a) ± 0.5 **or beyond**	a) CVT to be replaced

***Replaced/Repaired/Refurbished Equipment (or part of equipment) shall have 2 years warranty without prejudice to contractual warranty period.**

APPENDIX-I
TO TECHNICAL SPECIFICATION
FOR FIRE PROTECTION SYSTEM REV.-6



LEGEND

- ALARM
- GATE VALVE NORMALLY OPEN
- GATE VALVE NORMALLY CLOSED
- NON-RETURN VALVE
- GLOBE VALVE NORMALLY OPEN
- GLOBE VALVE NORMALLY CLOSED
- FLOAT OPERATED GATE VALVE
- TEST VALVE
- PRESSURE GAUGE
- PRESSURE SWITCH
- LEVEL GAUGE
- LEVEL SWITCH
- BASKET STRAINER
- FLOAT OPERATED LEVEL GAUGE
- Y-TYPE STRAINER
- WATER MOTOR GONG
- REDUCER
- THREE WAY COCK/ VALVE
- VENT
- DRAIN
- OUT DOOR HYDRANT
- QUARTZOID BULB DETECTOR
- HVW SPRAY NOZZLE
- PUMP
- WATER LINE
- DELUGE VALVE

NOTES: 1. THE HYDRANT POINTS FOR TRANSFORMER/ REACTOR SHALL BE LOCATED AT LEAST 20M AWAY FROM THEM.

2. AS SAFETY MEASURE, A WARNING PLATE SHALL BE PLACED NEAR HYDRANT POINTS FOR TRANSFORMER/ REACTOR TO CLEARLY INDICATE THAT WATER SHALL BE SPRAYED ONLY AFTER ENSURING THAT THE POWER TO THE TRANSFORMER/ REACTOR WHICH IS ON FIRE IS SWITCHED OFF AND THERE ARE NO LIVE PART WITHIN 20 M. DISTANCE OF THE PERSONNEL USING THE HYDRANT.

3. FIRE HYDRANT PIPE LINE OUTSIDE THE PUMP HOUSE SHALL BE SUITABLY SECTIONALIZED AS PER LAYOUT REQUIREMENT. MINIMUM ONE(1) GATE VALVE TO BE PROVIDED FOR EVERY 200 METER OF MAIN HYDRANT PIPE FOR PURPOSE OF MAINTENANCE.

FOR TENDER PURPOSE ONLY

POWER GRID CORPORATION OF INDIA LIMITED
(A GOVERNMENT OF INDIA ENTERPRISE)

APPD.	RECOMMENDED	DATE	DRAWN	CHKD.	APPD.
		17.07.2019	HIMANSHU	S K THAKUR	

PROJECT: 765kV AND 400kV SUBSTATION

TITLE: PIPING & INSTRUMENTATION DIAGRAM FOR HYDRANT & HVW SPRAY SYSTEM.

NTS | DRG.NO. C/ENGG/STD/FP/I Sheet 1 of 1 | REV 5

TECHNICAL DATA SHEETS

DATA SHEET FOR DELUGE VALVE

1.0	Manufacturer	POWERGRID Approved make
2.0	Number & size	As per approved system drawings.
3.0	Type	Differential Diaphragm type
4.0	Rating	
4.1	Flow in M^3/hr. 1. 150 mm ø 2. 100 mm ø	170 to 650 50 to 225
4.2	Pressure	Working Pressure – 12.3 kg/cm^2 Test Pressure - 25 kg/cm^2
4.3	Pressure drop in equivalent length 1. 150 mm ø 2. 100 mm ø	 19M 11M
5.0	**Material of construction**	
5.1	Body	CI IS:210 Gr. FG 260
5.2	Valve internal	Cast Bronze – IS:318-LTB 2 / Ductile Iron ASTM A536 65-45-12
5.3	Seat Seal	EPDM/ Neoprene Rubber
5.4	Diaphragm	EPDM/ Neoprene Rubber
6.0	Differential pressure required for operation	Differential Ratio – 50%
7.0	Water Motor Gong provided	Yes
7.1	Type	Hydraulic type
7.2	**Material of Construction:**	
7.2.1	Housing	Al. Alloy-IS:617
7.2.2	Cover/Rotor./Gong	Aluminium to IS:737
7.2.3	Manual actuation lever provided?	Yes
8.0	Remote actuation with Solenoid Valve provided?	Yes
9.0	Resetting type	Manual resetting type
10.0	Deluge valve complete with test and drain valves, manual operation arrangement, supporting structures and all necessary accessories	Yes
11.0	Approval of Deluge Valve.	FM of USA, UL of USA, LPCB of U.K. or VDS of Germany

METHODOLOGY FOR SUPPLY, INSTALLATION & SIZING OF CABLES

Supply of 1.1kV grade Cables:

- The quantities of various type of 1.1kV grade power and control cables shall be assessed by POWERGRID. The Sizes of 1.1 kV grade Control cables to be adopted for installation is enclosed at Appendix I . For Sizes of Power Cable, Clause 1.1.4 of Section Power and control Cable rev 06 is amended at Appendix-II

  For Applications in addition to those specified, appropriate cable size shall be considered by the contractor with prior approval of Employer during execution stage

- Supply of 1.1kV grade power and control cables of various sizes shall be as per unit quantities mentioned in BPS.

- The Cables from Control Room/SPR/ACDB/DCDB/BMK to Equipment Marshalling box (MB)/Local control Cubical (LCC) shall be considered under the BPS item for supply of cables.

- The Interpole cables between AIS Instrument Transformer (CT/CVT), Surge Arrester and associated Junction Box shall be as per unit quantities mentioned in BPS.

- The Interpole cables between Circuit Breaker, Isolator and associated Marshalling box shall be deemed to be included in price of Equipment.

Installation of 1.1kV grade Cables:

- The quantity of Installation of cables is to be assessed by the contractor for the complete scope of work specified in Section project.

- The installation of 1.1kV grade power and control cables (including interpole cable of Equipment & illumination cables) shall be quoted in "LOT" basis.

- Supply and installation of Cable accessories like lugs, glands etc. for entire cabling work shall be deemed to be included in Installation charges of cables quoted by contractor in Bid price schedule.

- No variation shall be admissible on account of Installation of Cables/supply and installation of associated accessories, irrespective of variation (either positive or negative) in supply quantity of Cable specified in BPS.

Extra Consumption of 1.1 kV Power and control cables.

The Contractor shall make every effort to minimise wastage of the cables during installation. The Permitted Overall scarp/wastage shall be limited to 0.50% of actual supplied quantity for each size of cables. Any wastage more than the above limit shall be recovered from the contractor. All balance unused cables shall be returned to the employer by rewinding in separate drums for each size with discrete markings on drums.

Cut pieces of Cables having length less than following shall be considered for Scrap. The Contractor shall dispose of the scrap (if any), at their own cost :

1.) **Length less than 20 M**
   - **a)** Control Cable (3C, 5C, 7C & 10 Core)
   - **b)** Power Cable(2CX 6Sqmm,4CX6Sqmm, 4CX16Sqmm)

2.) **Length less than 50 M**
   - **a)** Control Cable having more than 10 Cores
   - **b)** Power Cable of sizes above 16 Sq mm

For Illumination purpose, ACP's shall be supplied as per BPS. From ACP to luminous all the required cables, accessories(including lugs and gland for cables between MLDB & ACP) , SLP/JB etc as required shall be assessed and supplied by the contractor. The price of these items shall be deemed to be included in price of luminaries.

Appendix-I: Control Cable Sizes

S.No.	From	To	Proposed Cable size
1.	CB MB	CRP panels	i) 10CX2.5Sq mm ii) 19CX1.5 Sq mm iii) 27CX 1.5 Sq mm
2.	CB MB	Earth switch MB	i) 3CX 2.5 Sqmm ii) 5C X2.5 Sq mm
3.	Isolator MB	Earth switch MB	10CX2.5Sq mm
4.	Isolator MB	CRP panels	19CX1.5 Sq mm
5.	CT	CT JB	i) 5C X2.5 Sq mm ii) 10C X2.5 Sq mm
6.	CT JB	CRP panels	i) 5C X2.5 Sq mm ii) 10C X2.5 Sq mm
7.	CVT	CVT JB	i) 5C X2.5 Sq mm ii) 10C X2.5 Sq mm
8.	CVT JB	CRP panels	i) 5C X2.5 Sq mm ii) 10C X2.5 Sq mm
9.	LA	LA JB	3C X2.5 Sq mm
10.	LA JB	CRP panels	5C X2.5 Sq mm
11.	Reactor MB/CMB (for 1-Ph)	CRP panels	i) 3CX2.5Sq mm ii) 5CX2.5 Sq mm iii) 19CX 1.5 Sq mm iv) 27CX 1.5 Sq mm v) Paired Cables
12.	ICT MB/CMB (for 1-Ph)	CRP panels	i) 3CX2.5Sq mm ii) 5CX2.5 Sq mm iii) 19CX 1.5 Sq mm iv) 27CX 1.5 Sq mm v) Paired Cables

Note:

i) For Applications in addition to those specified, appropriate cable size shall be considered by the contractor with prior approval of Employer during execution stage.

ii) GTP of 1.5 Sq mm Cable shall be submitted during detailed engineering stage for employers approval.

iii) In case, more nos. of runs or larger sizes of cables are required between two points based on design calculations, same shall deemed to be included in the scope of bidder.

Appendix-II Power cable sizes.

S.No.	From	To	Existing Cable size	Cable type
1.	Main Switch Board	LT Transformer	2-1C X 630 mm^2 :For each phase 1-1C X 630 mm^2 : for neutral	XLPE
2.	Main Switch Board	AC Distribution Board	2-3½C X 300 mm^2	XLPE
3.	Main Switch Board	Oil Filtration Unit	1-3½C X 300 mm^2	XLPE
4.	Main Switch Board	Colony Lighting	1-3½C X 300 mm2	XLPE
5.	Main Switch Board	HVW pump LCP	1-3½C X 300 mm2	XLPE
6.	Main Switch Board	Main Lighting distribution board	2-3½C X 300 mm2	XLPE
7.	AC Distribution Board	D.G. Set AMF Panel	For 500 kVA DG set: 2-3½C X 300 mm2 For 250 kVA DG set: 1-3½C X 300 mm2	XLPE
8.	AC Distribution Board	Emergency Lighting distribution board	3½C X 70mm2 :For 765/400kV S/s 3½C X 35mm2 :For 400/220kV S/s	PVC
9.	AC Distribution Board	ICT MB	3½C X 70mm2 :For 765/400kV S/s 3½C X 35mm2 :For 400/220kV S/s	PVC
10.	AC Distribution Board	Bay MB	3½C X 70mm2 :For 765/400kV S/s 3½C X 35mm2 For 400/220kV S/s	PVC
11.	Bay MB	AC Kiosk	1-4C X 16 mm2	PVC
12.	AC Distribution Board	Battery Charger 220 V	1-3½C X 70 mm2	PVC

13.	AC Distribution Board	Battery Charger 48 V	1-3½C X 35 mm	PVC
14.	DCDB	Battery	2-1C X 150 mm2	PVC
15.	DCDB	Battery Charger	2-1C X 150 mm2	PVC
16.	DCDB	Protection/PLCC panel	1-4C X 16 mm2 : 765/400kV S/s 1-4C X 6 mm2: 400/220kV S/s	PVC
17.	Main Lighting DB	Lighting panels(Indoor)	1-3½C X 35 mm2	PVC
18.	Main Lighting DB	Lighting panels (outdoor)	1-3½C X 70 mm2	PVC
19.	Main Lighting DB	Receptacles (Indoor)	1-3½C X 35 mm2	PVC
20.	Main Lighting DB	Receptacles (Outdoor)	1-3½C X 70 mm2	PVC
21.	Lighting Panel	Sub lighting panels	These Cables shall be included in Price of item for Lighting fixture	PVC
22.	Lighting Panel	Street Lighting Poles	These Cables shall be included in Price of item for Lighting fixture	PVC
23.	Lighting Panel/ Sub lighting panels	Lighting Fixtures (Outdoor)	These Cables shall be included in Price of item for Lighting fixture	PVC
24.	Bay MB	Equipment	1-4C X 16 mm^2 : For CB 1-4C X 6 mm^2: For Isolator/earths switch 1-2C X 6 : For CT/CVT	PVC
25.	ELDB	Lighting panel	3½C X 70mm^2 :For 765/400kV S/s 3½C X 35mm2 :For 400/220kV S/s	

Annexure-S2

AIR CONDITIONING & VENTILATION SYSTEM FOR GIS BUILDING

AIR CONDITIONING SYSTEM FOR GIS

1 GENERAL

1.1 This specification covers supply, installation, testing and commissioning and handing over to POWERGRID of Air conditioning system for the Local Control rooms & Maintenance Room in the GIS halls.

1.2 Air conditioning system shall be designed to maintain the inside DBT below 24°C. Bidder shall submit necessary design calculations for employer's approval.

1.3 At least 50% spare Air-Conditioning capacity shall be provided for Local Control rooms in the GIS halls.

1.4 Controllers shall be provided in Local Control room inside GIS hall for controlling and monitoring the AC units in these rooms as detailed in clause no.2.6

1.5 Each Local Control room inside GIS hall shall be provided with temperature transducer to monitor the temperature of the Local Control rooms in the GIS halls. The Temperature transducer shall have the following specification:

Sensor	:	Air temperature sensor (indoor use)
Output	:	4 to 20mA
Temperature range	:	-5°C to 60°C
Resolution	:	0.1°C
Accuracy	:	0.5°C or better.

2 AIR CONDITIONING SYSTEM REQUIREMENTS.

2.1 Air conditioning requirement of the buildings shall be met using a combination of following types Air Conditioning units as required.

a) Cassette type split AC units of 3TR.
b) High wall type split AC units of 2TR.

2.2 Type & Capacity of air conditioners shall be so chosen such that quantity of air conditioners in the room is optimized keeping the necessary air flow.

2.3 **Scope**

The scope of the equipment to be furnished and services to be provided under the contract are outlined hereinafter and the same is to be read in conjunction with the provision contained in other sections/ clauses. The scope of the work under the contract shall be deemed to include all such items, which although are not specifically mentioned in the bid documents and/or in Bidder's proposal, but are required to make the equipment/system complete for its safe, efficient, reliable and trouble free operation.

2.3.1 Required number of Cassette type split AC units of 3TR capacity each complete with air cooled outdoor condensing unit having hermetically sealed compressor unit with cordless remote controller.

2.3.2 Required number of High wall type split AC units of 2TR capacity each complete with air cooled outdoor condensing unit having hermetically sealed compressor and high wall type indoor evaporator unit with cordless remote controller.

2.3.3 Copper refrigerant piping complete with insulation between the indoor and outdoor units as required.

2.3.4 First charge of refrigerant and oil shall be supplied with the unit.

2.3.5 GSS/Aluminium sheet air distribution ducting for distributing conditioned dehumidified air along with supply air diffusers and return air grilles with volume control dampers and necessary splitters etc., suitable fixtures for grilles/diffusers and supports for ducting complete with insulation.

2.3.6 Local start/stop facility for local starting/ stopping of all electrical equipment/ drives.

2.3.7 All instruments and local control panels alongwith controls and interlock arrangements and accessories as required for safe and trouble free operation of the units.

2.3.8 PVC drain piping from the indoor units upto the nearest drain point.

2.3.9 Supply and erection of Power and control cable and earthing.

2.3.10 MS Brackets for outdoor condensing units, condensers as required.

2.4 **Technical specifications.**

2.4.1 **Cassette type split AC units.**

The Cassette type AC units shall be complete with indoor evaporator unit,

outdoor condensing units and cordless remote control units.

2.4.1.1 Outdoor unit shall comprise of hermetically/ semi hermetically sealed compressors mounted on vibration isolators, fans and copper tube aluminium finned coils all assembled in a sheet metal casing. The casing and the total unit shall be properly treated and shall be weatherproof type. They shall be compact in size and shall have horizontal discharge of air.

2.4.1.2 Indoor units shall be of 4-way, ceiling mounted cassette type. The indoor unit shall be compact and shall have elegant appearance. They shall have low noise centrifugal blowers driven by suitable motors and copper tube aluminium finned cooling coils. Removable and washable polypropylene filters shall be provided. They shall be complete with multi function cordless remote control unit with

special features like programmable timer, sleep mode etc.

2.4.1.3 Cooling capacity of 3TR AC units shall not be less than 36000btu/hr. and shall have energy efficiency rating of 5 star as on the date of NOA.

2.4.2 **High wall type split AC units**

2.4.2.1 The split AC units shall be complete with indoor evaporator unit, outdoor condensing units and cordless remote control units.

2.4.2.2 Outdoor unit shall comprise of hermetically/semi hermetically sealed compressors mounted on vibration isolators, propeller type axial flow fans and copper tube aluminium finned coils all assembled in a sheet metal casing. The casing and the total unit shall be properly treated and shall be weatherproof type. They shall be compact in size and shall have horizontal discharge of air.

2.4.2.3 The indoor units shall be high wall type. The indoor unit shall be compact and shall have elegant appearance. They shall have low noise centrifugal blowers driven by suitable motors and copper tube aluminium finned cooling coils. Removable and washable polypropylene filters shall be provided. They shall be complete with multi function cordless remote control unit with special features like programmable timer, sleep mode and soft dry mode etc.

2.4.2.4 Cooling capacity of 2TR AC units shall not be less than 22000btu/hr. and shall have energy efficiency rating of 5 star as on the date of NOA.

2.5 Controllers shall be provided in Local Control room inside GIS hall, one controller for each room, to control and monitoring of AC units and shall have the following facilities;

- Standby units shall come in to operation automatically when the running main unit fails
- Main and standby units shall be changed over periodically which shall be finalised during detailed engineering.
- Following alarms shall be provided:

  a. Compressor On/OFF condition of each unit
  b. Compressor failure of each unit
  c. Power OFF to AC unit
  d. High temperature in room.

2.6 **Warranty**

All compressors shall have minimum 5 years Warranty from the date of commissioning.

Annexure-S2

Ventilation system for GIS Hall

Each GIS Hall shall have an independent ventilation system. Each Ventilation system shall consist of two 100% capacity systems, one operating and one stand-by.

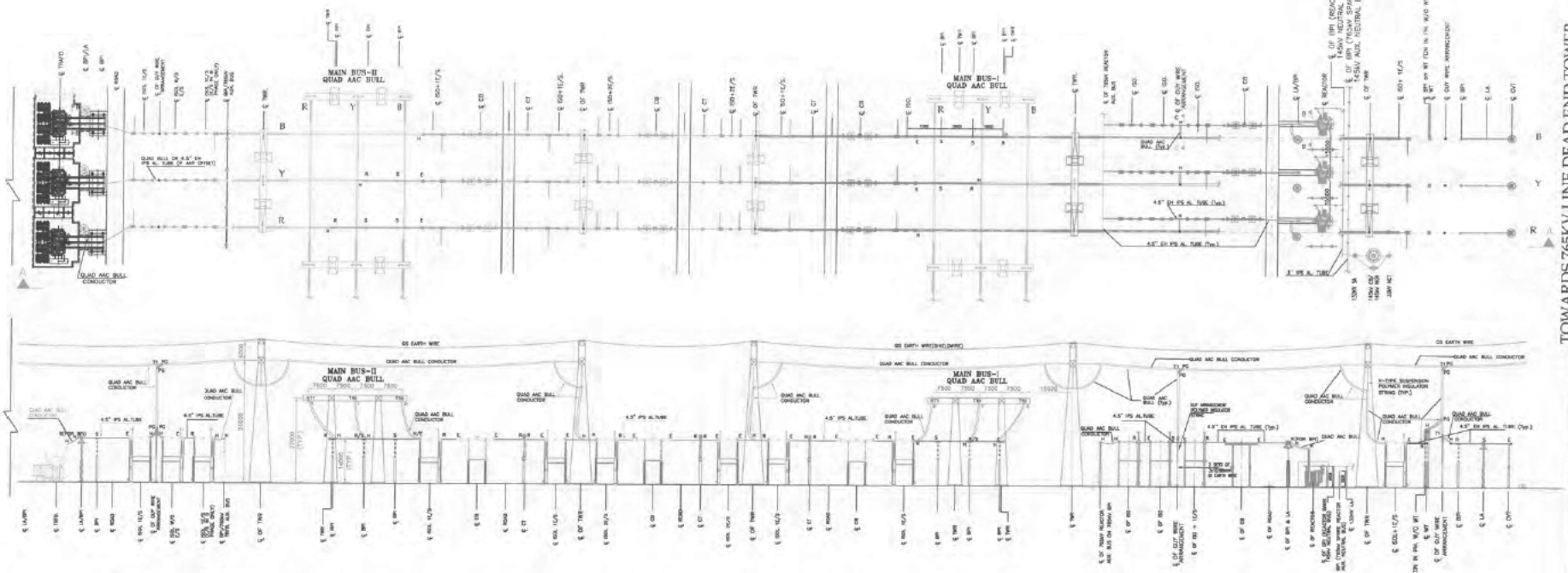
To ensure that the air being supplied to the GIS hall is free from dust particles, a minimum two stage dust filtration process shall be supplied. This shall consist of at least the following:

1. Pre Filters: To remove dust particles down to 10 micron in size with at least 95% efficiency.

2. Fine Filters: To remove dust particles down to 5 microns in size with at least 99% efficiency.

All the filters shall be panel type. Easy access should be available to the filters for replacement/cleaning.

The ventilation of the GIS hall shall be of a positive pressure type with minimum 2 air changes per hour. The pressure inside the GIS hall shall be maintained 5 mm of water above the atmospheric pressure. Fresh outdoor air shall be filtered before being blown into the GIS hall by the air fans to avoid dust accumulation on components present in the GIS hall. GIS hall shall be provided with motorized exhaust dampers with local control.



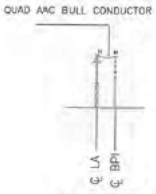
SECTION A–A (TYPICAL PLAN & SECTION FOR 765kV SIDE OF 765/400/33kV ICT –TIE–765kV LINE WITH LINE REACTOR BAY)

LEGENDS:

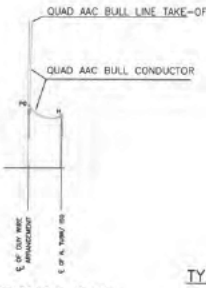
R– RIGID CONNECTION
E– EXPANSION TYPE CONNECTION
S– SLIDING TYPE CONNECTION
PG–PARALLEL GROOVE CONNECTION
T1– T1 TYPE CONNECTION (EACH T CONNECTOR SHALL BE OF TWIN TO TWIN CONDUCTOR TYPE FOR QUAD TO QUAD CONNECTION)
H– HORIZONTAL TYPE CONNECTION

NOTES:

1) TWIN–TWIN CONNECTOR SHALL BE USED FOR QUAD–QUAD DROPPER CONNECTION.
2) AUXILIARY BUS ARRANGEMENT FOR 765kV TRANSFORMERS & REACTOR NEUTRALS, SPARE TRANSFORMER/REACTOR CONNECTION, TERTIARY ARRANGEMENT OF TRANSFORMERS ARE NOT SHOWN COMPLETELY.
3) CANTILEVER STRENGTH OF 765KV INSULATORS/BPI USED FOR 765KV ISOLATORS/WT SHALL BE OF 10KN AND FOR OTHER BPI IN SWITCHYARD SHALL BE OF 8KN MINIMUM.
4) HORIZONTAL TAKE–OFF OF JUMPERS AT EQUIPMENT LEVELS WITH ADEQUATE SAG SHALL BE PROVIDED



SECTION B–B



SECTION C–C

TYPICAL SECTION FOR 765KV LINE SIDE EUIPMENT CONNECTION ARRANGEMENT IN PHASE WITHOUT WT

PREPARED BY			REVIEWED BY			APPROVED BY
GAUTAM SHARMA	D.OJHA	A.SAMBAIAH	ABHAY KUMAR	P.K. DAS	RAJIL SRIVASTAVA	R.N. SINGH
CDE (ENGG–S/S)	DGM (ENGG–S/S)	DGM (ENGG–S/S)	Sr. GM (ENGG–S/S)	Sr.GM (ENGG–S/S)	CGM (ENGG–S/S)	ED (ENGG.–S/S,T/L & Civil)

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

TITLE: CONCEPTUAL CONNECTION ARRANMENT OF 765KV TRANSFORMER BAY–TIE BAY– LINE WITH LINE REACTOR BAY'S

DRAWING NO. C/ENGG/SS/CONCEPTUAL 765KV BAY CONNECTIONS

REV. 1

SH.10F1

ANNEXURE- S4

SHORT CIRCUIT FORCES & SPACER SPAN FOR 765kV & 400kV GANTRY STRUCTURE

For new 765kV and 400 kV AIS switchyard with one & a half breaker switching scheme, three gantry type arrangement (i.e. arrangement having single gantry in Tie bay) shall be considered. Further, Short-Circuit Forces (SCF) for the design of Gantry Structure and spacer spans shall be as mentioned below:

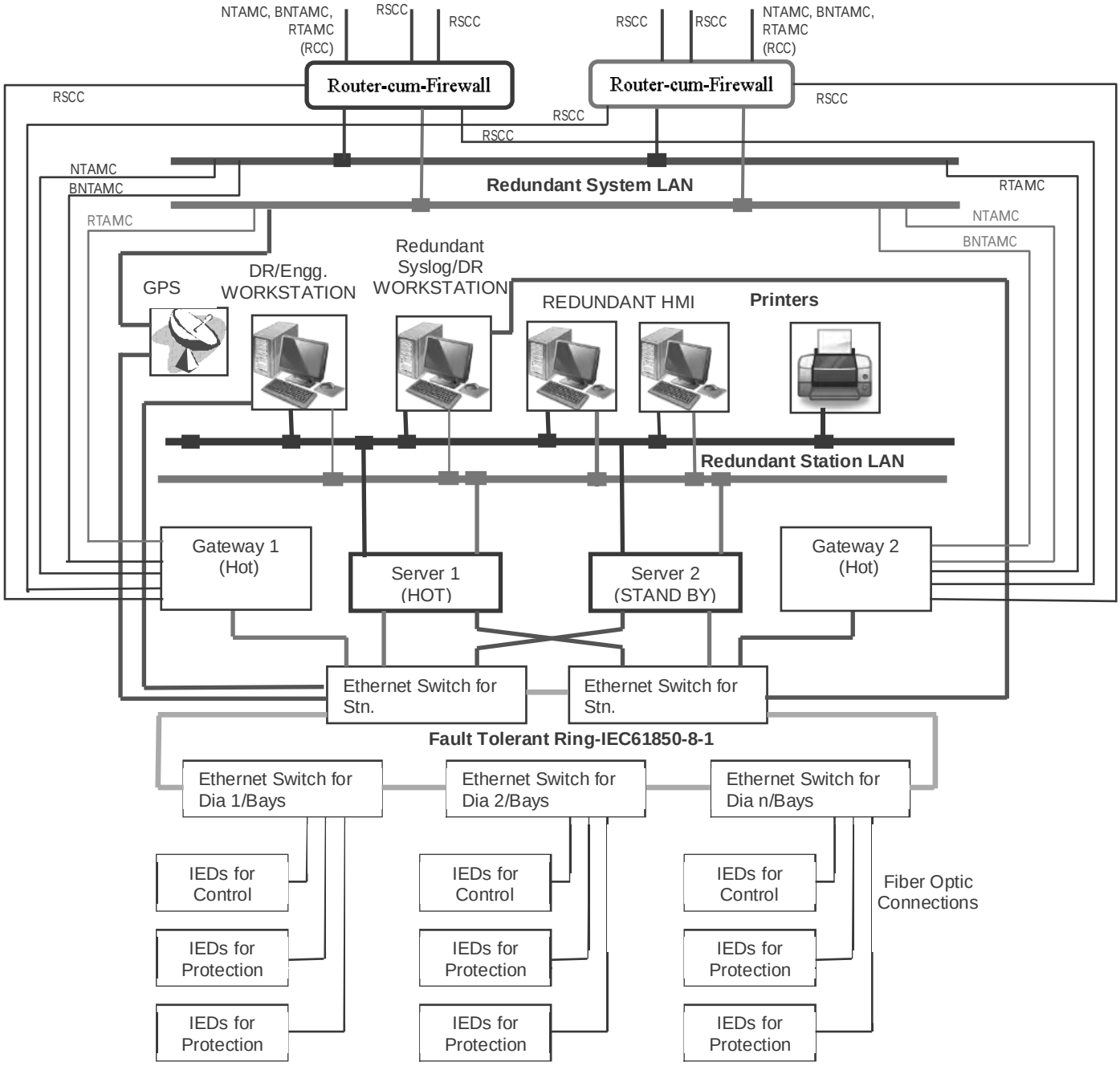
Voltage Level: 765kV, Fault Level: up to 50kA for 1 sec								
Bus Type	**Height of Bus (from FGL)**	**Max Span**	**Bus Conductor Configuration**	**Ph-Ph Spacing**	**Normal Tension per phase**	**SCF per phase**	**Spacer Span**	**Applicable Wind Speed**
Main Bus	27 Mtr	108 Mtr	Quad Bull	15Mtr	8T	9.75T	6Mtr	Upto 50m/s
Jack Bus	40 Mtr	140 Mtr		15Mtr	9.5T	11.26T	6Mtr	Upto 50m/s
Jack Bus	40 Mtr	114 Mtr		15Mtr	9.5T	11.10T	6Mtr	Upto 50m/s
Voltage Level: 400kV, Fault Level: up to 63kA for 1 sec, Bay Width : 24 Mtr								
Bus Type	**Height of Bus (from FGL)**	**Max Span**	**Bus Conductor Configuration**	**Ph-Ph Spacing**	**Normal Tension per phase**	**SCF per phase**	**Spacer Span**	**Applicable Wind Speed**
Main Bus	15mtr	72.0Mtr	Quad Bersimis	6.5mtr	5T	7.32T	4Mtr	Upto 50m/s
Jack Bus	23Mtr	75.0Mtr		6.5mtr	5T	7.36T	4Mtr	Upto 47m/s
Jack Bus	23Mtr	75.0Mtr		6.5mtr	5T	7.36T	3.5Mtr	Upto 50m/s
Jack Bus	23Mtr	59.0Mtr		6.5mtr	5T	7.12T	4Mtr	Upto 50m/s
Jack Bus	23Mtr	46.0Mtr		6.5mtr	4T	6.20T	4Mtr	Upto 50m/s

Above shall also be applicable for following cases unless otherwise specified elsewhere:

(i) Extension of 765kV switchyard with existing three gantry type arrangement
(ii) Extension of 400kV switchyard with existing three gantry type arrangement and having bus heights matching with above.

For design of gantry structures with spans, wind speed or conductor configurations other than that mentioned above, conductor tension shall be considered based on actual requirement of present & future scope of work. Relevant design calculations for such cases shall be submitted by the contractor for employer's approval.

TYPICAL ARCHITECTURAL DRAWING OF SUBSTATION AUTOMATION SYSTEM (Without Process Bus) for New Substation



Note:

1. The redundant managed bus (station LAN) shall be realized by high speed optical bus using industrial grade components and shall be as per IEC 61850.
2. Inside the sub-station, all connections shall be realized as per IEC 61850 protocol.
3. For gateway, it shall communicate with Remote Supervisory Control Centre (RSCC) on IEC 60870-104 protocol. The number of ports required shall be as per clause no. 1.1 and 3.3 of this specification.
4. The printer as required shall be connected to station bus directly and can be managed either from station HMI, HMI view node or disturbance recorder work stations.
5. The above layout is typical. However if any contractor offers slightly modified architecture based on their standard practice without compromising the working, the same shall be subject to approval during detailed engineering.
6. RCC means NTAMC/RTAMC. Similarly, RSCC could be SLDC for state owned substations/bays.
7. Syslog server to be Linux based. However DR/Engg. PC workstation can be other Operating System.

SPECIFICATION FOR SWITCHES

Substation System LAN:

2 (two) nos. managed Ethernet switches with 16 copper 10/100 Mbps RJ45 ports on each switch shall be supplied to form redundant system LAN as shown in typical architecture drawing. These switches shall be different from IEC 61850 LAN and specifically used for the purpose of connecting various devices of different sub-systems (SCADA, VMS, VOIP etc.) for integration with NTAMC/RTAMC. These switches shall be suitable for substation environment and shall comply with the requirements of IEC 61850-3 standard for EMI/EMC.

These LAN switches shall have the following compliance and functional features:

(a) Compliance as per NERC-CIP-3, NERC-CIP-5. NERC-CIP-7 standard for cyber security
(b) Support SNMPv3 (Full SNMP support including Traps)
(c) Web based GUI or CLI based with HTTPS/HTTP and SSH/ Telnet support
(d) Support for IPv4 and IPv6 switching simultaneously
(e) Layer 3 Static routing functionality
(f) Syslog facility for local as well as remote server
(g) Support for remote management
(h) LED indication for port status/supply etc.
(i) Shall support VLAN IEEE 802.1Q
(j) IGMP snooping
(k) Spanning tree protocol IEEE 802.1d or RSTP IEEE 802.1w
(l) Shall support SNTP
(m) Port based Network Access Control (IEEE 802.1x)
(n) Quality of Service (IEEE 802.1p)
(o) Shall support unicast as well as multicast IP traffic
(p) SNTP time synchronization
(q) Shall support Mac Binding
(r) Fanless design

Annexure-S7

Technical Specification for Next Generation Firewalls (NGFW)

1. NGFW shall have following features including but not limited to:
   Encryption through IPSec VPN (Virtual Private Network), Deep Packet Inspection (DPI), Denial of service (DoS) & Distributed Denial of Service (DDoS) prevention, Port Block/ Allow, rules/ policies for block/allow, IP (Internet Protocol) & Media Access Control (MAC) spoofing protection, threat detection, Intrusion Prevention System (IPS), Anti-Virus, Anti-Spyware, Man In The Middle (MITM) attack prevention.

2. The proposed firewall shall be able to handle (alert, block or allow) unknown /unidentified applications e.g. unknown TCP & UDP packets. It shall have the provision to define application control list based on application group and/or list.

3. Firewall shall have feature and also have capability to update the definition/ Signatures of Anti-Virus online as well as offline. Firewall shall also be compatible to update the definitions/signatures through CMC. There shall be a defined process for security patching and firmware up-gradation. There shall be a feature to field validate firmware checksum. The same shall also be validated before using the OEM provided file/binary in the process of firmware up-gradation and security patching

4. Firewall shall have Management Console port to configure remotely.

5. Firewall shall be EMI/EMC compliant in Substation environment as per IEC 61850-3.

6. Firewall shall be rack mounted in existing standard equipment cabinets.

7. Firewall shall have support of SCADA applications (IEC-60870-5-104), ICCP, PMU (IEEE C37.118), Sub-Station Automation System (IEC 61850), Ethernet and other substation environment protocols.

8. Client based Encryption/ VPN must support different Operating System platforms e.g. Windows, Linux & Mac.

9. The solution must have content and comprehensive file detection policies, blocking the files as function of their types, protocols and directions.

10. Firewall shall have logging facility as per standard logs/events format. Firewall shall have features to export the generated/stored logs/events in csv (Comma Separated Value) and also any other standard formats for offline usage, analysis and compliance. Firewall shall have suitable memory architecture and solution to store and be enable to export all logs/events for a period of last 90 days at any given time.

11. Firewall shall have features and be compatible with local as well as central authentication system (RADIUS, LDAP, or TACACS+) for user account and access right management. It shall also have Role Based User management feature.

12. Firewall shall have the capability to configure sufficient number of VLANs.

13. Firewall shall have the capability to support sufficient number of sessions.

14. Firewall shall have provision to configure multiple IP Sec VPNs, at least 100 nos., (one-to-many or many-to-one). Shall support redundant operation with a similar router after creation of all the IP Sec VPN. IPSec VPN shall be with encryption protocols as AES128, AES256 and hashing algorithms as MD5 and SHA1. IPSec VPN throughput shall be at least 300 Mbps.

15. Firewall shall be capable of SNMP v3 for monitoring from Network Management system. It shall also have SNMPv3 encrypted authentication and access security.

16. Firewall shall operate in Active/Passive or Active-Active mode with High Availability features like load balancing, failover for firewall and IPsec VPN without losing the session connectivity.

17. Firewall should have integrated traffic shaping (bandwidth, allocation, prioritisation, etc.) functionality.

18. Shall support simultaneous operation with both IPv4 and IPv6 traffic.

19. Firewall shall be compatible with SNTP/NTP or any other standards for clock synchronization.

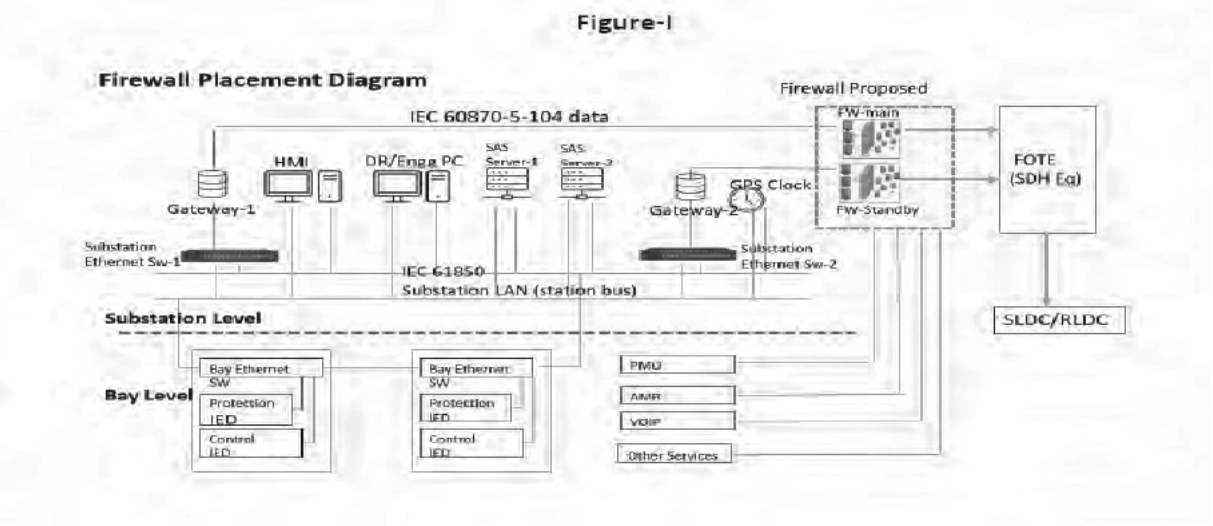
20. Firewall shall have the features of port as well as MAC based security.

21. Firewall shall support exporting of logs to a centralized log management system (e.g. syslog) for security event and information management.

22. Firewall time shall be kept synchronised to official Indian Timekeeping agency, time.nplindia.org.

23. Firewall product shall be provided with all applicable updates at least until 36 months since the applicable date of product shipping to the concerned utility.

Figure-I



SPECIFICATION FOR DIGITIAL PROTECTION COUPLER

1.0 Digital protection coupler for protection signalling through optical fibre cablesystem

1.1 The Digital protection signalling equipment is required to transfer the trip commands from one end of the line to the other end in the shortest possible time with adequate security and dependability. It shall also monitor the healthiness of the link from one end to the other and give alarms in case of any abnormality. The protection signalling equipment shall have a proven operating record in similar application over EHV systems and shall operate on 48V DC (+15%/-20%). It shall provide minimum four commands. These commands shall be suitable for Direct tripping, Intertripping and Blocking protection schemes of EHV lines.

The protection signalling equipment shall communicate to the remote end interfacing with SDH terminal equipment at its 2Mbps port. It shall provide suitable interfaces for protective relays, which operate at 220V DC. Power supply points shall be immune to electromagnetic interface

1.2 Principle of operation

During normal operation, protection signalling equipment shall transmit a guard signal/code. In case Protection signalling equipment is actuated by protective relays for transmission of commands, it shall interrupt the guard signal/code and shall transmit the command code to the remote end. The receiver shall recognize the command code and absence of the guard code and will generate the command to the protective relays.

All signal processing i.e. generation of tripping signal and the evaluation of the signals being received shall be performed completely digital using Digital Signal Processing techniques.

1.3 Loop testing

An automatic loop testing routine shall check the teleprotection channel.

It shall also be possible to initiate a loop test manually at any station by pressing a buttonon the front of the equipment.

Internal test routine shall continuously monitor the availability of the protection signaling equipment.

Proper tripping signal shall always take the priority over the test procedure.

The high speed digital protection signalling equipment shall be designed and provided with following feature.

- Shall work in conjunction with SDH terminal equipment.
- It shall communicate on G 703 (E1,2 Mbps)
- Full Duplex operation
- Auto loop facility shall be provided
- Shall meet IEC 60834-1 standard
- Shall be able to transmit upto 4 commands with trip counter simultaneouslyor sequentially in one 2Mbps channel

Bidder shall quote for protection signalling equipment suitable for 4 commands with separate trip counters for transmit and receive. With regard to trip counters alternate arrangement .i.e. Laptop along with software & all accessories to download eventsincluding carrier receipt and transmit shall be acceptable. Laptop for the above shall be supplied at each substation under substation package.

High security and dependability shall be ensured by the manufacturer. Probability of false tripping and failure to trip shall be minimum. Statistical curves/figures indicating above mentioned measures shall be submitted along with the bid.

The DPC can be either housed in offered Control & Protection Panel / PLCC Panel or in separate panel.

Reports of the following tests as per clause 9.2 of Section-GTR shall be submitted for approval for protection signalling equipment and relays associated with the protection signalling equipment and interface unit with protective relay units, if any.

i) **General equipment interface tests:-**

a) Insulated voltage withstand tests
b) Damped oscillatory waves disturbance test
c) Fast transient bursts disturbance test
d) Electrostatic discharge disturbance test
e) Radiated electromagnetic field test
f) RF Disturbance emission test

ii) **Specific power supply test**

a) Specific power supply test
b) Power supply variations
c) Interruptions
d) LF disturbance emission
e) Reverse polarity

iii) **Tele-protection system performance test:-**

a) Security
b) Dependability
c) Jitter
d) Recovery time
e) Transmission time
f) Alarm functions
g) Temperature and Humidity tests (As per IEC 68-2)
- Dry heat test (50°C for 8 hours
- Low temperature test (-5°C for 8 hours)
- Damp heat test (40°C/95%RH for 8 hours

All the above tests at i, ii & iii (except temperature & humidity tests) shall be as per IEC

60834-1 and the standards mentioned therein.

iv) **Relays**

a) Impulse voltage withstand test as per clause 6.1 of IS:8686 (for a test voltage appropriate to clause III as per clause 3.2 of IS:8686

b) High frequency disturbance test as per clause 5.2 of IS:8686 (for a test voltage appropriate to clause III as per clause 3.2 of IS:8686).

The protection signalling equipment shall be of modular construction and preferably mounted in the Relay panels. Cabling between the protection signalling equipment & Protection relays and between protection signalling equipment & Communication equipment shall be in the scope of bidder.

The input/output interface to the protection equipment shall be achieved by means of relays and the input/output rack wiring shall be carefully segregated from other shelf/cubicle wiring.

The isolation requirements of the protection interface shall be for 2kV rms.

1.4 Major technical Particulars

The major technical particulars of protection signalling equipment shall be as follow.

i) Power supply 48V DC +15% /-20%

ii) Number of commands 4 (four)

iii) Operating time <7 ms

iv) Back to back operate time without propagation delay ≤ 8ms

v) Interface to Protection relays

	Input:	Contact Rating:	
	Rated voltage	:	250 volts DC
	Maximum current rating:		5 amps
Output:	Contact Rating:		
	Rated voltage	:	250 volts DC
	Rated current	:	0.1 A DC
	Other parameters :		As per IEC-255-0-20

vi) Alarm contact

Rated voltage	:	250 volts DC
Rated current	:	0.1 A DC
Other parameters :		As per IEC-255- 0-20

vii) Digital communication interface: G 703(E1

Annexure-S9

Technical Specification for Visual monitoring system for watch and ward of Substation premises:

Visual monitoring system (VMS) for effective watch and ward of sub station premises covering the areas of entire switchyard, Control Room cum Administrative building, Fire fighting pump house, stores and main gate, shall be provided. The contractor shall design, supply, erect, test and commission the complete system including cameras, Digital video recorder system, mounting arrangement for cameras, cables, LAN Switches, UPS and any other items/accessories required to complete the system. To provide all the necessary licenses to run the system successfully shall be in the scope of contractor.

System with Color IP Cameras for VMS surveillance would be located at various locations including indoor areas and outdoor switchyard and as per the direction of Engineer-In-Charge. The VMS data partly/completely shall be recorded (minimum for 15 days) and stored on network video recorder.

The number of cameras and their locations shall be decided in such a way that any location covered in the area can be scanned. The cameras shall be located in such a way to monitor at least:

1. The operation of each and every isolator pole of the complete yard in case of AIS Sub-station.
2. The Operation of each bay(s) of GIS Hall as Applicable.
3. All the Transformer and Reactors All the Entrance doors of Control Room Building and Fire-fighting Pump House, GIS Hall and Switchyard Panel room as applicable.
4. All the gates of switchyard.
5. Main entrance Gate
6. All other Major AIS Equipment (such as CB, CT, CVT, SA etc. as applicable)

The cameras can be mounted on structures, buildings or any other suitable mounting arrangement to be provided by the contractor.

1.1 Technical requirements of major equipment of Visual Monitoring System.

1.1.1 The Video Monitoring system shall be an integrated system with IP network centric functional and management architecture aimed at providing high-speed manual/automatic operation for best performance.

1.1.2 The system should facilitate viewing of live and recorded images and controlling of all cameras by the authorized users.

1.1.3 The system shall use video signals from various types of indoor/outdoor CCD colour cameras installed at different locations, process them for viewing on workstations/monitors in the control Room and simultaneously record all the cameras after compression using **H 264**/MPEG 4 or better standard. Mouse/Joystick-Keyboard controllers shall be used for Pan, Tilt, Zoom, and other functions of desired cameras.

1.1.4 The System shall provide sufficient storage of all the camera recordings for a period of 15 days or more

@ 25 FPS, at 4 CIF or better quality using necessary compression techniques for all cameras. It shall be ensured that data once recorded shall not be altered by any means. The recording resolution and frame rate for each camera shall be user programmable.

1.1.5 The surveillance VMS System shall operate on 230 V, 50 Hz single-phase power supply. System shall have back up UPS power supply meeting the power supply need of all the cameras in the stations including those which are installed at gate for a period of 2 hours. The bidder shall submit the sizing calculation for the UPS considering the total load requirement of Video Monitoring System.

1.2 System requirements:

a) System must provide built-in facility of watermarking or Digital certificate to ensure tamperproof recording.

b) All cameras may be connected through a suitable LAN which shall be able to perform in 765kV class sub-station environment without fail.

c) All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. Camera ID, Location/Area of recording & date/time shall be programmable by the system administrator with User ID & Password.

d) Facility of camera recording in real-time mode (25 FPS)/15/12.5/10 or lower FPS as well as in any desired combination must be available in the system.

e) Facility of Camera recording in HD (1280X720p), D1 , 4CIF , CIF, VGA, as well as in any combination i.e. any camera can be recorded in any quality.

f) System to have facility of **100%** additional camera installation beyond the originally planned capacity.

g) In order to optimize the memory, while recording, video shall be compressed using H **264**/MPEG-4 or better standard and streamed over the IP network.

h) System shall be triplex i.e. it should provide facility of Viewing, Recording & Replay simultaneously.

i) The offered system shall have facility to export the desired portion of clipping (from a specific date/time to another specific date/time) on CD or DVD. Viewing of this recording shall be possible on standard PC using standard software like windows media player etc.

j) System shall have provision of WAN connectivity for remote monitoring.

k) The equipment should generally conform to Electro magnetic compatibility requirements for outdoor equipment in EHV switchyards. The major EMC required for Cameras and other equipment shall be as under:

1. Electrical Fast Transient (Level 4) – As per IEC 61000-4-4
2. Damped Oscillatory (1 MHz and 100 KHz) (level 3) – As per IEC 61000-4-18
3. AC Voltage Dips & Interruption/Variation (class 3) – As per IEC 61000-4-11
4. Electrostatic Discharge (Level 4) – As per IEC 61000-4-2
5. Power Frequency Magnetic Field (level 4) – As per IEC 61000-4-8
6. Ripple on DC input Power Supply Port immunity test(level 4) - As per IEC 61000-4-17

Type test reports to establish compliance with the above requirement shall be submitted during detailed engineering.

1.2.1 VIDEO SURVEILLANCE APPLICATION SOFTWARE

a) Digital video surveillance control software should be capable to display and manage the entire surveillance system. It should be capable of supporting variety of devices such as cameras, video encoder, Servers, NAS boxes/Raid backup device etc.

b) The software should have inbuilt facility to store configuration of encoders and cameras.

c) The software should Support flexible 1/2/4/8/16/32 Windows Split screen display mode and scroll mode on the PC monitor.

d) The software should be able to control all cameras i.e. PTZ control, Iris control, auto / manual focus, and color balance of camera, Selection of presets, Video tour selection etc.

e) The software should have user access authority configurable on per device or per device group basis. The system shall provide user activity log with user ID, time stamp, action performed, etc.

f) The users should be on a hierarchical basis as assigned by the administrator. The higher priority person can take control of cameras, which are already being controlled by a lower priority user.

g) It should have recording modes viz. continuous, manual, or programmed modes on date, time and camera-wise. All modes should be disabled and enabled using scheduled configuration. It should also be possible to search and replay the recorded images on date, time and camera-wise. It should provide onscreen controls for remote operation of PTZ cameras. It should have the facility for scheduled recording. Different recording speeds (fps) and resolution for each recording mode for each camera should be possible.

h) The software for clients should also be working on a browser based system for remote users. This will allow any authorized user to display the video of any desired camera on the monitor with full PTZ and associated controls.

i) Retrieval: The VMS application should allow retrieval of data instantaneously or any date / time interval chosen through search functionality of the application software. In case data is older than 15 days and available, the retrieval should be possible. The system should also allow for backup of specific data on any drives like DVD's or any other device in a format which can be replayed through a standard PC based software. Log of any such activity should be maintained by the system.

j) VMS shall provide the full functionality reporting tool which can provide reports for user login/logoff, camera accessibility report, server health check reports etc.

1.2.2 Network video recorder

The Network Video recorder shall include at least Server (min 3.0 GHZ, 4GB RAM, 3000GB HDD(min)), RAID 5 ,with suitable configuration along with Colored TFT 22" High resolution monitor, and Internal DVD writer. Windows XP/Vista/7 Prof. or VMS compatible operating system latest version with hardware like graphic cards, licensed Anti-virus etc.

Further the digital video recorder shall conform to the following requirements:

1.	Server Spec	Intel Quad Core (or better) 3.0 Ghz (min.) , 8 MB Cache , 4 GB memory , with suitable NVIDIA graphics card,3 TB HDD , Raid 5
2.	Recording and Display Frame Rate	Real-time 25 frames per second per channel , manual select

3.	Recording Resolution	(PAL): 1280X720 , 704(H) x 586(V) It should be possible to select lower resolutions
4.	Compression Method	H.264/MPEG-4 or better and latest
5.	Video Motion Detection Capable	Standard and built-in (selectable in menu)
6.	Monitoring Options	Split screen 1, 2, 4 , 8, 16, 32 or more cameras
7.	Playback Options	Search, still image capture
8.	Alarm/Event Recording Capable	To be provided with built-in external alarm input/ output ports minimum(8 in, 2 out)
9.	Network Operation Capable	To be provided by using WAN or LAN router
10.	Remote Internet Viewing Capable	Using WAN or LAN router
11.	HDD Storage Consumption	1GB ~ per hour / channel variable based on frame speed and resolution settings, as well as compression
12.	Operation	Triplex operation (simultaneous recording, playback, network operation)
13.	Number of Video Channel	32
14.	Audio Recording Capable	32
15.	Input Voltage	230V AC or equivalent with UPS as a back up for 30 minutes.

1.2.3 VMS Camera

a) The color IP camera for substation shall have PAN, TILT and ZOOM facilities so that it can be focused to the required location from the remote station through a controller. Whereas wireless IP cameras with PTZ controls are required for installation at gates of the POWERGRID premises as per the direction of Engineer-In-Charge

b) The IP Camera at the main gate can be fixed or PTZ based and shall be used for monitoring entry and exit

c) It should have sufficient range for viewing all the poles of isolators and other equipments with high degree of clarity.

d) The VMS camera shall be suitable for wall mounting, ceiling mounting and switchyard structure mounting.

e) It shall be possible to define at 128 selectable preset locations so that the camera gets automatically focused on selection of the location for viewing a predefined location.

f) The camera should be able to detect motion in day & night environments having light intensity of Color: 0.5 Lux; B&W:0.05 Lux

g) Housing of cameras meant for indoor use shall be of IP 42 or better rating whereas outdoor camera housing shall be of IP 66 or better rating. Housing shall be robust and not have the effect of electromagnetic induction in 765/400KV switchyard.

h) All camera recordings shall have Camera ID & location/area of recording as well as date/time stamp. Camera ID, Location/Area of recording & date/time shall be programmable by the system administrator with User ID & Password

i) Facility of camera recording in real-time mode (25 FPS)/15/12.5/10 or lower FPS as well as in any desired combination must be available in the system.

A. Outdoor IP Fixed Megapixel Camera Specifications (For Main Gate)

1.	Image Sensor	2-megapixel Progressive ,1 / 3" CMOS/CCD sensor, Minimum illumination 0.1 Lux
2.	Min Luminous	0.5LUX(Color) 0.05Lux(Black)
3.	Camera Enclosure Type	IP66 Grade
4.	Iris/Focus	Auto/Manual
5.	Video Compression	Dual Stream H.264 and MPEG 4 user selectable
6.	Support Dual-stream	primary/secondary stream, H.264/MPEG 4 optional
7.	Video Definition	Primary stream:1600x1200,1280x960,1280x720, Secondary stream:800x600,400x288,192x144
8.	Video Parameters	Brightness, hue, contrast, saturation and image quality
9.	Video Frame Rate	PAL: 1-25frames/second NTSC:1-30frames/second
10.	Video Compression BR	32Kbit/S - 6Mbit/S
11.	Video Output	One channel composite Streaming
12.	Supported Protocols	TCP, UDP, IP, HTTP, FTP, SMTP, DHCP, DNS,ARP, ICMP, POP3, NTP, IPsec, UpnP, RTP, RTCP
13.	Operating Temperature	-5 ~ +50°C
14.	Operating Humidity	10 ~ 90%

B. Outdoor IP66 PTZ HD Camera Specifications (For Switch Yards)

1.	Image sensor	1/3 type Solid State Progressive Scan CCD,WDR(High Definition)
2.	Security	Multiple user access with password protection
3.	Effective Pixels	**(PAL): Main Stream：1280x720** Sub Stream：640x360、320x280 selectable
4.	Compression	Dual Stream H.264 and MPEG 4 user selectable
5.	Signal System	50 Hz
6.	S/N (signal to noise) Ratio	Better than 50 dB
7.	Electronic Shutter	1/60 ~ 1/10,000 sec. automatic or better
8.	Scanning System	Progressive/interlace
9.	Low Light Sensitivity (lux)	Color: 0.5 Lux; B&W:0.02 Lux
10.	Lens	Minimum 10x (minimum) optical in High Definition **(The system shall be able to zoom the images on the monitor without any distortion to the maximum level of optical zoom)**
11.	Lens Size	Minimum 4.1~73.8 mm
12.	Lens Aperture	F1.6(wide)~F2.8(tele), f=4.1~41.0mm, 10X Zoom, Video Auto Focus Angle of View Horizontal : 52°(wide) , 2.8°(tele)
13.	PTZ Data Transfer Baud/Bit Rates Supported	Selectable 2400 bps / 4800 bps / 9600 bps

14.	Panning Range	Complete 360 degrees (horizontal)
15.	Pan Speed	Adjustable, 0.1 degrees / second ~ 250 degrees / second
16.	Tilting Range	Minimum 180° Tilt Rotation
17.	Tilt Speed	Adjustable, 0.1 degrees / second ~ 150 degrees / second
18.	In Built Storage	Camera should have inbuilt storage TF or SD format for recording and storing Pictures
19.	IP Class	IP66 Standard
20.	Working temperature	-0°C ~ +50°C
21.	Working Humidity	10 ~ 90%

1.2.4 PTZ-Keyboards

The features of PTZ shall include:

- Fully functional dynamic keyboard/joystick controllers
- Controls all pan, tilt, zoom, iris, preset functions
- Control up to 255 units from a single keyboard
- Many preset options and advanced tour programming
- Compatible with all connected cameras

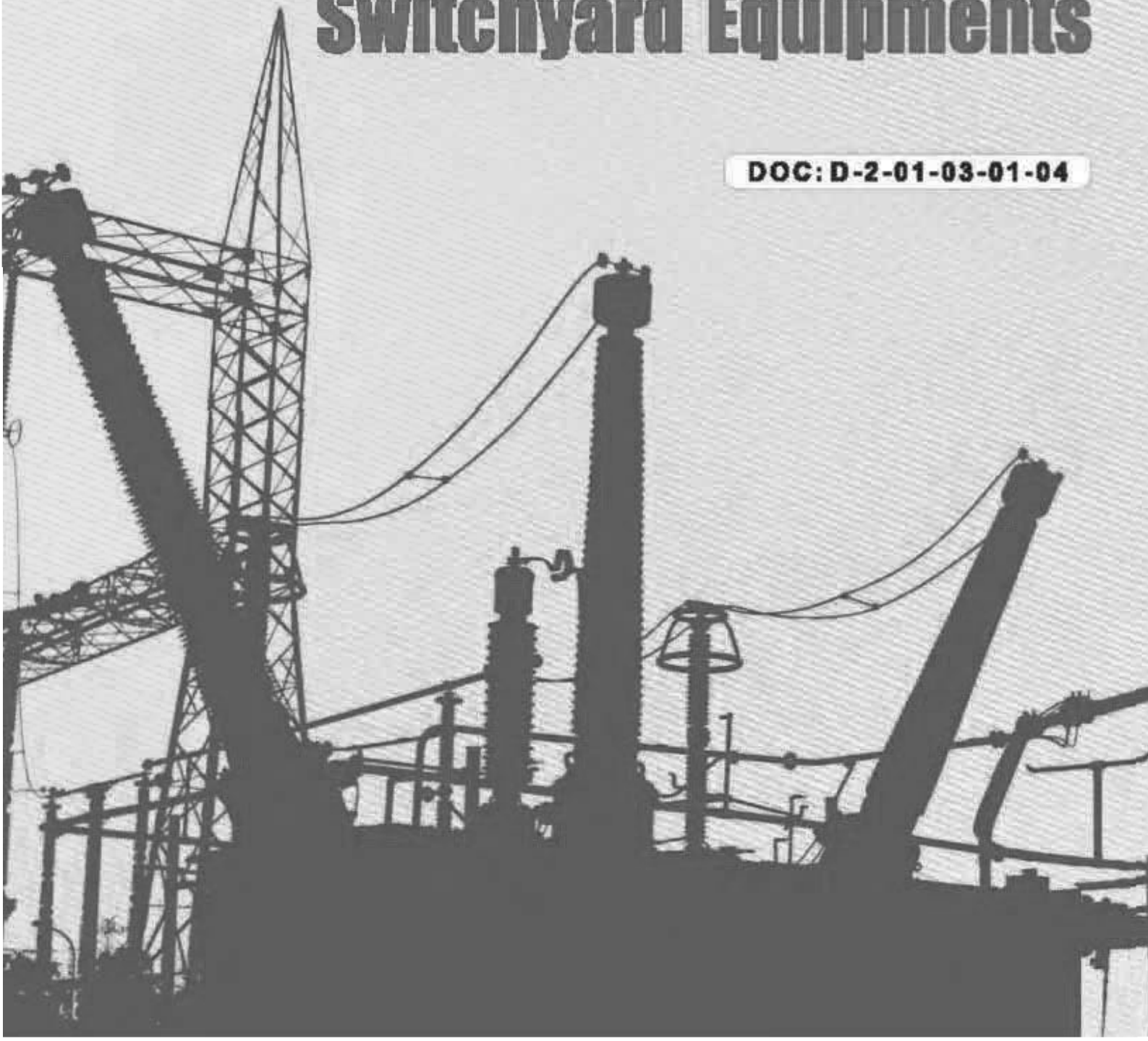
1.	Key Application	wired keyboard control operation of PTZ functions for weatherproof dome cameras
2.	Pan / Tilt / Zoom Protocol Languages Supported	Selectable
3.	PTZ Data Transfer Baud Rates Supported	selectable 1200 bps / 2400 bps / 4800 bps / 9600 bps
4.	Additional Features	dynamic joystick for smooth camera movements, preset location option for quick access to frequently monitored areas

APRIL 2013

पावरग्रिड

Pre-Commissioning Procedures and Formats for **Switchyard Equipments**

DOC: D-2-01-03-01-04



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PRE-COMMISSIONING PROCEDURES FOR SWITCHYARD EQUIPMENTS

1.1 Purpose

This document is to provide guidance to POWERGRID personnel in carrying out Pre-commissioning checks along with formats for recording the test data and subsequently charging of Substation Bay equipments along with associated auxiliary equipments.

Pre-commissioning checks/ tests are the activities carried out to ascertain the correctness, completeness of installation and healthiness of the equipment before its charging. These checks/ tests are to be carried out by Contractor's representative in the presence of POWERGRID's authorized representative.

1.2 Commissioning Team

1.2.1 **Constitution of Commissioning team:** After completion of erection in all respects, a commissioning team may be constituted (as per procedures laid down in Works & Procurement Policy and Procedures -Clause C2.15.4.6 of WPPP Vol. II), to oversee/ coordinate with erection agency/ manufacturer of the equipment for the pre-commissioning tests and subsequently charging of the equipment. In case of Substation, Commissioning team may consist of following:

(i) I/C of Substation

(ii) O&M executive not below Manager

(iii) T&C executive not below Sr. Engineer

1.2.2 **Role of Commissioning team**: The Commissioning Team shall examine the following statutory and other clearances obtained by Execution Site prior to clearance for test charging of the equipment/transmission line at rated voltage:

Statutory Clearances:

a) Electrical Inspector's Clearance (provisional or final) for charging transmission line/bay equipment as per I.E. rules.

b) P.T.C.C. clearance.

c) Copy of notification informing public/administration regarding charging of the line.

d) Forest Clearance

Other Clearances:

a) Charging instruction from SEF Group of Corporate Engineering.

b) Relay setting details from Corporate Engineering.

(Clause C2.15.4.8 (v) of WPPP Vol-II)

1.2.3 **Responsibilities of Commissioning team** The responsibilities of the commissioning team are to go through statutory clearances and standing instructions before initial charging of new equipment, witness Pre-Commissioning tests after erection of individual equipment as per requirement of guidelines issued by Corporate OS or in line with manufacturer's recommendation and test charging, investigate failure of equipment during test charging, declare commencement of trial operation and evaluate guaranteed test results and recommend acceptance as may be provided in the contract, list out deviations/ exception/ incomplete work, for acceptance/ rejection (Clause C2.15.4.7 of WPPP Vol-II). Proper documentation also to be ensured by the Commissioning team based upon the observations for the above for future reference.

1.2.4 The Team shall also go through the factory test reports. If such tests have been repeated during pre-commissioning, the Team shall list out deviations, if any, in the results of pre-commissioning tests with respect to the factory tests.

(Clause C2.15.4.8 (vii) of WPPP Vol-II)

1.2.5 After all pre-commissioning checks and tests are found to be acceptable taking into account permissible deviation limits, the commissioning team, in consultation with regional O&M, shall give clearance for commissioning/ charging.

Please Note: In case of Transformers & Reactors, commissioning team shall forward the Pre-Commissioning report along with their recommendations to RHQ-OS and CC-OS for charging clearance and CC-OS shall give the final charging clearance after reviewing of the test results. In case of circuit breakers, operation timings and DCRM records to be sent to CC-OS for charging clearance.

1.3 Safety

All measures and precautions should be undertaken to prevent occurrence of unsafe acts. All the personnel involved should be thoroughly apprised about the safe procedures to be adopted while performing various activities including carrying out tests in the switchyard.
Adequate fire-fighting system as per procedures and their healthiness is to be ensured before charging.
Warning signs and Safety barriers should be positioned in conformity to IE rules as amended from time to time.

1.4 General Procedures during Pre-commissioning of Switchyard Equipment

All the equipment after erection/assembly at site, should be tested in order to check that it has not been damaged during transport, erection/assembly to such an extent that its future operation will be at risk. The significance of various tests with brief procedure has been

elaborated in the subsequent sections of this document. Regarding the detailed testing methods / procedures for conducting various pre-commissioning tests refer to Doc. No. D-2-03-XX-01-01: Maintenance Procedures for Switchyard Equipments-Part 1: EHV Transformers & Reactors and Doc No. D-2-03-XX-01-01 –Part 2: Other Switchyard Equipments.

1.5 Documentation

The results of the test shall be documented on the test record formats as mentioned below, which are also part of this documentation:

Sl.No.	FORMAT NO.	EQUIPMENT
1.	No. CF/ICT/01/ R-4 DATED 01/04/2013	ICT
2.	No. CF/SR/02/ R-4 DATED 01/04/2013	SHUNT REACTOR
3.	No. CF/CB/03/ R-4 DATED 01/04/2013	CIRCUIT BREAKER
4.	No. CF/CT/04/ R-4 DATED 01/04/2013	CURRENT TRANSFORMER
5.	No. CF/CVT/05/ R-4 DATED 01/04/2013	CVT
6.	No. CF/BAY/06/ R-4 DATED 01/04/2013	BAY/FEEDER
7.	No. CF/ISO/07/ R-4 DATED 01/04/2013	ISOLATOR/GROUND SWITCH
8.	No. CF/SA/08/ R-4 DATED 01/04/2013	SURGE ARRESTOR
9.	No. CF/WT/09/ R-4 DATED 01/04/2013	WAVE TRAP
10.	No. CF/C&P/10/ R-4 DATED 01/04/2013	CONTROL & PROTECTION

These formats have all the tests recordings to be performed at site before energization/ charging. Switching and operational activities will be recorded in regular manner in the operator's log. Copies of this log, notes on special observations from inspections and other measurements will constitute the test records. The test records had to be signed by the responsible personnel from the OEM, the supplier, the erection agency and the POWERGRID representative. The test formats/records are to be distributed to Regional O&M office and Concerned Sub-Station library.

TRANSFORMER AND REACTOR

2.1 Following points to be checked after receipt of Transformer/Reactor at Site

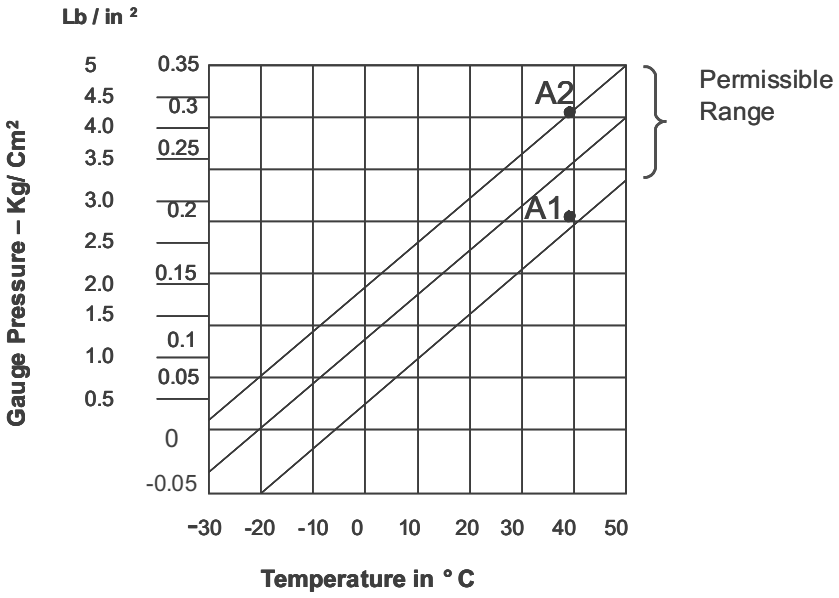
2.1.1 N_2 pressure and Dew point to be checked after receipt of Transformer at Site. It should be within permissible band (as per graph provided by manufacturer & given below in Fig-1)

2.1.2 Core Insulation Test shall be carried out to check insulation between Core (CC&CL) and Ground. (Not applicable for Air Core Reactors)

2.1.3 The data of impact recorder shall be analyzed jointly in association with the manufacturer. In case the impact recorder indicates shocks of • 3g during shipment, further course of action for internal inspection shall be taken jointly with the manufacturer/ supplier. Impact Recorder should be detached from the Transformer/ Reactor preferably when the main unit has been placed on its foundation.

As present day impact recorders are of electronic type, analysis of impact recorder along with dew point and Core insulation tests to be performed on trailer itself. In case, the test results are not meeting permissible limits, same to be informed to OEM, CC-Engg. & CC-OS for further course of action.

Graph showing variation of Pressure v/s Temperature of gas for gas filled unit during Transport or storage



Example: For 40 °C Temperature (Depending upon the pressure of gas at the time of filling),
- minimum pressure of gas can be 0.185 Kg/ Cm² at point A1
- maximum pressure of gas can be 0.32 Kg/ Cm² at point A2

Fig. 1

2.1.4 Unpacking and inspection of all accessories to be carried out taking all precautions so that the tools used for opening do not cause damage to the contents. Proper storage of all accessories are to be ensured after unpacking. Fragile instruments like oil level gauge, temperature indicators, etc. are to be stored indoor. Any damaged or missing components should be reported to equipment manufacturer and insuring agency so that the same can be investigated or shortage made up as per the terms/ conditions of the contract.

2.1.5 Storage of the main unit and the accessories at site:

- If erection work can not start immediately due to some reasons, then accessories should be repacked into their own crates properly and packing list should be retained.
- All packing cases should be kept above ground by suitable supports so as to allow free air flow underneath. The storage space area should be such that it is accessible for inspection, water does not collect on or around the area and handling/transport would be easy. Proper drainage arrangement in storage areas to be ensured so that in no situation, any component gets submerged in water due to rain, flooding etc.
- It is preferable to store the main unit on its own location/foundation. If the foundation is not likely to be ready for more than three (3) months, then suitable action plan has to be taken from the manufacturer regarding proper storage of the Main Unit.
- If the transformer/ Reactor is to be stored up to three (3) months after arrival at site, it can be stored with N_2 filled condition. N_2 pressure to be monitored on daily basis so that chances of exposure of active part to atmosphere are avoided. In case of drop in N_2 pressure, dew point of N_2 has to be measured to check the dryness of the Transformer/ Reactor. If there is drop in dew point, fresh nitrogen need to be filled. Leaks are to be identified and rectified and Nitrogen to be filled to the required pressure.
- In case the transformer/ reactor is to be stored for more than 3 months, it needs to be stored in oil filled condition. Processed oil to be filled which complies the required specification and ppm • 5ppm and BDV • 70kV. In case of storage of transformer in oil-filled condition, the oil filled in the unit should be tested for BDV and moisture contents once in every three months. The oil sample should be taken from bottom valve. If BDV is less and moisture content is more than as given for service condition then oil should be filtered.

2.2 Insulating Oil

When oil is dispatched to site separately it is usually in sealed steel drums. In some of the cases, oil is supplied in tankers also. The oil to be used to filling and topping up must comply with oil specification given in POWERGRID Technical Specification for acceptance criteria. Oil Samples shall be taken from oil drums/ tanker received at site and sent to our nearest oil Lab for oil parameter testing (BDV > 50 kV, ppm<40, Resistivity > 150 x 10^{12} Ohm-cm & Tan delta < 0.0025 @ 90 °C). The later is important since dirty transportation vessels can significantly contaminate the oil. High dielectric losses cannot be removed by filter treatment, such lots have to be rejected. If the oil is supplied in railroad or trailer tanks, one or two samples are sufficient. If the oil is delivered in 200 litres drums, the following scheme for checking is recommended.

Number of drums delivered	No. of drums to be checked
2 to 5	2
6 to 20	3
21 to 50	4
51 to 10	7
101 to 200	10
201 to 400	15

In case any doubt arises, number of drums to be checked needs to be increased. However, before filling oil, each drum has to be physically checked for free moisture and appearance. A register needs to be maintained indicating the number of drums supplied in each lot as per LOA and number of drums of each lot used in filling a particular Transformer/ Reactor. The oil test results carried out as above should also be recorded.

The copy of test certificate of routine testing at oil refinery should be available at site for comparison of test results.

2.2.1 Samples from Oil Drum

Check the seals on the drums. The drum should first be allowed to stand with bung (lid) vertically upwards for at least 24 hours. The area around the bung should be cleaned & clean glass or brass tube long enough to reach to within 10mm of the lowermost part of the drum should be inserted, keeping the uppermost end of the tube sealed with the thumb while doing so. Remove the Thumb thereby allowing oil to enter the bottom of the tube. Reseal the tube and withdraw an oil sample. **The first two samples should be discarded**. Thereafter, the sample should be released into a suitable receptacle. Samples to be collected preferably in clean glass bottles. The bottles are to be rinsed with the same oil and to be without any air bubble.

2.3 Internal Inspection

Before starting erection, thorough internal inspection of Transformer/ Reactor is to be carried out by POWERGRID engineer along with manufacturer's representative.
Internal inspection should be preferred in dry and sunny weather and should be finished as quickly as possible to avoid ingress of moisture admitting dry air.
Prior to making any entry into the transformer tank, establish a foreign material exclusion programme to avoid the danger of any foreign objects falling into the transformer:

- Loose articles should be removed from the pockets of anyone working on the transformer cover.
- All jewellery, watches, pens, coins and knives should be removed from pockets.
- Protective clothing and clean shoe covers are recommended.
- Tools should be tied with clean cotton tape or cord securely fastened.
- Plated tools or tools with parts that may become detached should be avoided.
- An inventory of all parts taken into transformer should be recorded and checked before closing inspection cover to assure all items were removed.

If any object is dropped into the transformer and cannot be retrieved, the manufacturer should be notified.

The inspection should include:

- Removal of any shipping blocking or temporary support.
- Examination for indication of core shifting.
- Tests for unintentional core or core clamp grounds.
- Visual inspection of windings, leads, and connections including clamping, bracing, blocking, spacer alignment, phase barriers, oil boxes, and coil wraps.
- Inspection of DETC and in-tank LTCs including contact alignment and pressure.
- Inspection of current transformers, including supports and wiring harness.
- Checks for dirt, metal particles, moisture, or other foreign material.

In case of any abnormality noticed during internal inspection, same to be referred to manufacturer, CC-Engg. & CC-OS immediately before starting erection activities.
Detailed photographs of all visible parts/ components as per above are to be taken during internal inspection and to be attached with pre-commissioning report.

2.4 Precautions during erection

During erection, efforts to be made to minimize the exposure of active parts (core and coils) of transformer/ reactor. Moisture may condense on any surface cooler than the surrounding air. Excessive moisture in insulation or dielectric liquid lowers its dielectric strength and may cause a failure of Transformer/ Reactor.

Further, either dry air generator should be running all the time or dry air cylinders may be used to minimize ingress of moisture. The transformer should be sealed off after working hours. **Transformer/ reactor shall never be allowed to be opened without application of dry air.**

Remarks: As N2 is heavier than air, application of Vacuum to be ensured and thereafter dry air to be admitted before entering inside Transformer after shipment in N2 filled condition. Oxygen content should be between 19 % and 25 % prior to any entry. During inspection, dry air to be purged continuously.

It is practical to apply a slight overpressure overnight with dry air or N2 inside – less than 300 mbar (30 kPa or 0.3 atmospheres). Next day the pressure is checked and suspected leaks may be detected with leak detection instruments/ with soap water or with plastic bags tightened around valves (being inflated by leaking air)

For oil filled units whenever oil is drained out below the inspection covers, job will be treated as exposed. Other exposure activities are as below:

1) Bushing erections
2) Jumper connections of Bushings
3) Fixing bushing turrets
4) Core insulation checking (in case the checking point not accessible outside)
5) Buchholz relay pipe work fixing on cover
6) Gas release pipes/equalizer pipe fixing
7) Entering inside the tank for connections/inspection etc

For oil filled units depending upon the level up to which the oil is drained decides the exposure time. All such exposure time should be recorded in a log sheet to decide the oil processing (drying) and oil filling of transformer.

"GET THE TRANSFORMER UNDER OIL AS SOON AS POSSIBLE!" It is good practice to proceed with the erection in such a sequence that all fittings and auxiliaries with oil seals to the tank are assembled first. The oil filling will then be performed as easily as possible. The "active part" inside - core and coils - is then impregnated and protected. It has good time to soak properly, before the unit shall be energized, while remaining fittings are assembled on the unit, and commissioning checks carried out.

For transformers with a gas pressure of 2.5- 3 PSI, the acceptable limits of dew point shall be as under: (Courtesy: BHEL, Bhopal)

Temperature of Insulation in °F	Permissible dew point in °F	Temperature of Insulation in °C	Permissible dew point in °C
0	-78	-17.77	-61.11
5	-74	-15.0	-58.88
10	-70	-12.22	-56.66
15	-66	-9.44	-54.44
20	-62	-6.66	-52.22
25	-58	-3.33	-49.99
30	-53	-1.11	-47.22
35	-48	+1.66	-44.44
40	-44	+4.44	-42.22
45	-40	+7.44	-39.39
50	-35	+9.99	-37.22
55	-31	12.77	-34.99
60	-27	15.55	-32.77
65	-22	18.33	-29.99
70	-18	23.11	-27.77
75	-14	23.88	-25.55
80	-10	26.66	-23.33
85	-6	29.44	-21.11
90	-1	32.22	-18.33
95	+3	34.99	-16.11
100	+7	37.75	-13.88
110	+16	43.33	-8.88
120	+25	48.88	-3.88
130	+33	54.44	+0.55
140	+44	59.99	+5.55

TABLE 1- Variation of Dew Point of N2 Gas Filled in Transformer Tank w.r.t Temperature

2.5 Final tightness test with vacuum (i.e. leakage test or Vacuum Drop Test)

Before oil filling is started, a final check is made for the tightness of the transformer tank by applying vacuum. When vacuum is applied to a transformer without oil, a leakage test must be carried out to ensure that there are no leaks in the tank which would result in wet air being drawn into the transformer. The following procedure is to be adopted:

- Connect the vacuum gauge to a suitable valve of the tank. (Vacuum application and measurement should be performed only on top of the main tank) - A vacuum gauge of Mc Leod type or electronic type, with a reading range covering the interval - 1 kPa (1 - 10 mm mercury) to be used
- Connect the vacuum pump to another opening.
- Evacuate the transformer/ reactor tank until the pressure is below 50 mbar (5 kPa).
- Shut the vacuum valve and stop the pump.
- Wait for an hour and take a first vacuum reading – say P1
- Take a second reading 30 minutes later- say P2
- Note the volume of the tank (quantity of oil required according to the rating plate) and express as volume, V, in m^3
- Take the difference between P2 and P1, and multiply this with the oil quantity V. If the pressures are expressed in kPa, and the oil quantity in m^3, then the product shall be less than 3.6.

  (P2 – P1) x V < 3.6

  The transformer is then considered to be holding sufficient vacuum and is tight. Continue reading (at least 2 to 3) at successive 30 min intervals to confirm the result.
- If the leak test is successful, the pumping will be continued, until the pressure has come down to 0.13 kPa (1 Torr) or less. The vacuum shall then be held for the time given in Table-3 before the oil filling starts.
- If the specified vacuum cannot be reached, or if it does not hold, the leak in the transformer system shall be located and corrected.

In case the transformer is provided with an On Load Tap Changer (OLTC), while evacuating the main transformer tank, the diverter switch compartment may also be evacuated simultaneously so that no undue pressure is allowed on the tap changer chamber. While releasing vacuum, the tap changer chamber vacuum should also be released simultaneously. For this one pressure equalizer pipe should be connected between main tank and tap changer. Manufacturer's instruction manual should be referred to protect the air cell/diaphragm in the conservator during evacuation.

This vacuum must be maintained for the time specified as per the voltage class in Table-3 before and should also be maintained during the subsequent oil filling operations by

continuous running of the vacuum pumps.

2.6 Oil Filling

Once the oil is tested from the drums and found meeting the requirements, the oil is transferred to oil storage tank for oil filtration before filling inside the transformer.

The drums or trailer tanks shall not be emptied to the last drop - a sump of an inch or so is left, to avoid possible solid dirt or water in the bottom.

Before being used, the tanks and hoses are visually inspected inside for cleanness. Any liquid residue from earlier use will be carefully removed, and the container flushed with a small quantity of new oil, which is then discarded.

After filtration, oil sample is tested for meeting POWERGRID specification for new oil.

Prior to filling in main tank at site and shall be tested for:

1. Break Down voltage (BDV)	: 70kV (min.)
2. Moisture content	: 5 ppm (max.)
3. Tan-delta at 90 °C	: Less than 0.01
4. Interfacial tension	: More than 0.035 N/m

For transformer dispatched with gas (N2) filled from the works, the filling of oil inside the tank is done under vacuum. Transformer of high voltage ratings and their tanks are designed to withstand full vacuum. Manufacturer's instructions should be followed regarding application of full vacuum during filling the oil in the tank.

When filling a transformer with oil it is preferable that the oil be pumped into the bottom of the tank through a filter press or other reliable oil drying and cleaning device should be interposed between the pump and the tank (please refer Fig-2).

The oil flow at the entry valve must be controlled to maintain a positive pressure above atmospheric and to limit the flow rate if necessary to 5000 litres / hour, or a rise in oil level in the tank not exceeding one meter / hour (as measured on the oil level indicator)

Continue oil filling until the level reaches approximately 200 mm above the ambient oil level indicated on the magnetic oil level gauge in the expansion vessel. Then, release the vacuum, with dry air of dew point -40deg C or better.

The diverter tank can now be topped up at atmospheric pressure. Reconnect oil outlet hose to valve on flange on tap changer diverter head. Reinstate breather and very slowly top up the diverter switch such that the correct level is reached in the diverter expansion vessel. In the event the expansion vessel is overfull drain oil from flange into a suitable container until the correct level is reached.

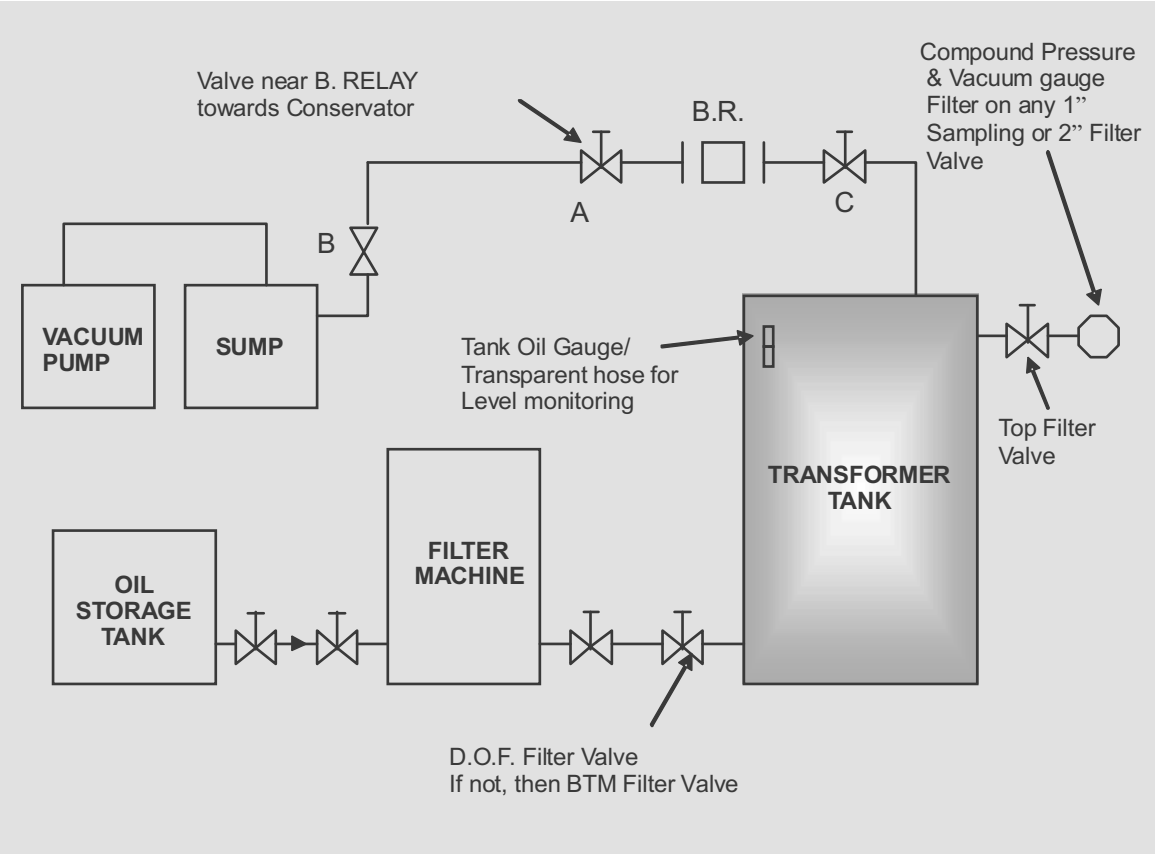


Figure-2 : Arrangement for Evacuation and Oil filling upto tank Oil gauge & Conservator

When the vacuum filling of the transformer and diverter tank is complete, the cooling system/ Radiator bank can be filled (WITHOUT VACUUM) at atmospheric pressure, via an oil processing plant. Oil must be admitted, very slowly, through the bottom cooler filter valve, with the cooler vented at the top and the top cooler filter valve unblanked and open to atmosphere. As the oil level reaches the top vent, then top valve to be closed and the processing plant can be shut down.

Note: Care must be taken not to pressurize the coolers/ radiators.

Upon completion, open the top cooler isolating valve in order to equalize the pressure in the cooler with the transformer tank. This will also allow contraction or expansion of the oil as the ambient temperature changes.

Before filling oil into the conservator, the air cell/ bellow to be inflated to 0.5 PSIG i.e. 0.035kg/cm2 max. by applying pressure (N2/Compressed dry air) so that it can take shape. After releasing pressure, breather pipe is to be fitted however it is recommended not to fit breather in position, instead a wire mesh guard over and flange of the pipe to prevent entry of any insect inside the pipe. This will ensure free air movement from the air cell to the atmosphere.

Use flow meter / indicator on outlet of filter machine and regulate the flow using the valve to limit oil filling rate to 2000 litres per hour (max.) in case filter capacity is more.

Oil to be pushed slowly into conservator through the transformer via valve No. 5 (valve 2,3 & 4 to remain open) till the oil comes out first through valve Nos. 2 & 3 (close these valves) and then through valve No. 4. Allow some oil to come out through valve No.4. Oil should come out freely into the atmosphere. This will ensure that air inside the conservator is expelled out and the space surrounding the air cell is full of oil. (Close valve No. 4). During all these operations valve No.1 shall be in closed position.

Excess oil from the conservator is to be drained by gravity only through valve No. 1 or through drain valve of the transformer via valve No. 5. Do not use filter machine for draining oil from the conservator. Also do not remove buchholz relay and its associated pipe work, fitted between the conservator and the transformer tank while draining oil.

Stop draining oil till indicator of magnetic oil level gauge reaches position-2 on the dial, which is corresponding to 30 °C reading on the oil temperature indicator. Fill the conservator according to the oil temperature and not the atmospheric temperature

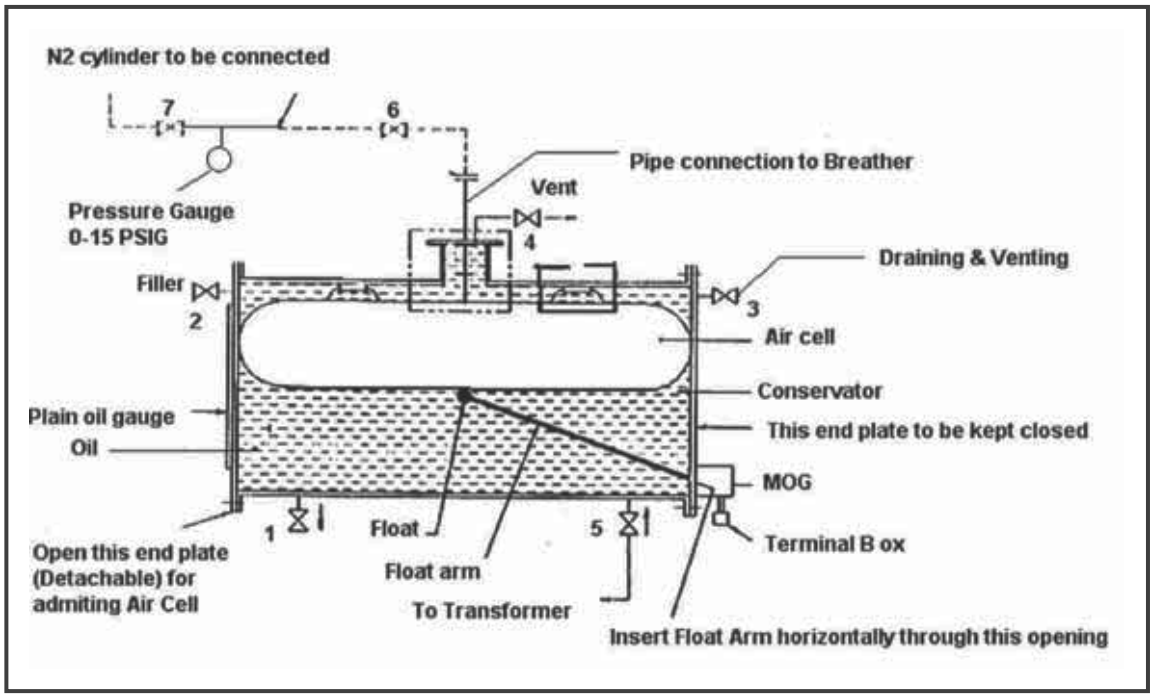


Figure-3 : General Arrangement For Oil Conservator

After Oil filling, Hot Oil Circulation has to be applied to all the Transformers/ Reactors except under the circumstances when active part of Transformer/ Reactor gets wet. Following conditions can be considered to define the Transformer/ Reactor wet:

1. **If Transformer/ Reactor received at site without positive N2 pressure.**
2. **If Dry air not used during exposure while doing erection activities**
3. **Overexposure of active part of Transformer/ Reactor during erection (Overexposure when exposure > 12 Hrs)**

Under above mentioned conditions, Manufacturer shall take necessary action for effective dry out of the Transformer/ Reactor. However general guidelines for dry out in such cases is given in section 2.8

2.7 HOT OIL CIRCULATION USING HIGH VACUUM OIL FILTER MACHINE

To ensure proper dryness and absorption of possible trapped gas bubbles, the oil in the tank is circulated through the vacuum filter and with circulation direction as shown in Fig.-4.

The circulation procedure for the main tank is as follows.

2.7.1 The Transformer/ Reactor is connected to the oil filter machine in a loop through the upper and lower filter valves. The direction of circulation shall be from the filter to the transformer at the top and from the transformer to the filter at the bottom. (Please note that at the initial oil filling time the direction is reverse to avoid air bubble formation).

2.7.2 The temperature of the oil from the filter to the Transformer should be around 60 ° C and in no case it should go beyond 70 ° C otherwise this may cause oxidation of oil.

2.7.3 The circulation shall proceed until a volume of oil has passed through the loop corresponding to 2 times the total oil volume in the tank. (At freezing ambient temperature the circulation time is increased, circulate 3 times the volume at temperature down to minus 20 ° C, increase to 4 times below that temperature).

The oil sample from the transformer tank, after filling in tank before commissioning should meet the following specifications (as per latest POWERGRID Revision) given in table-2 below.

Table-2

1.	Break Down voltage (BDV)	: 70 kV (min.)
2.	Moisture content	: 5 ppm (max.)
3.	Tan-delta at 90 °C	: 0.01 (max.)
4.	Total Gas Content	: < 1%
5.	Resistivity at 90 °C	: 6 X 10^{12} ohm-cm (min.)
6.	Interfacial tension	: 0.035 N/m (min.)
7.	*Oxidation Stability (Test method as per IEC 61125 method C, Test duration: 500 hour for inhibited oil)	
	a) Acidity	: 0.3 (mg KOH /g) (max.)
	b) Sludge	: 0.05 % (max.)
	c) Tan delta at 90 °C	: 0.05 (max.)

* For Sr. No. 7 separate oil sample shall be taken and test results shall be submitted within 45 days after commissioning for approval of Powergrid.

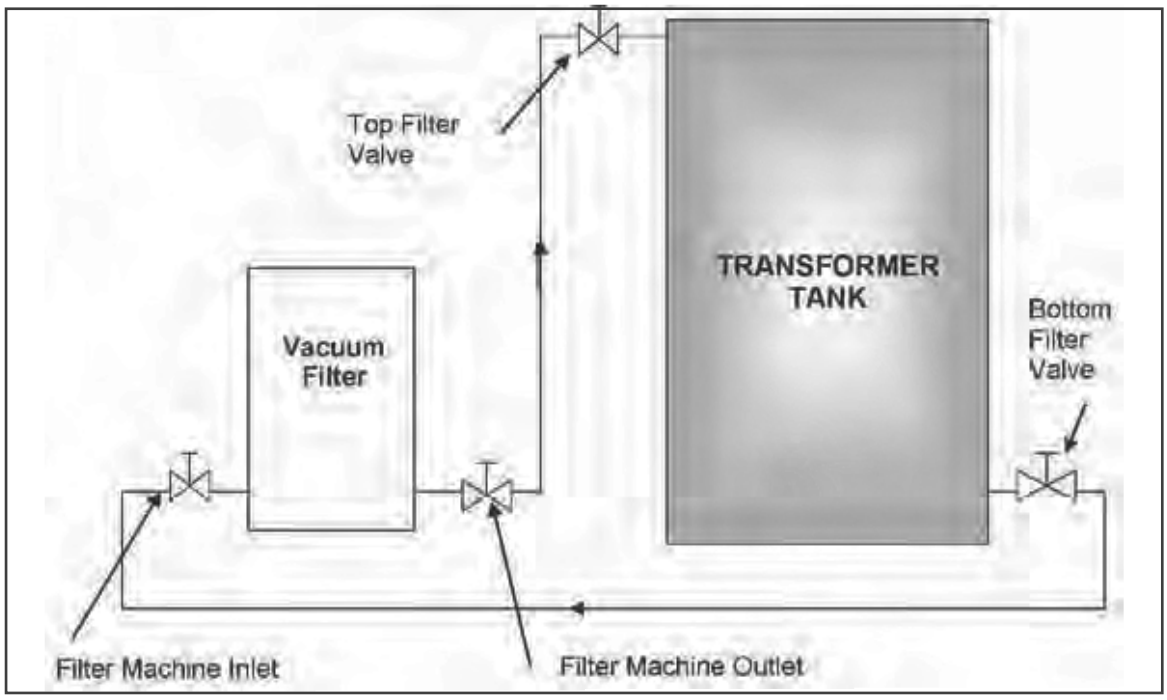


Figure-4: Arrangement for Hot Oil Circulation and Filtration

2.8 PROCEDURE FOR DRY OUT OF WET WINDING OF TRANSFORMER/REACTOR BY APPLICATION OF VACUUM, N2 FILLING AND HEATING

The drying of a new Transformer/ Reactor is required when the moisture gets absorbed by the solid insulation used in Transformers/ Reactors due to various reasons. The process of drying out a transformer requires care and good judgment. If the drying out process is carelessly or improperly performed, a great damage may result to the transformer insulation. In no case shall a transformer be left unattended during any part of the dry out period unless on-line dryout process is adopted which incorporates all necessary safety features. The transformer should be carefully watched throughout the dry-out process and all observations to be carefully recorded.

When the transformer is being dried out, it is necessary to ensure that fire fighting equipment is available near the transformer as a precaution as there are chances of fire as we are dealing with heat and inflammable oil.

2.8.1 Isolation Required

All the openings of transformer main tank like openings for coolers/radiators, conservator, OLTC etc. is to be properly isolated and totally blanked.

2.8.2 Procedure

a. Fill the main transformer/ reactor tank with Nitrogen (Use only Dry N2 gas as per IS: 1747 with less than 50 ppm moisture and 1% oxygen by volume) until it comes to a positive pressure of 0.15 Kg/cm$^{2.}$ It is kept for about 48 hrs. At the end of 48 hrs, dew point of N_2 at outlet is measured. If the dew point is not within acceptable limits as per Table-I, dry out method should be continued.

b. While N2 circulation is in progress, the heaters are to be installed around the transformer tank. The heaters are to be kept ON until we achieve a temperature of about 75–80 °C of the core & winding of transformer as measured by top oil temperature in the transformer.

c. After ascertaining that there is no leakage, pull out vacuum and keep the transformer/reactor under near absolute vacuum (1-5 torr) and keep under vacuum for about 96 hours running the vacuum pump continuously. The duration of vacuum can vary between 48 to 96 hrs depending upon the dew point being achieved. Keep vacuum machine ON and collect condensate for measurement. Observe the rate of condensate collection on hourly basis. Depending on the value of rate of condensate (less than 40 ml/hr for 24 hrs), continuation of further vacuum shall be decided.

d. Then the vacuum is broken with dry nitrogen. The dew point of nitrogen at the inlet is to be measured and should be of the order of - 50 °C or better. When the nitrogen comes to the positive pressure of 0.15 kg/cm^2, it is stopped and kept for 24 hours. Heating from outside is to be continued while N2 circulation is in progress. Then the nitrogen pressure is released and the outlet nitrogen dew point is measured. If the dew point is within acceptable limits as per Table-I then the dryness of transformer is achieved. If not again the transformer is taken for vacuum treatment and then nitrogen is admitted as mentioned above and tested. The cycle is to be continued till desired dew point as per Table-1 is achieved.

e. Periodicity of vacuum cycle may vary between 48-96 hrs. Initially two N2 cycles may be kept for 24 hrs. After that it may be kept for 48 hrs depending upon dew point being achieved.

After completion of drying process, oil filling and hot oil circulation is to be carried out before commissioning. Please ensure standing time as per table-3 given below before charging.

Note: If already known that the transformer is wet based on the tests or exposure time, then (a) above can be skipped to save time.

Transformer HV Rated Voltage (in kV)	**Application of Vacuum & holding for (before oil filling)*** (in Hours)	**STANDING TIME After Oil circulation and before energising** (in Hours)
Up to 145kV	12 HRS	12 HRS
145 kV and up to 420kV	24 HRS	48 HRS
Above 420 kV	48 HRS	120 HRS

*Without running the vacuum pump and leakage rate to be • 40mbar-lit/sec

Table-3

After the expiry of this time, air release operation is to be carried out in Buchholz relays, turrets and other release points given by the manufacturers before charging.

For subsequent activities, proceed to format no. CF/ICT/01/ R-4 Dated 01/04/2013 for ICT & format No. CF/SR/02/ R-4 Dated 01/04/2013 for Reactor. Refer pre-commissioning test procedures given in next section for all required tests to be performed.

2.9 RELATION BETWEEN DIFFERENT UNITS (CONVERSION OF UNITS)

Pressure

1 bar = 10^5 Pa = 750 Torr = 14.5 psi = 1.02kg/cm^2
1 Torr = 1.33 mbar = 0.133 kPa
1 kPa(kilo-Pascal) = 10^3 Pa = 10 mbar = 7.501 Torr(mm of mercury)
1 MPa = 10^6 Pa
1 atmosphere=0.1 MPa=1.02kg/cm^2= 14.5 psi

Force

1 kp = 9.807 N

Weight

1 ton=1000 kg=2200 lbs

Temperature

$$^\circ C = \frac{5}{9} * (^\circ F - 32)$$

$$^\circ F = \frac{9}{5} * (^\circ C) + 32$$

Volume

1m^3= 1000 litres=260 US gallons=220 Imp gallons
1 litre =0.26 US Gallons
1 US Gallons = 3.78 litres
1 litre =0.22 Imp Gallons

Benchmarks

1-mm mercury (Torr) is about 1 millibar or 0.1 kPa
1 m^3 of oil weights 0.9 tons –say 1 ton
1000 US gallons of oil weights 3.5 tons

PRE- COMMISSIONING CHECKS/TESTS FOR TRANSFORMERS AND REACTORS

Once oil filling is completed, various pre-commissioning checks/ tests are performed to ensure the healthiness of the Transformer/ Reactor prior to its energization. Various electrical tests are to be performed and their significance is given below

Sr. No.	Name of Test/ Check point	Purpose of test/ check
3.1	Core insulation tests	Allows for investigating accidental grounds which results in circulating currents if there is more than one connection between the core and ground.
3.2	Earth pit resistance measurement	To check the resistance of earth pit provided for Transformer. In case, the resistance is more, proper treatment is to be given.
3.3	Insulation Resistance (IR) measurement	Test reveals the condition of insulation (i.e. degree of dryness of paper insulation), presence of any foreign contaminants in oil and also any gross defect inside the transformer (e.g. Failure to remove the temporary transportation bracket on the live portion of tap-changer part)
3.4	Capacitance and Tanδ measurement of bushings	Measurement of C1 & C2 Capacitance and Tanδ in UST mode. Changes in the normal capacitance of an insulator indicate abnormal conditions such as the presence of moisture layer, short -circuits or open circuits in the capacitance network.
3.5	Capacitance and Tan δ measurement of windings	Dissipation factor/Loss factor nd capacitance measurement of winding is carried out to ascertain the general condition of the ground and inter-winding insulation
3.6	Turns ratio (Voltage ratio) measurement	To determine the turns ratio of transformers to identify any abnormality in tap changers/ shorted or open turns etc
3.7	Vector Group & Polarity	To determine the phase relationship and polarity of transformers
3.8	Magnetic Balance test	This test is conducted only in three phase transformers to check the imbalance in the magnetic circuit
3.9	Floating Neutral point measurement	This test is conducted to ascertain possibility of short circuit in a winding.
3.10	Measurement of Short Circuit Impedance	This test is used to detect winding movement that usually occurs due to heavy fault current or mechanical damage during transportation or installation since dispatch from the factory.

Sr. No.	Name of Test/ Check point	Purpose of test/ check
3.11	Exciting/Magnetising current measurement	To locate defect in magnetic core structure, shifting of windings, failures in turn to turn insulation or problems in tap changers. These conditions change the effective reluctance of the magnetic circuit thus affecting the current required to establish flux in the core
3.12	Operational checks on OLTCs	To ensure smooth & trouble free operation of OLTC during operation.
3.13	Tests/ Checks on Bushing Current Transformers (BCTs)	To ascertain the healthiness of bushing current transformer at the time of erection
3.14	Operational Checks on protection System	Operational checks on cooler bank (pumps & Fans), Breathers (Silicagel or Drycol), MOG, temperature gauges (WTI/OTI), gas actuated relays (Buchholz, PRD, SPR etc.) and simulation test of protection system
3.15	Stability of Differential, REF of Transformer/ Reactor	This test is performed to check the proper operation of Differential & REF protection of Transformer & Reactor by simulating actual conditions. Any problem in CT connection, wrong cabling, relay setting can be detected by this test.
3.16	Frequency Response Analysis (FRA) measurement	To assess the mechanical integrity of the transformer. Transformers while experiencing severity of short circuit current looses its mechanical property by way of deformation of the winding or core. During pre-commissioning this test is required to ascertain that Transformer active part has not suffered any severe impact/ jerk during transportation.
3.17	Winding resistance measurement	To check for any abnormalities due to loose connections, broken strands and high contact resistance in tap changers
3.18	Dissolved Gas Analysis (DGA) of oil sample	Oil sample for DGA to be drawn from transformer main tank before commissioning for having a base data and after 24 hrs. of charging subsequently to ensure no fault gas developed after first charging. DGA analysis helps the user to identify the reason for gas formation & materials involved and indicate urgency of corrective action to be taken

3.1 CORE INSULATION TEST

This test is recommended first after receiving the equipment at site and to be performed on trailer itself. Thereafter, before the unit is placed in service or following modifications to the transformer that could affect the integrity of its core insulation and at other times, when indicated by DGA (key gases being ethane and/or ethylene and possibly methane) or usually during a major inspection.

For core-insulation to ground test, remove the cover of the terminal block, Disconnect the closing link that connects the two terminals CL-G. Apply 1.0 kV direct voltage between CL and CC + G (core grounding strap). The tank shall be grounded during the test.

Acceptable Limit: The insulation value after 1min. should be minimum 10 M for new transformer at the time of commissioning. Core insulation resistance is generally more than 100 M for new assembled transformer when tested at factory.

3.2 Earth pit resistance measurement

Earth tester is used for measurement of Earth resistance. If earth resistance is more, proper treatment is to be given. For measurement of earth pit resistance, pit earthing connection should be disconnected from main grid. Thereafter, measurement is to be carried out by three point method.

Working of Earth Tester: - There is hand operated D.C.generator. While feeding current to spike, D.C. current is converted into A.C. current by the converter and A.C. current received from spike is again converted in D.C. current by the help of rectifier, while going to generator. A.C. current is fed to the spike driven in earth because there should not be electrolytic effect.

Measurement of Earth Resistance (Three point method):-

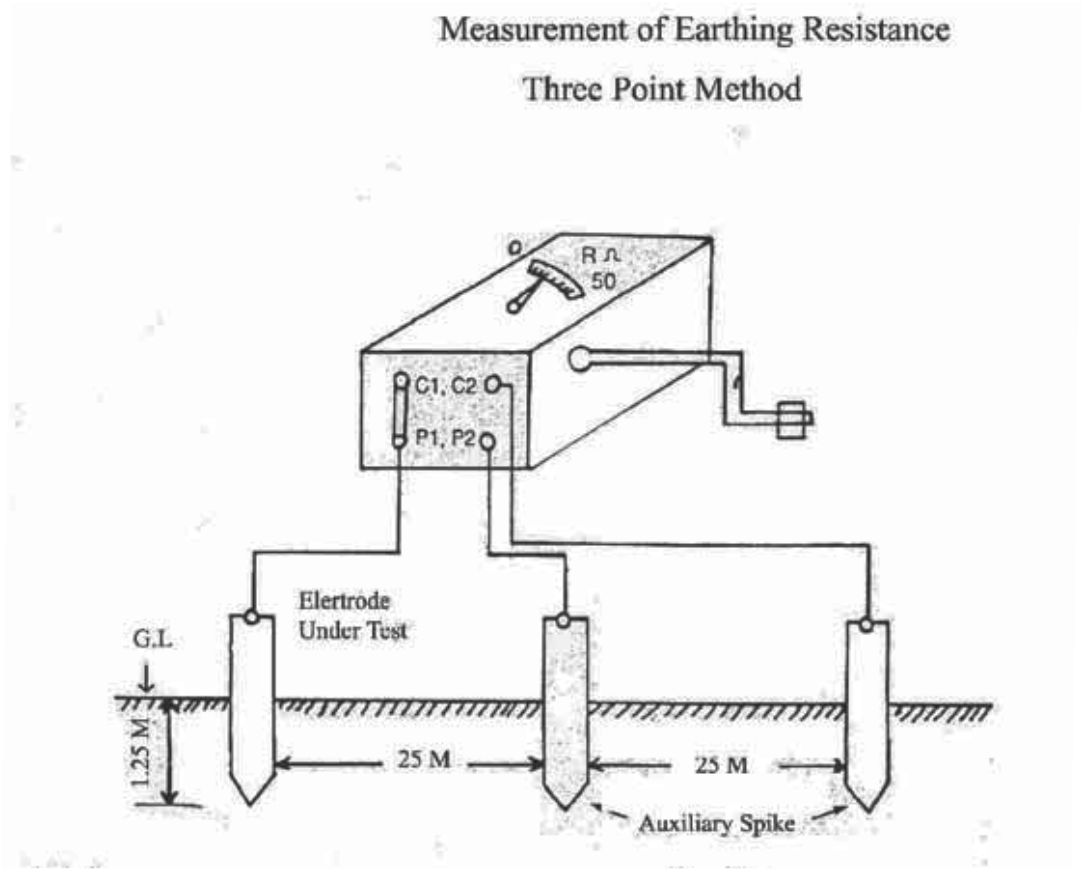


Figure-5

In this method, earth tester terminals C1 & P1 are shorted to each other and connected to the earth electrode (pipe) under test. Terminals P2 & C2 are connected to the two separate spikes driven in earth. These two spikes are kept in same line at the distance of 25 meters and 50 meters due to which there will not be mutual interference in the field of individual spikes. If we rotate generator handle with specific speed we get directly earth resistance on scale.

Acceptable Limit: Value of earth pit resistance should be less than or equal to 1Ω.

3.3 INSULATION RESISTANCE (IR) MEASUREMENT

IR measurements shall be taken between the windings collectively (i.e. with all the windings being connected together) and the earthed tank (earth) and between each winding and the tank, the rest of the windings being earthed. Before taking measurements the neutral should be disconnected from earth. Following table gives combinations of IR measurements for auto-transformer, three -winding transformer & Shunt Reactor

For Auto-transformer	For 3 winding transformer	For Shunt Reactor
HV + IV to LV	HV + IV to LV	HV to E
HV + IV to E	HV + LV to IV	
LV to E	HV + IV +LV to E	

Where HV-High voltage, IV-Intermediate voltage, LV-Low voltage/Tertiary voltage windings, E- Earth

Acceptable Limits: Unless otherwise recommended by the manufacturer, the following IR values as a thumb rule may be considered as the minimum satisfactory values at 30°C (one minute measurements) at the time of commissioning.

Rated Voltage class of winding	Minimum desired IR value at 1 minute (Meg ohm)
11kV	300 MΩ
33kV	400 MΩ
66kV & above	500 MΩ

Insulation resistance varies inversely with temperature and is generally corrected to a standard temperature (usually 20°C) using table (Source: BHEL instruction Manual) as given below:

Difference in temperatures (°C)	Correction Factor (k)
10	1.65
20	2.6
30	4.2
40	6.6
50	10.5

(The measured value to be multiplied by the factor k i.e $T_{20} = k*T_{measured}$)

The ratio of 60 second insulation resistance to 15 second insulation resistance value is called **dielectric absorption coefficient or Index (DAI).** For oil filled transformers with class A insulation, in reasonably dried condition the absorption coefficient at 30°C will be more than **1.3.**

The polarization index test is performed generally by taking mega ohm readings at 1min and 10min insulation resistance value. The **polarization index** is the ratio of the 10 min to the 1 min mega ohm readings.

PI= R_{10}/ R_1 (dimensionless), Where PI is Polarization Index and R is resistance

The following are guidelines for evaluating transformer insulation using polarization index values

Polarization Index	Insulation Condition
Less than 1	Dangerous
1.0-1.1	Poor
1.1-1.25	Questionable
1.25-2.0	Fair
2.0 – 4.0	Good
Above 4.0	Excellent

A PI of more than 1.25 and DAI of more than 1.3 are generally considered satisfactory for a transformer when the results of other low voltage tests are found in order. PI less than 1 calls for immediate corrective action. For bushings, an IR value of above 10,000 MΩ is considered satisfactory.

3.4 Capacitance and Tan δ measurement of Bushings

Dissipation Factor
Dissipation factor/loss factor (Tan delta) is defined as the ratio of resistive component (I_r) of current to that of capacitive current (I_c) flowing in an insulating material.

Power Factor
Power factor is the ratio of resistive current to that of total current. For very low value of resistive currents, values of dissipation factor and power factor are same (up to 2%).

UST
Test set connected for Ungrounded Specimen Test mode. This is used when specimen is isolated from earth e.g. Transformer bushing, CTs with test tap, CVTs and CB voltage grading capacitors. The test mode is often used to reduce the effect of stray capacitance losses to ground, and to reduce the effect of interference pickup from energized apparatus.

GST
Test set connected for grounded specimen test mode. This is used when specimen do not have two specific points (isolated from ground) for Tan delta measurement e.g. Transformer/ Reactor winding, CTs without test tap etc.

GSTg
This test is used to separate the total values of a GST test into separate parts for better analysis. Often this test is used with GST test to confirm the test readings made using the UST mode

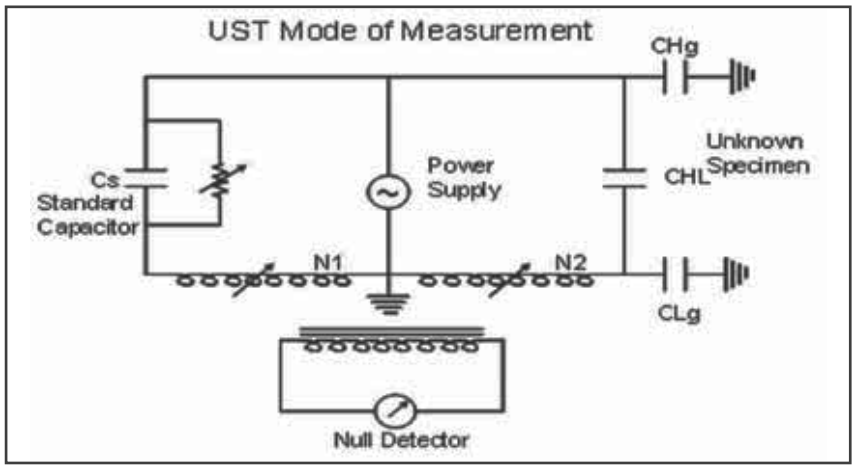
TEST EQUIPMENT

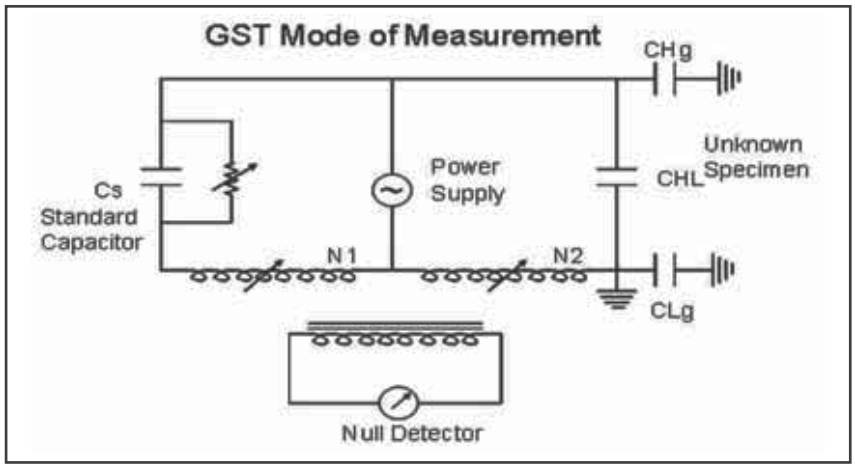
10 KV or 12 KV fully automatic Capacitance and Tan delta test kit to be used for accurate measurement and repeatability of test results.

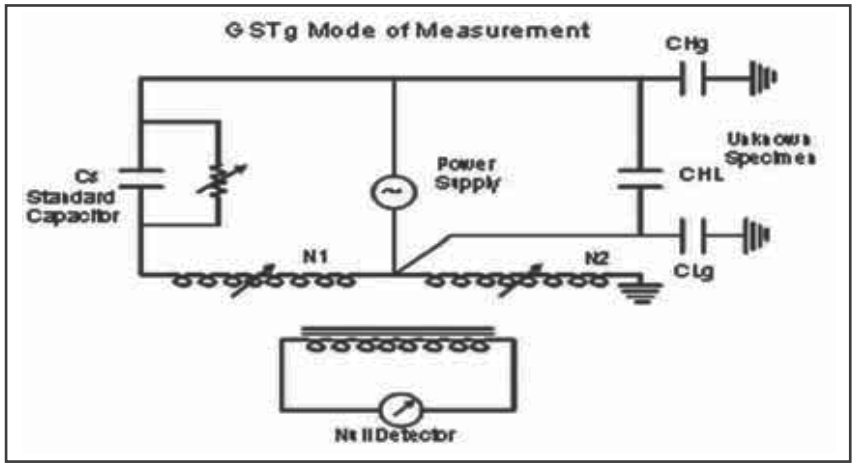
TESTING PROCEDURE

Typical arrangement for Tan δ measurement is given below:

Figure-6







PRECAUTIONS

a) There should be no joints in testing cables.

b) HV lead should be screened with double shield and shields should not have internal shorting otherwise tests in GST/GSTg modes, shall not be possible. Check the same by Insulation Tester(100V)

c) Test leads should not touch any live part.

d) Never connect the test set to energized equipment

e) The ground cable must be connected first and removed at last

f) High voltage plugs should be free from moisture during installation and operation.

g) Testing must be carried out by **experienced/ certified** personnel only.

h) After testing with high voltage (10 kV), test terminals must be grounded before being touched by any personnel.

- For 3-Ph auto-transformer, short together all 400kV, 220kV and Neutral (isolated from earth) Bushings. Also short all 33kV Bushings and earth the same.

  Measurement of C1 Capacitance and Tanδ: Connect the crocodile clip of the HV cable to the top terminal of the shorted HV/IV bushings. Unscrew the test tap cover, Insert a pin in the hole of the central test tap stud by pressing the surrounding contact plug in case of 245 kV OIP Bushing and remove the earthing strip from the flange by unscrewing the screw (holding earth strip to the flange body) in case of 420 kV OIP Bushing. Connect the LV cable to the test tap (strip/central stud) of the bushing under test to the **C & TANδ KIT** through a screened cable and earth the flange body. Repeat the test for all Bushings by changing only LV lead connection of the kit to test tap of the Bushing which is to be tested

  Measurement of C2 Capacitance and Tanδ : HV lead to be connected to the test tap of the bushing under test (if required additional crocodile type clip may be used) and LV of the kit to be connected to the ground. HV of the bushing is to be connected to the Guard terminal of the test kit. Test to be carried out in GSTg mode at 1.0kV.

- For measurement of 33kV Bushing Tan Delta, earth HV/IV Bushings (already shorted). Apply HV lead of the Test kit to shorted 33kV Bushings and connect LV lead of the test kit to Test tap of the Bushing under test.

- Measurements shall be made at similar conditions as that of a previous measurement. The oil-paper insulation combination of bushings exhibit fairly constant tan delta over a wide range of operating temperature. Hence, effort is to be made for testing at temperature near to previous test and correction factor need not be applied.

- Do not test a bushing (new or spare) while it is in its wood shipping crate, or while it is lying on wood. Wood is not as good an insulator as porcelain and will cause the readings to be inaccurate. Keep the test results as a baseline record to compare with future tests.

- It is to be ensured that C& Tan δ measurement of bushings and testing of turrets carried out before installation. This will prevent installation of bushings having C& Tan δ values beyond permissible limits.

- It is to be ensured that Test Tap points are earthed immediately after carrying out the measurements for that particular Bushing and earthing of test tap to be ensured by carrying out continuity test.

Acceptable Limits: Bushing Tan δ should be less than 0.5% for all type of bushings.

3.5 CAPACITANCE AND TAN δ MEASUREMENT OF WINDINGS

The combination for C & tan δ measurement of winding is same as that of measurement of IR value. The summery of probable combination is given below.

Auto-Transformer (Two winding)	Test Mode	Shunt Reactor	Test Mode	3 winding Transformer	Test Mode
HV + IV to LV	UST	HV to E	GST	HV to LV1	UST
HV + IV to E	GSTg			HV to LV2	UST
LV to E	GSTg			LV1 to LV2	UST
				HV to Ground	GSTg
				LV1 to Ground	GSTg
				LV2 to Ground	GSTg

Table 4: Combination for C & tan δ measurement of winding for various transformers/ Shunt Reactor

- Ensure that test specimen is isolated from other equipments. **Removal of Jumpers from Bushings is Pre-Requisite for C & Tan δ Measurement of Windings.**
- **For ICTs (Auto-Transformers):** Shorting of all three phase Bushings (400kV&220kV) and neutral to be done. In case of single phase, 400kV, 220kV and neutral Bushings to be shorted Capacitance and Tan δ measurement of windings should be done in following combinations.

Test No.	Winding Combination	Test mode	Cap Symbol	Test lead Connection	Remarks
1.	HV-IV/LV	UST	C_{HL}	HV lead of test kit to HV/IV bushings of transformer LV lead of test kit to LV bushing of transformer	
2.	HV-IV/ LV+G	GST	$C_{HL}+C_{HG}$	-do-	
3.	HV-IV / LV with Guard	GST_g	C_{HG}	do–	LV to be Guarded
4	HV-IV/LV	UST	C_{HL}	LV lead of test kit to HV/IV bushings of transformer HV lead of test kit to LV bushing of transformer	
5	LV/ HV-IV +G	GST	$C_{HL}+C_{LG}$	-do-	
6.	LV/ HV-IV with Guard	GST_g	C_{LG}	-do-	HV to be Guarded

Table 5:.Winding combination for C & tan δ measurement for auto transformer

- Measurement inter-check can be done by calculating $C_1 = C_2 - C_3$ & $C_4 = C_5 - C_6$ & $DF_1 = C_2DF_2 - C_3DF_3 / C_2 - C_3 = C_4DF_4 - C_5DF_5 / C_4 - C_5$ Where C stands for capacitance and DF for dissipation factor or tan δ and attached suffix (1…6) denotes the sr. no. of test in above table.

- For Reactors: All 400kV and neutral Bushings to be shorted. HV of the test kit to be connected to shorted Bushings and LV of the test kit to be connected to Earth connection. Measure the Capacitance and tan δ in GST mode. Neutral connection with earth/ NGR to be isolated before the test.

Acceptable Limit: Winding Tan δ should be less than 0.5% in all combinations.

3.6 TURNS RATIO (VOLTAGE RATIO) MEASUREMENT

Ratio measurements must be made on all taps to confirm the proper alignment and operation of the tap changers. The test should preferably be performed by automatic Transformer turns ratio (TTR) meter.

Open turns in the excited winding will be indicated by very low exciting current and no output voltage. Open turns in the output winding will be indicated by normal levels of exciting current, but no or very low levels of unstable output voltage. The turns-ratio test also detects high-resistance connections in the lead circuitry or high contact resistance in tap changers by higher excitation current and a difficulty in balancing the bridge.

Acceptable Limit: Results of the voltage ratio are absolute, and may be compared with the specified values measured during factory testing. The turns-ratio tolerance should be within 0.5 % of the nameplate specifications. For three phase Y connected winding this tolerance applies to phase to neutral voltage. If the phase-to-neutral voltage is not explicitly indicated in the nameplate, then the rated phase-to-neutral voltage should be calculated by dividing the phase-to-phase voltage by $\sqrt{3}$.

3.7 VECTOR GROUP AND POLARITY

Polarity and phase-relation tests are of interest primarily because of their bearing on paralleling or banking two or more transformers. Phase-relation tests are made to determine angular displacement and relative phase sequence. Phase-relation or vector group verification test is performed on a three phase transformer or on a bank of three single-phase transformers. The details of Additive and Subtractive polarity are given in IS: 2026-Part 1 and IEC 60076-1.

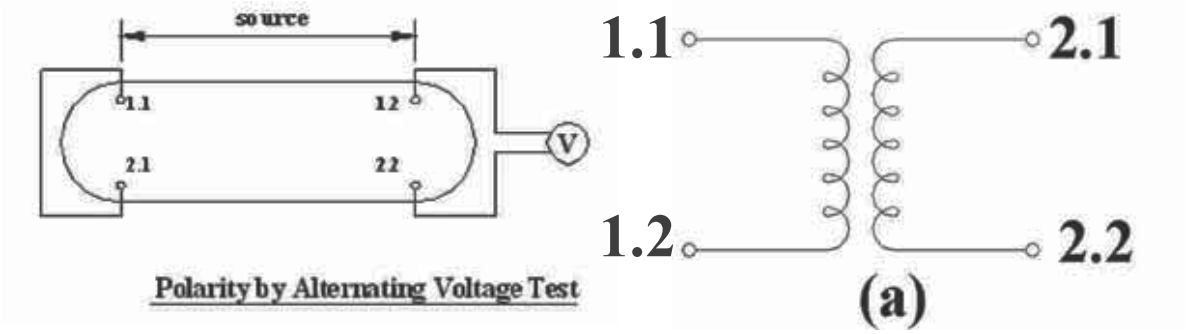


Figure-7

For a single-phase transformer having a ratio of transformation of 30 to 1 or less, the polarity test shall be done as follows. The line terminal of high voltage winding (1.1) shall be connected to the adjacent line terminal low-voltage winding (2.1) as shown in figure 7.

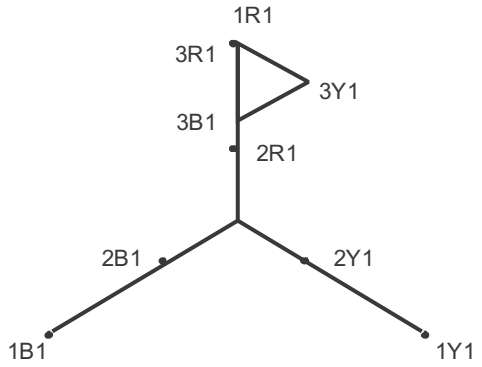
Any convenient value of alternating voltage shall be applied to the full high-voltage winding and readings shall be taken of the applied voltage and the voltage between the right-hand adjacent high-voltage and low-voltage leads.

When the later reading is greater than the former, the polarity is additive.

When the later reading is less than the former (indicating the approximate difference in voltage between that of the high-voltage and low-voltage windings), the polarity is subtractive. The test shall be conducted with 3 phase, 415V supply.

By the measured voltage data, it should be verified that the desired conditions of vector group and polarity are fulfilled

Example for Y D11



- Connect neutral point and LV phase with Earth
- Join 1R1 & 3R1 Terminals
- Apply 415 , 3-Ø supply to HV
- Ensure 2R1-N=2Y1-N=2B1-N=Constant
- If 3R1-N>3Y1-N>3B1-N, and 3Y1-1B1>3Y1-1Y1

Vector group Yna0d11 is confirmed and polarity verified.

Please Note: Most of the auto transformers in POWERGRID are of Yd11configuration.

3.8 MAGNETIC BALANCE TEST

This test is a low voltage test conducted at factory and site by applying single phase voltage between phase and neutral of a winding and measuring voltage induced in other two phases of the same winding. This test is carried out only in three phase units.

Keep the tap in nominal tap position. Disconnect transformer neutral from ground. Apply single phase 230 V across one phase of Highest Voltage (HV) winding terminal and neutral (call it v1) then measure voltage in other two HV terminals across neutral (call them v2 and v3 respectively). Repeat the test for each of the three phases. Repeat the above test for Intermediate Voltage (IV) winding also. The identical results confirm no damage due to transportation. The following points may be noted.

Transformer neutral should be disconnected from ground

(i) No winding terminal should be grounded, otherwise results would be erratic and confusing.

(ii) Zero voltage or very negligible voltage induced in any of the other two phases shall be investigated.

(iii) It is proposed that a set of readings should be taken for information and comparison later during service of the transformer.

Acceptable Limit: Also the applied voltage may be expressed as 100% voltage and the induced voltage may be expressed as percentage of the applied voltage. This will help in comparison of the two results when the applied voltages are different. **The voltage induced in the centre phase shall be 50 to 90% of the applied voltage. However, when the centre phase is excited then the voltage induced in the outer phases shall be 30 to 70% of the applied voltage.**

Zero voltage or very negligible voltage induced in the other two windings should be investigated.

3.9 FLOATING NEUTRAL POINT MEASUREMENT

This test is conducted by applying 3 phase 415 volt supply across HV windings or IV winding as the case may be after disconnecting the transformer neutral from the ground. For a healthy transformer, when 3 phase balance voltage is applied, the voltage between neutral and ground is zero or otherwise a negligible voltage will appear. But in case there is a short circuited winding, the voltage between the neutral and the ground is appreciable. This test will also help in detecting the gradual deterioration or development of fault in the winding during service.

Acceptable Limit For a healthy transformer the voltage between neutral and ground should be zero or negligible. **In case, significant voltage appears between neutral and ground, matter to be referred to the manufacturer.**

3.10 MEASUREMENT OF SHORT CIRCUIT IMPEDANCE

This test is used to detect winding movement that usually occurs due to heavy fault current or mechanical damage during transportation or installation since dispatch from the factory.

Ensure the isolation of Transformer from High Voltage & Low voltage side with physical inspection of open condition of the concerned isolators/ disconnectors. In case tertiary is also connected, ensure the isolation of the same prior to commencement of testing

The measurement is performed in single phase mode. This test is performed for the combination of two windings. The one of the winding is short circuited and voltage is applied to other winding. The voltage and current reading are noted.

The test shall be conducted with variac of 0-280 V, 10 A, precision RMS voltmeter and ammeter. The conductors used for short-circuiting one of the transformer windings should have low impedance (less than 1m-ohm) and short length. The contacts should be clean and tight.

Acceptable Limit: The acceptable criteria should be the measured impedance voltage having agreement to within **3 percent of impedance specified in rating and diagram nameplate** of the transformer. Variation in impedance voltage of more than 3% should be considered significant and further investigated.

3.11 EXCITING/ MAGNETISING CURRENT MEASUREMENT

This test should be done before DC measurements of winding resistance as saturation of winding due to the application of DC voltage may alter the test results. If there is suspected residual magnetism in the winding, transformer under test may be demagnetized before commencement of magnetizing current test.

Three-phase transformers are tested by applying Single-phase 10 kV voltage to one phase (HV terminals) and keeping other winding open circuited and measuring the current at normal, minimum and max. tap positions.

Keep the tap position in normal position and keep HV and LV terminals open. Apply 1phase 10kV supply on IV terminals. Measure phase to phase voltage between the IV terminals and current on each of the IV windings.

Acceptable Limit: The set of reading for current measurement in each of the tap position should be equal. Unequal currents shall indicate possible short circuits in winding. Results between similar single-phase units should not vary more than 10 % .The test values on the outside legs should be within 15 % of each other, and values for the centre leg should not be more than either outside for a three-phase transformers. Results compared to previous tests made under the same conditions should not vary more than **25%. If the measured exciting current value is 50 times higher than the value measured during pre-commissioning checks, then there is likelihood of a fault in the winding which needs further analysis**. The identical results confirm no damage due to transportation. The availability of test data of normal condition and faulty condition results help us to analyze the problem in future.

3.12 OPERATIONAL CHECKS ON OLTC

Following checks should be carried out during pre-commissioning:

- Manual Operation: The tap changer has to be run manually by the hand crank through the total operating cycle. In each operating position, the position indicators of motor drive and tap changer (On TC head) show the same position.
- Motor drive for step by step tap changing operation: Push button to be kept pressed till the motor stops i.e. driving motor should be automatically switched off when the tap changer has performed one switching operation.

(Note: At the time of change over selector operation (i.e. 9b to 10 & vice-versa), higher torque is required. Tap changer end position should be checked that the same is not overrun to avoid any failure during operation. Same can be seen through the inspection glass in the tap changer head cover).

With the tap-changer fully assembled on the transformer the following sequence of operations shall be performed:

a. With the transformer un-energized, one complete cycles of operations (a cycle of operation goes from one end of the tapping range to the other, and back again). Check continuity of winding during this test. Ensure that the voltmeter needle does not deflect to zero. Specify where and how to connect the analog Voltmeter.

b. With the transformer un-energised, and with the auxiliary voltage reduced to 85% of its rated value, one complete cycle of operation.

c. With the transformer energized at rated voltage and frequency at no load, one complete cycle of operation.

The following additional check points/ guidelines for OLTC is recommended in consultation with OLTC manufacturer to ensure the absence of problems and proper operation:

a) Function of control switches

b) OLTC stopping on position

c) Fastener tightness

d) Signs of moisture such as rusting, oxidation or free standing water and leakages

e) Mechanical clearances as specified by manufacturer's instruction booklet

f) Operation and condition of tap selector, changeover selector and arcing transfer switches

g) Drive mechanism operation

h) Counter operation, Position indicator operation and its co-ordination with mechanism and tap selector positions

i) Limit switch operation

j) Mechanical block integrity

k) Proper operation of hand-crank and its interlock switch

l) Physical condition of tap selector

m) Freedom of movement of external shaft assembly

n) Extent of arc erosion on stationary and movable arcing contacts

o) Inspect barrier board for tracking and cracking

p) After filling with oil, manually crank throughout entire range

q) Oil BDV and Moisture content (PPM) to be measured and recorded (Min BDV should be 60 KV and Moisture content should be less than 10 PPM)

3.13 TESTS/ CHECKS ON BUSHING CURRENT TRANSFORMERS (BCTs)

Continuity, Polarity and secondary winding resistance tests of individual cores of Bushing CTs.

3.14 OPERATIONAL CHECKS ON PROTECTION SYSTEM

(For detailed procedure, please refer to DOC NO: D-2-03-XX-01-01 Maintenance Procedures for Switchyard Equipments Part1: EHV Transformers/ Reactors)

1) Operational Checks on Breathers (Conventional Silcagel or Drycol as supplied with the transformers).

2) Visual check of MOG of Main Conservator

3) Marshalling Box & Kiosk Checks

4) Valve Operational Checks

5) Checks on Cooling System

   i. Checks on cooling fans-rotation, speed & Control (Manual /temp /load) setting checks

   ii. Checks on Cooling pumps- rotation, vibration/noise, oil flow direction

6) Checks on temperature Gauges (OTI/WTI-Calibration and Cooler Control, alarm & trip setting tests)

7) Checks on gas actuated (SPRs/ PRDs/ Buchholz) relays –Operational checks by simulation as well as shorting the respective contacts as applicable

8) Checks on tightness of Terminal connectors - micro-ohm measurement of each connection

9) Checks on Transformer/ Reactor protection (differential, REF, Over-current & stability tests etc.)

3.15 STABILITY OF DIFFERENTIAL, REF OF TRANSFORMER/ REACTOR

This test is performed to check the correctness of CT polarity, CT secondary core connections, connections at relay terminals and operation of relay under fault conditions. Here the entire electrical protection scheme is checked.

3.15.1 REF STABILITY TEST FOR TRANSFORMER

1) After opening the Circuit Breaker and isolators at both side (H.V. and L.V. side) of transformer, use "Primary Test Tap (M point or PI1/PI2)" provided in the BUSHING TURRET CTs to bypass the Transformer with the help of Primary current injection leads. Now, after ensuring completion of all CT wiring & normal polarity, inject current with the help of Primary Injection kits in the relevant turret CTs of R phase & Neutral, subject to the maximum rating of Primary Test Tap.

2) Measure the spill current in REF relay which should be nearly zero.

3) Switch off Current Injection.

4) Reverse the polarity of R phase Bushing CT and again start Current Injection. Appreciable spill current will appear in REF relay.

5) Normalize the CT circuit which was reversed in step no. (4), after switching off Current injection.

6) Repeat the same procedure for Y and B phases and note down the results in formats.

7) Normalize the connections of CT.

8) This test has to be performed from both HV side & LV side w.r.t. Neutral.

However, if Primary Test Tap is not available in the Turret CTs, adopt following procedure:

1) After opening the Circuit Breakers and Isolators at both side (H.V. and L.V. side) of transformer apply 440V three phase voltage at three phase bushing of H.V. side with the help of three phase variac.
2) Earth the R phase of the LV side (through isolator earth switch or discharge rod).
3) Measure the spill voltage (in mV)/ spill current (in mA) at REF relay which should be nearly zero.
4) Switch off 440V supply.
5) Reverse the polarity of R phase Bushing CT and again switch on 440V supply. Appreciable spill voltage/ current will appear in REF relay.
6) Normalize the CT circuit which was reversed in step no. (5), after switching off 440V supply.
7) Repeat the same procedure for Y and B phases and note down the results in formats.
8) Normalize the connections of CT and remove feeding of three phase supply.

3.15.2 REF STABILITY TEST FOR REACTOR

1) After opening the Circuit Breaker and Isolators of Reactor, use "Primary Test Tap (M point or PI1/PI2)" provided in the BUSHING TURRET CTs to bypass the Reactor with the help of Primary current injection leads. Now, after ensuring completion of all CT wiring & normal polarity, inject Current with the help of Primary Injection kits in the relevant Turret CTs of R phase of Reactor & earth side CT of NGR, subject to the maximum rating of Primary Test Tap.
2) Measure the spill current in REF relay which should be nearly zero.
3) Switch off Current Injection.
4) Reverse the polarity of R phase Bushing CT and again start Current Injection. Appreciable spill current will appear in REF relay.
5) Normalize the CT circuit which was reversed in step no. (4), after switching off Current injection.
6) Repeat the same procedure for Y and B phases and note down the results in formats.
7) Normalize the connections of CT.

However, if Primary Test Tap is not available in the Turret CTs, adopt following procedure:

1) After opening the C.B. and isolators of Reactor, remove the jumpers of three phase bushings. Reactor Neutral will remain connected to NGR, however Earth connection of NGR Bushing will be opened.
2) Apply 415 volts, phase to phase voltage across R phase bushing of Reactor & earth side Bushing of NGR, after ensuring completion of all CT wiring & normal polarity.
3) Measure the spill voltage (in mV)/ spill current (in mA) in REF relay which should be nearly zero.
4) Switch off 415V supply to Reactor / NGR Bushing.

5) Reverse the polarity of R phase bushing CT.

6) Switch on 415V supply to Reactor / NGR Bushing.

7) Appreciable spill voltage/ current will appear in REF relay.

8) Now normalize the polarity of the Bushing CT which was reversed in step (5).

9) Repeat the same procedure for Y and B phase and note down the results in formats.

10) After completing the test for all three phases normalize the reactor CT connection and jumpers & Earth connection of NGR Bushing.

3.16 FREQUENCY RESPONSE ANALYSIS (FRA) MEASUREMENT

Frequency Response Analysis (FRA) is conducted to assess the mechanical integrity of the transformer which may get disturbed due to transportation shocks. FRA signatures will be taken after assembly and oil filling and compared with factory testing to ensure the healthiness of core /coil assembly during transportation. These signatures will be the benchmark for future reference. The FRA signatures should be analyzed in conjunction with Impact Recorder readings. Report of Impact recorder readings is to be obtained from manufacturer.

It is recommended to follow the standard procedure for the SFRA measurement as per the Table-7. It should be done on maximum, normal and minimum tap of the transformer.

Combination of tests for Auto Transformer

Test Type	Test	3 Φ	1 Φ
Series Winding (OC) All Other Terminals Floating	Test 1	H1-X1	H1-X1
	Test 2	H2-X2	
	Test 3	H3-X3	
Common Winding (OC) All Other Terminals Floating	Test 4	X1-H0X0	X1-H0X0
	Test 5	X2-H0X0	
	Test 6	X3-H0X0	
Tertiary Winding (OC) All Other Terminals Floating	Test 7	Y1-Y3	Y1-Y2 (Y1-Y0)
	Test 8	Y2-Y1	
	Test 9	Y3-Y2	
Short Circuit (SC) High (H) to Low (L) Short (X1-X2-X3)	Test 10	H1-H0X0	H1-H0X0 Short (X1-H0X0)
	Test 11	H2-H0X0	
	Test 12	H3-H0X0	
Short Circuit (SC) High (H) to Tertiary (Y) Short (Y1-Y2-Y3)	Test 13	H1-H0X0	H1-H0X0 Short (Y1-Y2)
	Test 14	H2-H0X0	
	Test 15	H3-H0X0	
Short Circuit (SC) Low (L) to Tertiary (Y) Short (Y1-Y2-Y3)	Test 16	X1-H0X0	X1-H0X0 Short (Y1-Y2)
	Test 17	X2-H0X0	
	Test 18	X3-H0X0	

Table-7: Various combinations for FRA measurement in Auto Transformer

Combination of tests for Shunt Reactor

In case of Shunt Reactor, FRA to be done in following combinations:

- **H1-H0**
- **H2-H0**
- **H3-H0**

3.17 WINDING RESISTANCE MEASUREMENT

Preferably to be carried out using Automatic kit, in case of non availability V/I method can be adopted.

To reduce the high inductive effect, it is advisable to use a sufficiently high current to saturate the core. This will reduce the time required to get a stabilized reading. It is essential that temperatures of the windings are accurately measured. Care shall be taken that self inductive effects are minimized. Care also must be taken to ensure that direct current circulating in the windings has settled down before the measurement is done. In some cases this may take several minutes depending upon the winding inductance.

The winding resistance shall be preferably done when the difference in the top and bottom temperature of the winding (temperature of oil in steady-state condition) is equal to or less than 5 °C.

The winding resistance should preferably be carried out last after completion of all other LV tests, as after this test core gets saturated and tests like magnetizing current, magnetic balance etc. carried out after winding test may be affected and indicate a misleading results, if the core is not de-magnetized before carrying out these tests.

For star connected auto-transformers the resistance of the HV side is measured between HV terminal and IV terminal, then between IV terminal and the neutral AT ALL TAPS. The tap changer should be changed from contact to contact so that contact resistance can also be checked. Measurement of winding resistance is to be carried out from tap position 1 to 17 and again from 17 to 9. While doing measurements in reverse order, 2 to 3 steps shall be enough.

During tap changing operation, continuity checks between HV to neutral to be carried out by analog multimeter while changing tap.
For delta connected windings, such as tertiary winding of auto-transformers, measurement shall be done between pairs of line terminals and resistance per winding shall be calculated as per the following formula:

Resistance per winding = 1.5 x Measured value

Take the winding temperature reading while doing the resistance measurement.

Calculate the resistance at 75°C as per the following formula

$\mathbf{R_{75} = R_t (235+75)/(235+t)}$, Where R_t = Resistance measured at winding temperature t

Acceptable Limit: The resistance value obtained should be compared with the factory test value. Results are compared to other phases in Star-connected transformers or between pairs of terminals on a Delta–connected winding to determine if a resistance is too high or low. Because field measurements make it unlikely that precise temperature measurements of the winding can be made, the expected deviation for this test in the field is not more than **5.0%** of the factory test value.

3.18 DISSOLVED GAS ANALYSIS (DGA) OF OIL SAMPLE

Dissolved Gas Analysis (DGA) is a powerful diagnostic tool to detect any incipient fault developing inside the oil-filled equipment. The oil sample is to be taken after oil filling (before commissioning) as a benchmark and there after 24hrs of charging, 7 days, 15 days, one month and three months after charging to monitor the gas build up if any. The oil samples are to be sent to the designated labs for DGA and first two samples for oil parameter testing also.

For detailed procedure for each test, please refer Transformer and Reactor Maintenance manual (Doc No. D-2-03-XX-01-01)-First Revision, Part B, C & D.

CHECK LIST FOR ENERGISATION OF TRANSFORMER/ REACTOR

4.1 PRELIMINARY CHECKS

1. Release air at the high points, like oil communicating bushings, buchholz petcock, tank cover and the cooling devices including headers, radiators, pumps, expansion joints etc. of the transformer. Air release should be resorted from low points to high points.

2. Check the whole assembly for tightness and rectify where necessary.

3. Check the general appearance and retouch the paint work if needed.

4. Check that the valves are in the correct position :
   - Tank: valves closed and blanked
   - Cooling circuit: valves open
   - Conservator connection:valves open
   - By-pass: valves open or closed as the case may be.
   - On-load tap changer:valves open

5. Check that the silica gel is completely filled in the breather and is blue and that there is oil in the breather cup (oil seal)

6. Ensure that CC & CL are properly grounded.

7. Check the oil level in the main conservator and the conservator of on-load tap changer, as per manufacturers recommendations

8. Check the bushings:
   - Oil level (bushings fitted with sight-glasses)
   - Adjustment of spark-gaps /arcing horn –gaps, if provided
   - Conformity of connection to the lines (no tensile stress on the terminal heads)
   - Bushing CT secondary terminals must be shorted and earthed, if not in use.
   - Neutral bushing effectively earthed
   - Tan delta cap should be tight and properly earthed.

9. Check the on-load tap changer:
   - Conformity of the positions between the tap changer control cubicle and the tap changer head

- Adjustment of the tap-changer control cubicle coupling
- Electric and mechanical limit switches and protective relays
- Step by step operation- local and remote electrical operation as well as manual operation and parallel operation, if any
- Signaling of positions

10. Check the quality of the oil:
    - Draw a sample from the bottom of the tank.
    - Carry out DGA and oil parameters test

11. Prior to energization at site, oil shall be tested for following properties & acceptance norms as per below generally in line with IS: 1866 / IEC 60422:

1.	Break Down voltage (BDV)	: 70 kV (min.)
2.	Moisture content	: 5 ppm (max.)
3.	Tan-delta at 90 °C	: 0.01 (max.)
4.	Total Gas Content	: < 1%
5.	Resistivity at 90 °C	: 6 X 10^{12} ohm-cm (min.)
6.	Interfacial tension	: 0.035 N/m (min.)
7.	*Oxidation Stability (Test method as per IEC 61125 method C, Test duration: 500 hour for inhibited oil)	
	a) Acidity	: 0.3 (mg KOH /g) (max.)
	b) Sludge	: 0.05 % (max.)
	c) Tan delta at 90 °C	: 0.05 (max.)

· *For Sr. No. 7 separate oil sample shall be taken and test results shall be submitted within 45 days after commissioning for approval of POWERGRID

12 Check that equalizing link between OLTC tank and Main tank is removed

13 Extraneous materials like tools, earthing rods, pieces of clothes, waste etc. should be removed before energizing.

4.2 CHECKING OF AUXILIARY AND PROTECTIVE CIRCUITS

1. Ensure that the temperature indicators are calibrated.
2. Check the setting and working of the mercury switches of winding and oil temperature indicators

3. Ensure presence of oil in the thermometer pockets.
   - Follow the same procedure for the thermal replicas
4. Check the direction of installation of buchholz relay.
5. Check the operation of the buchholz relay and the surge protective relay of the tap-changer for:
   - Alarm and tripping
   - Protections and signals associated with these relays
6. Check the insulation of the auxiliary circuits with respect to ground by 2 kV insulation tester for 1 min. It should withstand the test.
7. Check the earthing of the tank and auxiliaries like cooler banks at two places.
8. Measure the supply voltages of the auxiliary circuits
9. Check the cooling system for the following:
   - Check the direction of installation of oil pumps
   - Check the direction of rotation of the pumps and fans
   - Check the working of the oil flow indicators
   - Check the setting of the thermal overload relays
   - Go through the starting up sequences, control and adjust, if necessary, the relay time delays
10. Check that there is sufficient protection on the electric circuit supplying the accessories and tightness of all electrical connections
11. Check the heating and lighting in the cubicles
12. Check the schemes of differential protection, over-current protection, restricted earth fault protection, over-fluxing protection etc. With implementation of settings as recommended by CC/Engg

After the inspection / tests are completed, the transformer may be energized from the incoming side on NO LOAD, 400kV or 220kV. The initial magnetizing current at the time of switching will be very high, depending upon the particular moment in the cycle. The transformer should be kept energised for twelve hours before taking on load. During this time, vibrations, abnormal cracking noise, etc. are to be observed.

After that it may be checked for gas collection. If the gas prove to be inflammable, try to detect the cause which may probably be an internal fault. If the breaker trips on differential /REF, buchholz or any other protective device, the cause must be investigated thoroughly before re-energizing the transformer/ reactor. After successful charging, performance of transformer / rector should be checked under loading; OTI/WTI readings should be monitored for 24 hours and ensured that they are as per loading.

DGA samples may be sent as per Standard practice (after 24 hrs of energizing, one week, 15 days, one month and three months after charging, thereafter as per normal frequency of 6 months). Loading data may be forwarded to CC/OS and manufacturer (if requested by them).

POST COMMISSIONING CHECKS/TESTS FOR TRANSFORMERS AND REACTORS

Sr. No.	Name of Test/ Check point	Purpose of test/ check
5.1	Thermovision Infra-red scanning (IR thermography)	A thermo vision Camera determines the temperature distribution on the surface of the tank as well as in the vicinity of the Jumper connection to the bushing. The information obtained is useful in predicting the temperature profile within the inner surface of tank and is likely to provide approximate details of heating mechanism.
5.2	On Line moisture measurement	To determine the moisture content in paper insulation by measuring % Relative Saturation/ Active Water. This test to be carried out once the Transformer/ Reactor is stabilized and operating at higher temperature (>60 deg C).
5.3	Vibration measurement of Oil-immersed Reactor	To measure the vibrations of core /coil assembly in the tank of the reactor. Movement of the core-coil assembly and shielding structure caused by the time–varying magnetic forces results in vibration of the tank and ancillary equipment. These vibrations have detrimental effects such as excessive stress on the core-coil assembly

5.1 THERMOVISION SCANNING (IR THERMOGRAPHY)

Once the transformer/ reactor is charged and loaded, Thermovision scanning is to be carried out to see any hotspots. Thermovision scanning of transformer to be done at least after 24 hrs. of loading and repeated after one week.

5.2 ON LINE MOISTURE MEASUREMENT

5.3 VIBRATION MEASUREMENT OF OIL-IMMERSED REACTOR

Movement of the core-coil assembly and shielding structure caused by the time –varying magnetic forces results in vibration of the tank and ancillary equipment. These vibrations have detrimental effects such as excessive stress on the core-coil assembly. The shunt reactor under test shall be completely assembled in normal operating condition with cooling equipments, gauges and accessories. The shunt reactor shall be energized at rated voltage and frequency. Three phase excitation for 3-ph units. The shunt reactor should be mounted on a level surface that will provide proper bearing for the base, in order to eliminate the generation of abnormal tank stresses.

The vibration of shunt reactor shall be measured by transducers, optical detectors or equivalent measuring devices. The measuring equipment should be accurate within +/- 10 % at 2nd harmonic of the exciting frequency. The peak-to-peak amplitude shall be determined by direct measurement or calculated from acceleration or velocity measurement. The average amplitude of all local maximum points shall not exceed 60 μm (2.36 mils) peak to peak. The maximum amplitude within any individual reading shall not exceed 200 μm (7.87 mils) peak to peak.

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 δ & 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	**Checks/ Tests applicable for CTs**	
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	**Checks/ Tests applicable for Circuit Breakers**	
6.3.1	Dew point measurement of SF6 gas	Dew point of SF6 gas is to measure moisture content in SF6 gas which shall indicate whether CB evacuation is done properly or not. This test shall be carried out preferably at rated pressure of SF6 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.
6.4	**Checks/ Tests applicable for CVTs**	
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.
6.5	**Checks/ Tests applicable for Isolators**	
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.
6.6	**Checks/ Tests applicable for Surge Arrestors**	
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 μA.
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.
6.7	**Checks/ Tests for other areas/ equipments**	
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.

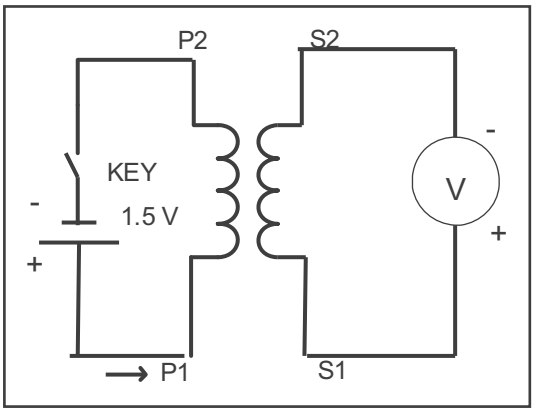


Figure - 9

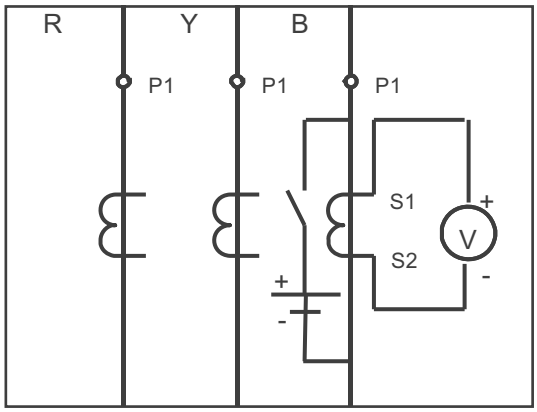


Figure - 10

6.2.2 MAGNETIZATION CHARACTERISTICS OF CTs

PRECAUTIONS

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.

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

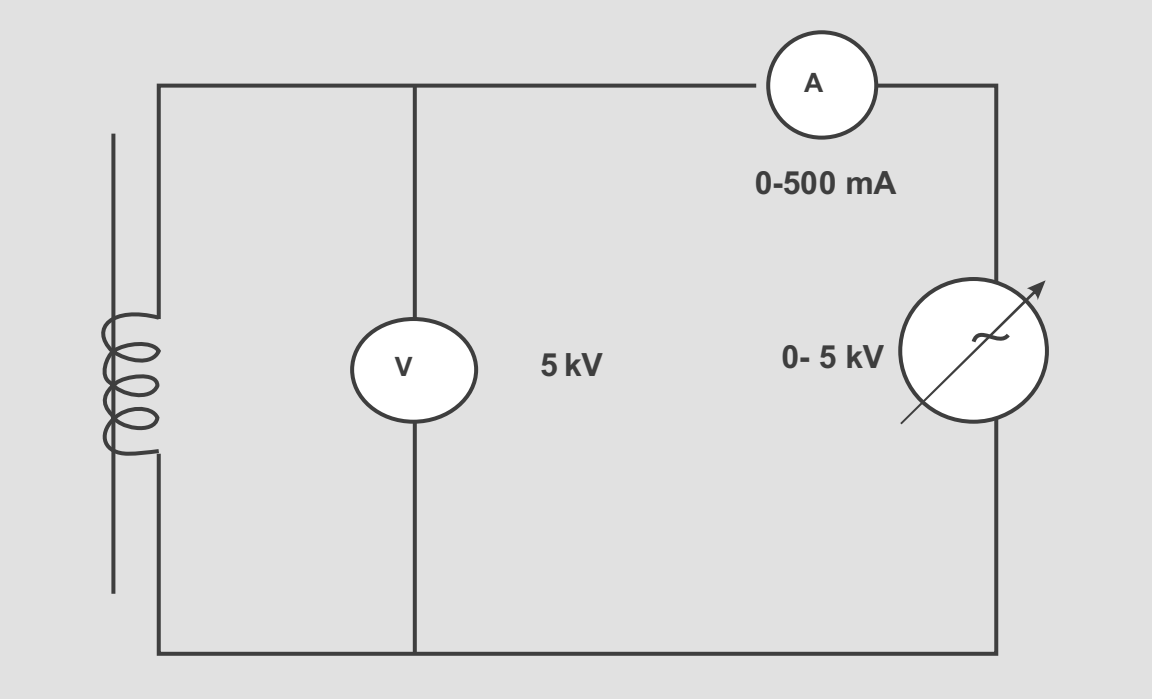


Figure - 11

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.

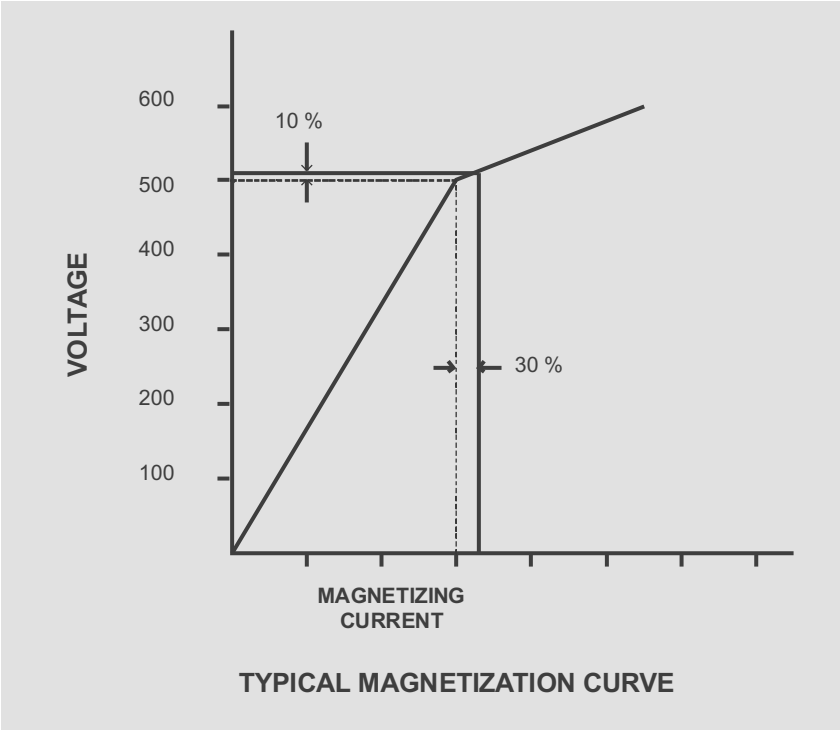


Figure - 12

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 slop 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.

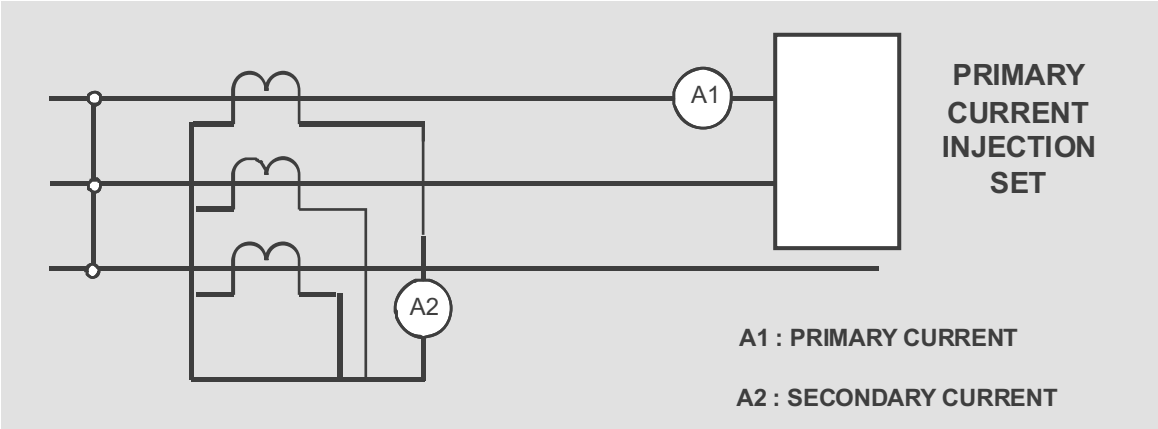


Figure - 13

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).

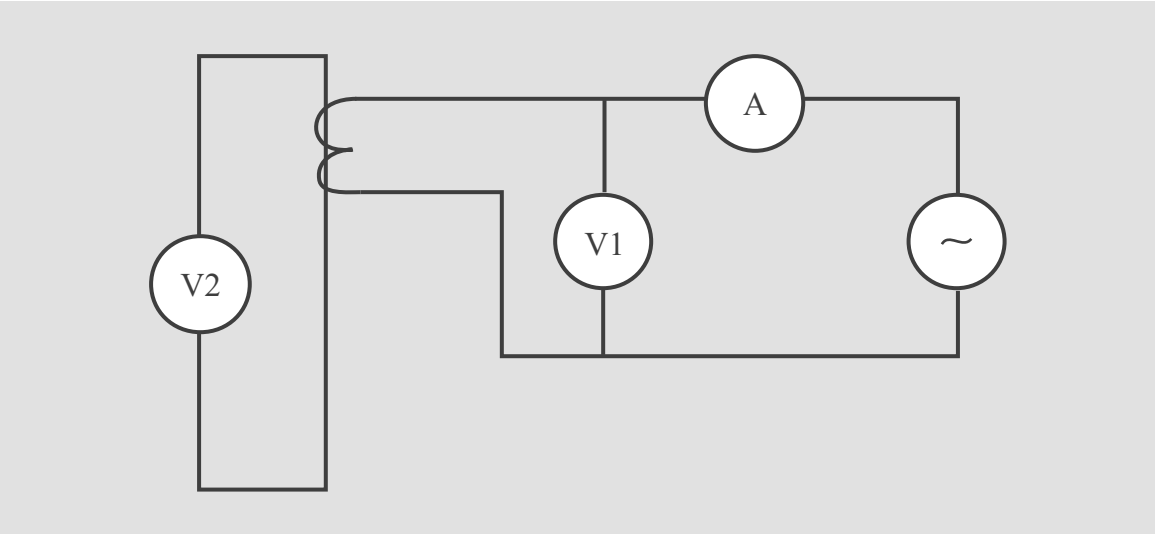


Figure - 14

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

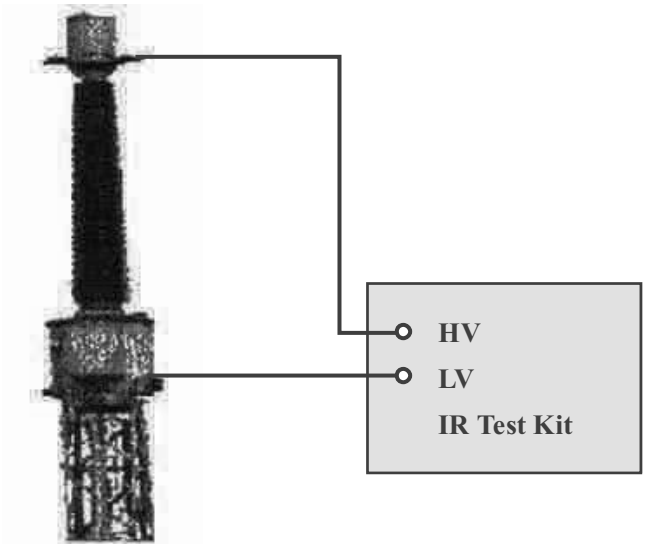


Figure-15 Typical Arrangement for IR measurement

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 SF6 GAS FOR CIRCUIT BREAKER

Dew Point is the temperature at which moisture content in SF6 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 SF6 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 SF6 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 SF6 gas. Hence, dew point of SF6 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

a) There should not be any joint in testing cables.
b) Test leads should not touch any live part.
c) Never connect the test set to energised equipment.
d) The ground cable must be connected first and removed at last.
e) High voltage plugs should be free from moisture during installation and operation.
f) Circuit Breaker Analyser body should be earthed (if separate earth is provided).
g) 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.
h) Surface/terminals should be cleaned where the connections for testing are to be made.
i) Clean earth point with sand paper/wire brush where earth terminal is to be provided.
j) Ensure that all the poles trip simultaneously through single close/trip command.

TESTING PROCEDURE

a) 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.
b) Make connections for recording operating timings of Auxiliary contacts.
c) Extend power supply to Circuit Breaker Analyzer.
d) 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.

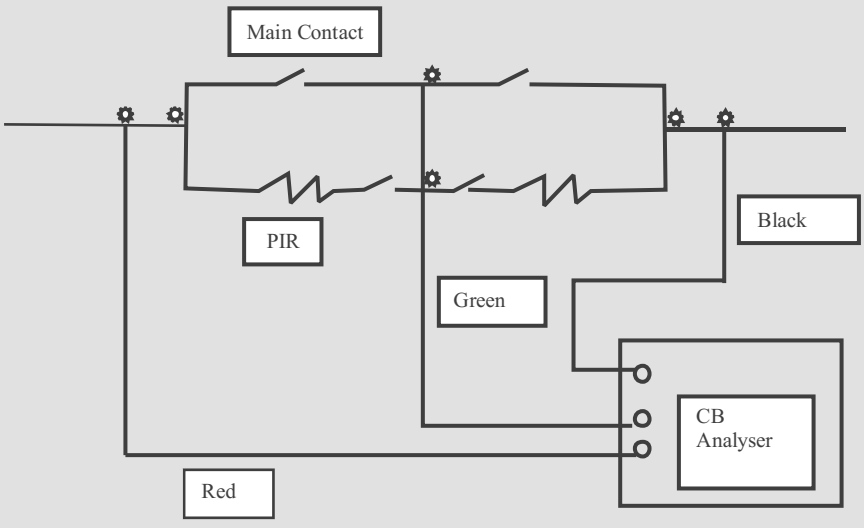
g) Note down the timings for `CO', and `OCO' by giving respective commands. CO command to be given without time delay but 300ms time delay to be given between O and CO operation in testing for OCO.

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.



Typical Arrangement for Operating Timings Measurement of CB

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 SF6 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 vide 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. SF6 GAS PRESSURE LOCKOUT

a) LOW PRESSURE ALARM

Close Isolation Valve between CB Pole(s) and density monitor. Start releasing SF6 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_6 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) CB AUTO 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 AR L/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) CB AUTO 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 ± 0.1 bar/ Kg/cm^2 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 ± 0.3 bar/ Kg/cm^2 of the set value.

C. OIL PRESSURE LOCKOUT

All the oil pressure switches settings should be checked and corrected and should be within ± 0.3 bar/ Kg/cm^2 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.

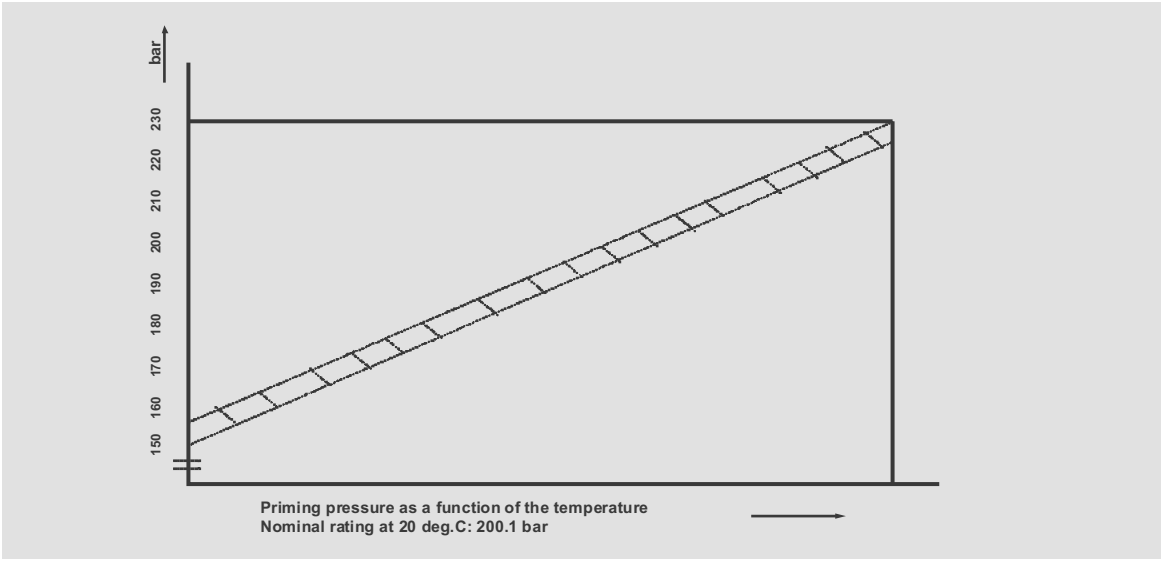


Figure - 17

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 MILLI VOLT 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

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

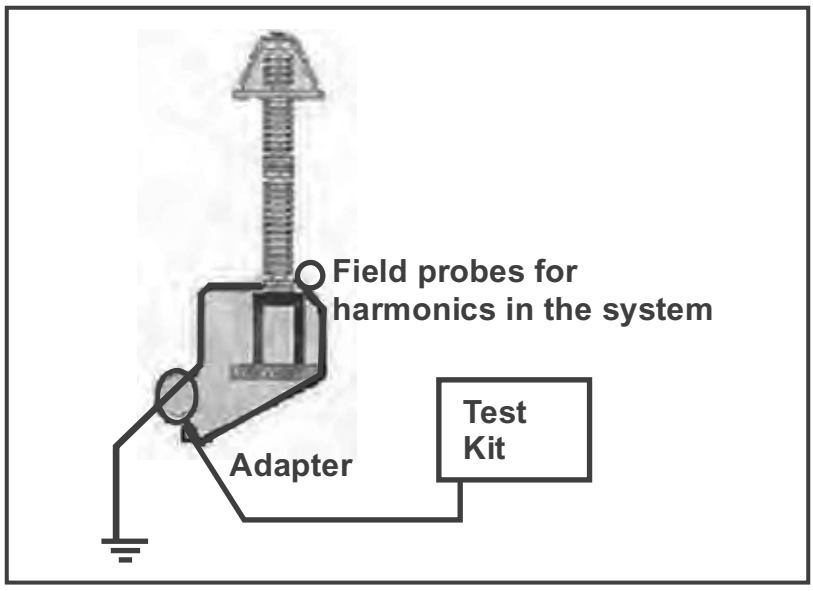


Figure- 18 Typical arrangement for THRCM Test

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 μA

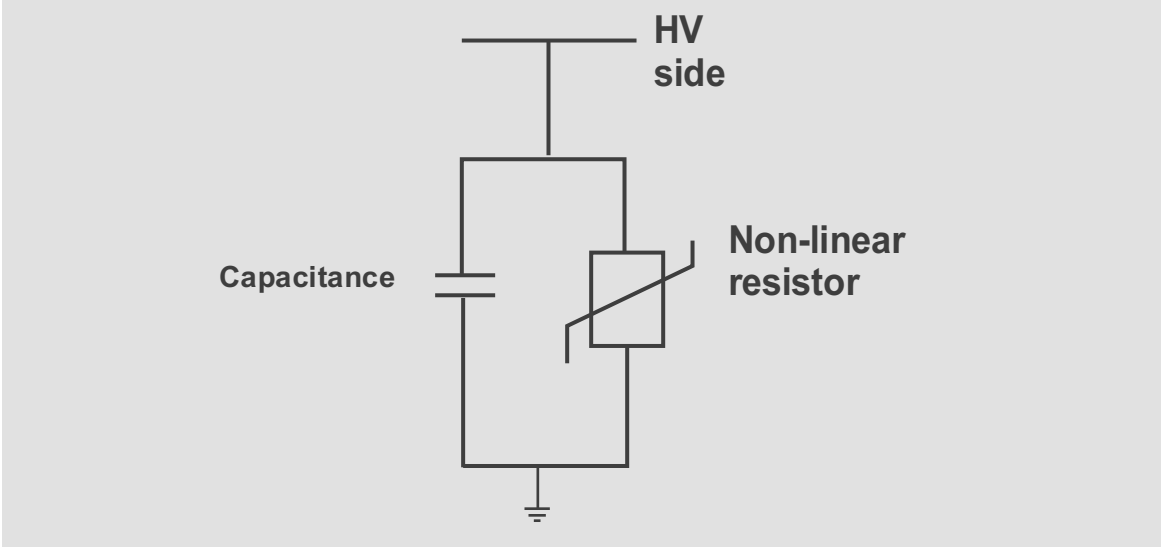


Figure-19 Arrester equivalent circuit

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

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.

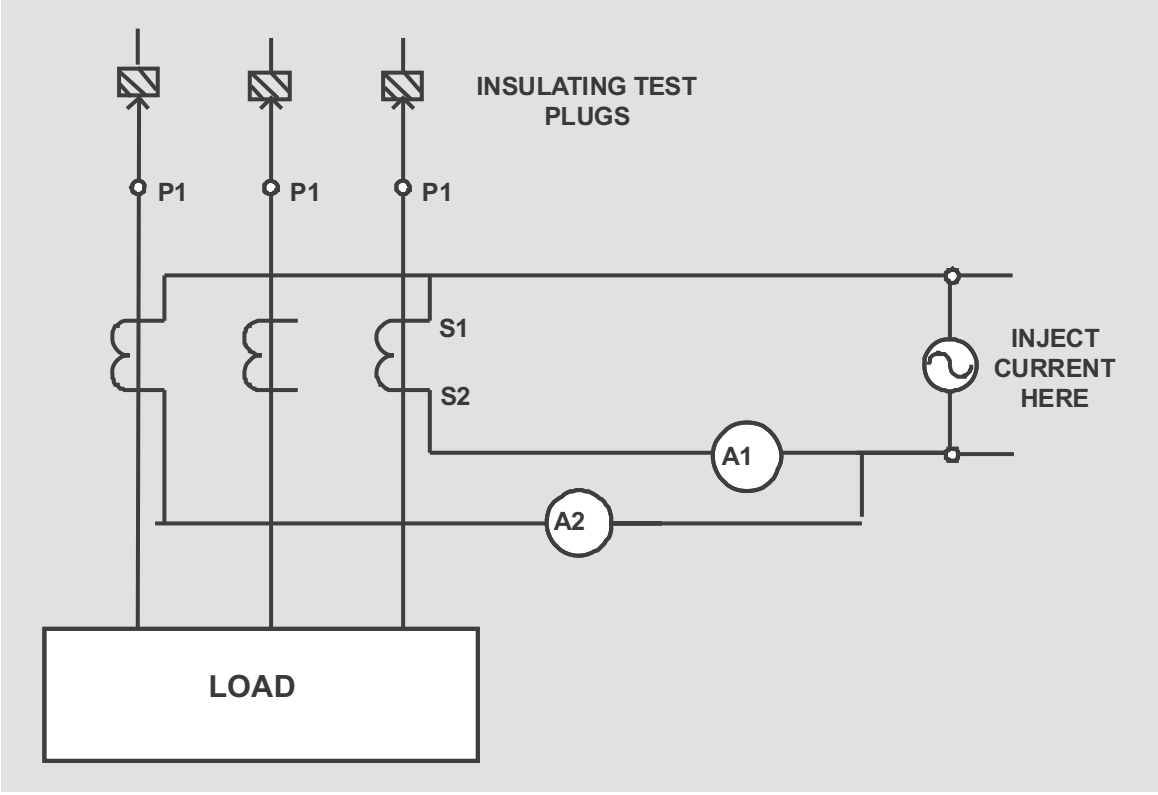


Figure - 20

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.

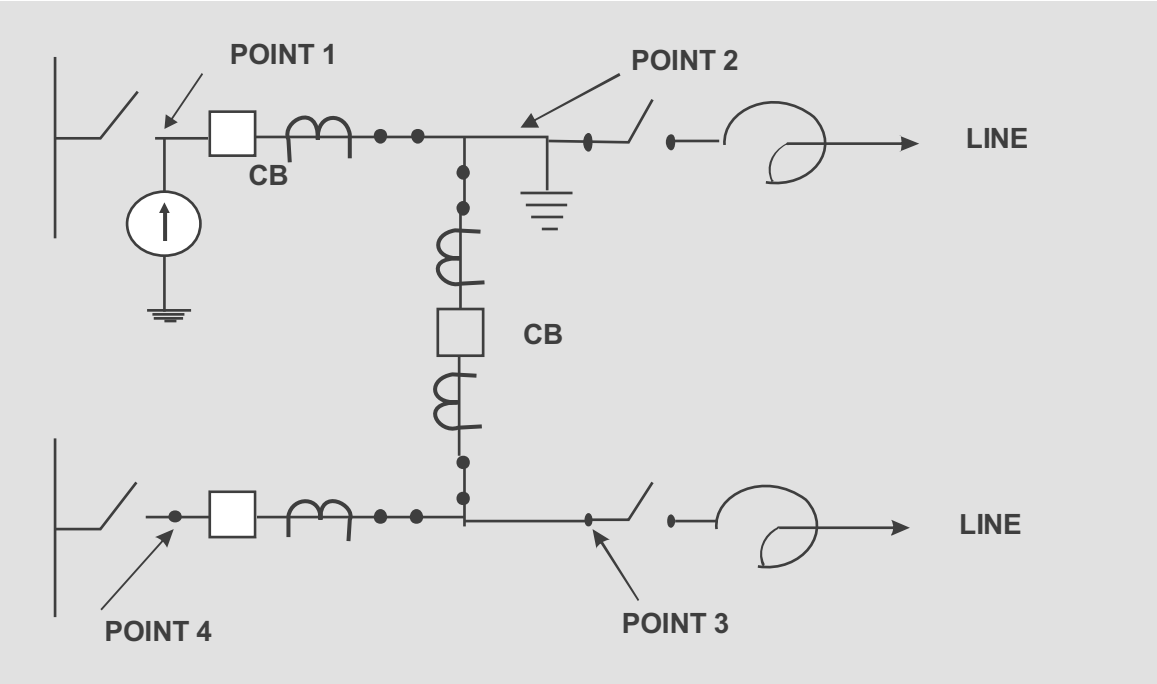


Figure-21 : Primary injection test to check contact tightness of Bay/ feeders

CHECKS/TESTS FOR BUS BAR PROTECTION

Types of bus bar protection
a) High impedance
b) Low impedance

7.1 High Impedance protection

The High-impedance protection scheme, is a good solution for single busbar arrangements, 1 ½ breaker systems or ring Busbars, provided that appropriate dedicated CT cores are available for this use alone.

Sensitive, stable and fast protection for single busbar arrangements and 1 ½ breaker systems.

Eg: RADHA (ABB), FAC 34 (EE), PBDCB (EE), PBLSB (EE)

7.1.1 Types of High impedance protection schemes

Two main protections with CT supervision feature

Main & check zone scheme

a) Two main protections

Generally used where direct measurement is possible without switching of the CT circuits

Trip command will be issued on operation of any one of the main protection.

b) Main & check zone scheme

Have highest degree of security in the form of check zone, generally used where CT switching is required through auxiliary contacts of isolator (like 220kV DMT scheme)

For a double busbar arrangement, two different high impedance units are required. In this case, the current must be switched between the two different measuring units by connecting auxiliary switches to the busbar isolator contacts.

In some cases the auxiliary switches did not operate correctly. This caused the busbar Protection to trip the busbar. For this reason, a safety precaution was introduced: An overall Check-Zone unit, fed from individual CT cores. This overall scheme does not include any switching of CT and therefore is more secure.

The TRIP command is only issued when both a discriminating and check-zone system Operates.

The relay coil will be designed as voltage measuring device consuming negligible current.

$V_f = I_f (Rct+2.Rl)$
$V_k = 2V_f$

Paralleling CT current should be done at CT marshalling boxes.

7.1.2 CT requirements for High impedance protection system

- **Knee point voltage requirement of the CT will be high**
- CT core shall be dedicated to the High-impedance Busbar Protection Scheme (i.e. cannot be shared with other protection relays)
- CT Must have identical turns-ratio (CT Ratio) (Aux.CT for ratio corrections not acceptable)
- Shall have a low resistance of the secondary windings
- Shall have a minimum knee-point voltage of approx. 300-500V.
- Should have a low magnetising current (few milliamps)

7.1.3 Supervision of the CT circuits

Any interruption of CT currents up to the point of parallel connection can cause instability during external faults even though their degree of unbalance is with in the limits during normal operation. Hence supervision scheme for CT wire are required.

Supervision relay should be provided across each phase for each zone.

It will block the current passing through the differential relay by shorting the CT terminals

General setting of the CT supervision relay is 10% of the lowest circuit rating.

Calculation of typical settings for bus bar differential protection

CT ratio:	: 2000/1
CT resistance:	: 10 Ohms
Max. bus fault MVA	: 10000 MVA
Max. fault current	: $10000 \times 10^6 / 1.732 * 400000 = 14434$ A
Fault current in secondary	: 7.217A
Voltage setting of the relay	: V_f or $V_S = I_f(R_{ct}+2R_L)$

Lead resistance of 1000m, 2.5sq.mm copper wire is 7.28 ohms

Assume 500m of lead length

Vs= 7.217* (10+2*7.28/2) =124.7V

Nearest available setting can be adopted for the relay

7.2 Low Impedance bus bar scheme

The most suitable protection scheme for Double and multiple busbar Systems (with or without transfer bus) with feeders being switched between sections of the busbar, which operates with full selectivity for all possible busbar configurations.

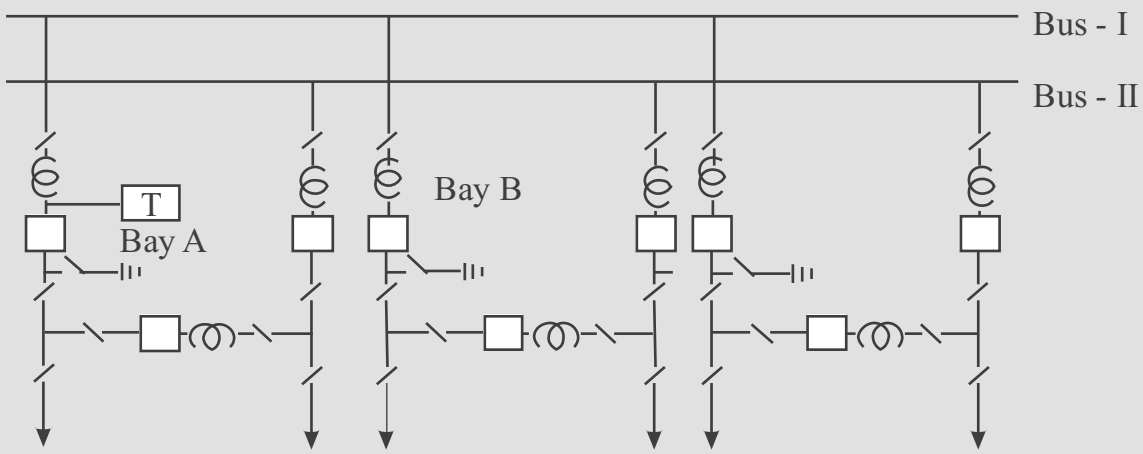
Free of any need for matched CT characteristic or ratios, low leakage reactance or resistance.

Other protective relays can be included in the same circuit.
Stable for infinite fault level.
Insensitive to CT saturation.

All the CT wiring will be routed to relay either directly or through aux. relay.

Eg: RADSS (ABB), MBCZ (EE)

7.3. Primary injection and bus bar differential stability test (New Substation)



T - Primary current injection text kit

1. Take one of the bays (A) as the reference

2. Select other bay (B) for testing the differential stability. Inhibit the tripping of the breaker in bay **B** from control room due to operation of distance or over current protection caused by primary current injection, if the earthing has been made after the breaker by using earth switch.

3. Earth the bus bar after CT using local earth or nearby earth switch on bay **B** to provide return path for the current.

4. Ensure bus bar is earthed only at bay **B**

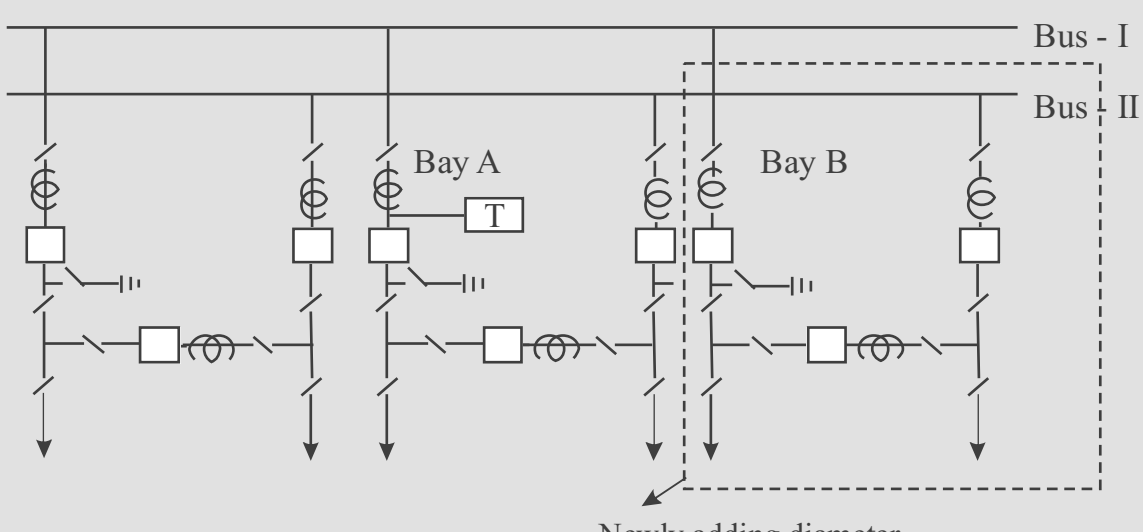
5. Inject primary current using primary current injection test kit across one phase (e.g.R Phase) and ground; don't use other phase as return path for the current.

6. Measure the current at both CT marshalling boxes and voltage across differential relay terminals incase of high impedance differential protection.

7. Measure currents before and after aux. CTs and at relay terminals, incase of low impedance differential protection is being installed.

8. The measured spill voltage/current at relay terminals should not be more than 2%.
9. If the spill voltage/current is more (almost twice the CT secondary current) at the relay terminals, stop injecting the primary current and then reverse the secondary terminals of CT at bay **B.**
10. Start injecting primary current and measure the current at both CT marshalling boxes and at the relay terminals at control room and observe the spill current/ voltage magnitude less than 2%.
11. Stop injecting primary current and then create in-zone fault on primary side (by providing earthing between the two CTs) and start injecting primary current and Measures the current at both CT marshalling boxes and at the relay terminals at control room and observe the spill current/ voltage of considerable magnitude corresponding to the injected primary current. (a pictorial example is attached herewith at Annexure)
12. After ensuring the above stop injecting the current. The CT connection should be as per polarity thus proved.
13. Repeat the test for other two phases.
14. Repeat the same procedure for other bays of the same bus bar by taking adjacent bus bar stability checked bay as the reference bay in order to inject max. possible current in the primary using primary injection test kit.
15. Repeat the above procedure for other bus bars also.
16. Above said procedure shall be carried out between Phase-Phase (R-Y &Y-B) by injecting in one phase and joining with other phase for using it as return path instead of earth return for one set of CTs (Two bays).

7.4. Primary injection and bus bar differential stability test (Bay Extension in the old substation):



T- Primary current injection test kit

1. Arrange the shutdown of the bus barunder test
2. Consider one of the existing bays (A) as the reference
3. Short the CT cores used for the other protections (like LBB, distance or differential or O/C or metering, etc), at CT MB itself, no CT core shall be in open condition.
4. Select one of new bays (B) for testing the differential stability and inhibit the tripping of the breaker from control room due to operation of distance or over current caused by primary current injection.
5. Earth the bus bar after CT using local earth or nearby earth switch on bay **B**.
6. Ensure bus bar is earthed only at bay **B**
7. Inject primary current using primary current injection testing kit across one phase (eg.R Phase) and ground; don't use other phase as return path for the current.
8. Measure the current at both CT marshalling boxes and voltage across differential relay terminals incase of high impedance differential protection.
9. Measure currents before and after aux. CTs and at relay terminals, incase of low impedance differential protection is being installed.
10. The measured spill voltage/current at relay terminals should not be more than 2%.
11. If the spill voltage/current is more (almost twice the CT secondary current) at the relay terminals, stop injecting the primary current and then reverse the secondary terminals of CT at bay **B.**
12. Start injecting primary current and measure the current at both CT marshalling boxes and at the relay terminals at control room and observe the spill current/voltage magnitude less than 2%.
13. Stop injecting primary current and then create in-zone fault on primary side (by providing earthing between the two CTs) and start injecting primary current and measure the current at both CT marshalling boxes and at the relay terminals at control room and observe the spill current/ voltage of considerable magnitude corresponding to the injected primary current. (a pictorial example is attached herewith at Annexure)
14. After ensuring the above stop injecting the current. The CT connection should be as per polarity thus proved.
15. Repeat the test for other two phases.
16. Repeat the same procedure for other bays of the same bus bar by taking adjacent bay (whose stability check completed) as the reference in order to inject max. possible current in the primary using primary injection test kit.
17. Repeat the above procedure for other bus bars also.
18. Restore the system to normal conditions.

7.5 Scheme Checking of bus bar protection & DC trip logic. (New substation & Bay extension)

7.5.1 Two Main protection philosophy

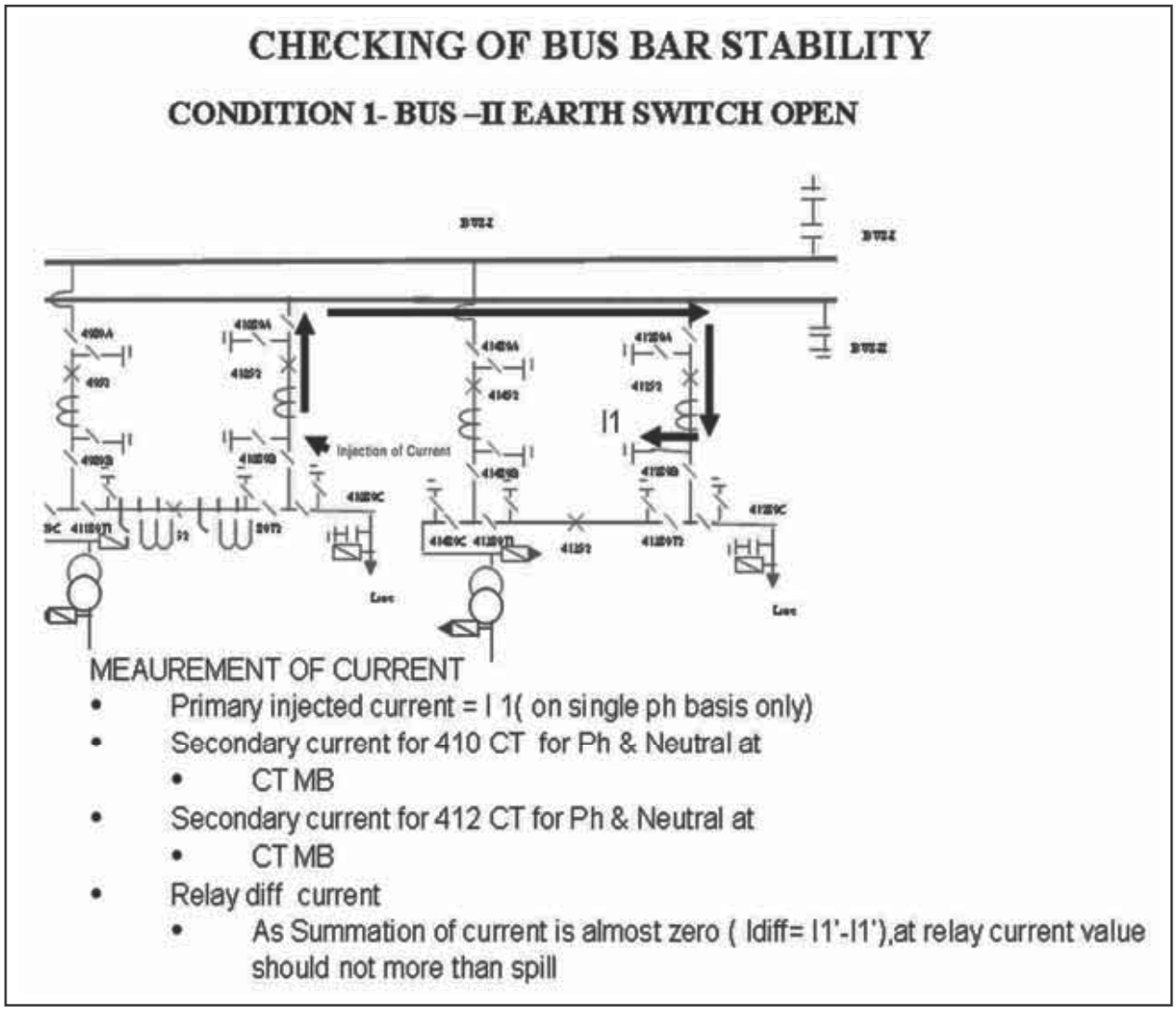
1. Test the relay by secondary injection.
2. Check the tripping of the corresponding breakers and non tripping of other bus breakers and tie breakers.
3. Check initiation of LBB relays of the breakers corresponding to particular bus.
4. Check blocking of the bus bar protection on operation of CT supervision relay.
5. Ensure that operation of CT supervision relay should not initiate bus bar tripping.
6. Check initiation of bus bar tripping by operation of corresponding breaker LBB relays.(Back Trip feature)
7. a. Check the direct tripping scheme on operation of bus bar protection (only if tie breaker is in open condition)
   b. Direct trip signal should not go on operation of Bus bar protection if the Tie CB is in close condition.
8. Test CT supervision relays and ensure for triggering control panel annunciation and event logger triggering as per approved scheme.
9. Check bus bar IN/OUT switch for correctness of wiring as per the drawing.

7.5.2 Main and Check zone philosophy

1. Test the both main and check zone relays by secondary injection.
2. Ensure bus bar should not initiate tripping for operation of either main or check zone alone.
3. For checking the tripping scheme, bypass the check zone contact.
4. Check the tripping of the corresponding breakers and non tripping of other bus breakers and tie breakers.
5. Check initiation of LBB relays of the breakers corresponding to particular bus.
6. Check blocking of the bus bar protection on operation of CT supervision relay.
7. Ensure operation of CT supervision relay should not initiate bus bar tripping.
8. Check initiation of bus bar tripping by operation of corresponding breaker LBB relays.(Back Trip feature)
9. a. Check the direct tripping scheme on operation of bus bar protection (only if tie breaker is in open condition)
   b. Direct trip signal should not go on operation of Bus bar protection if the Tie CB is in close condition.
10. Test CT supervision relays and ensure for triggering control panel annunciation and event logger triggering as per approved scheme.
11. Check bus bar IN/OUT switch for correctness of wiring as per the drawing.
12. Repeat the above for check zone and CT supervision schemes.

7.6 AMP Testing of bus bar protection and scheme

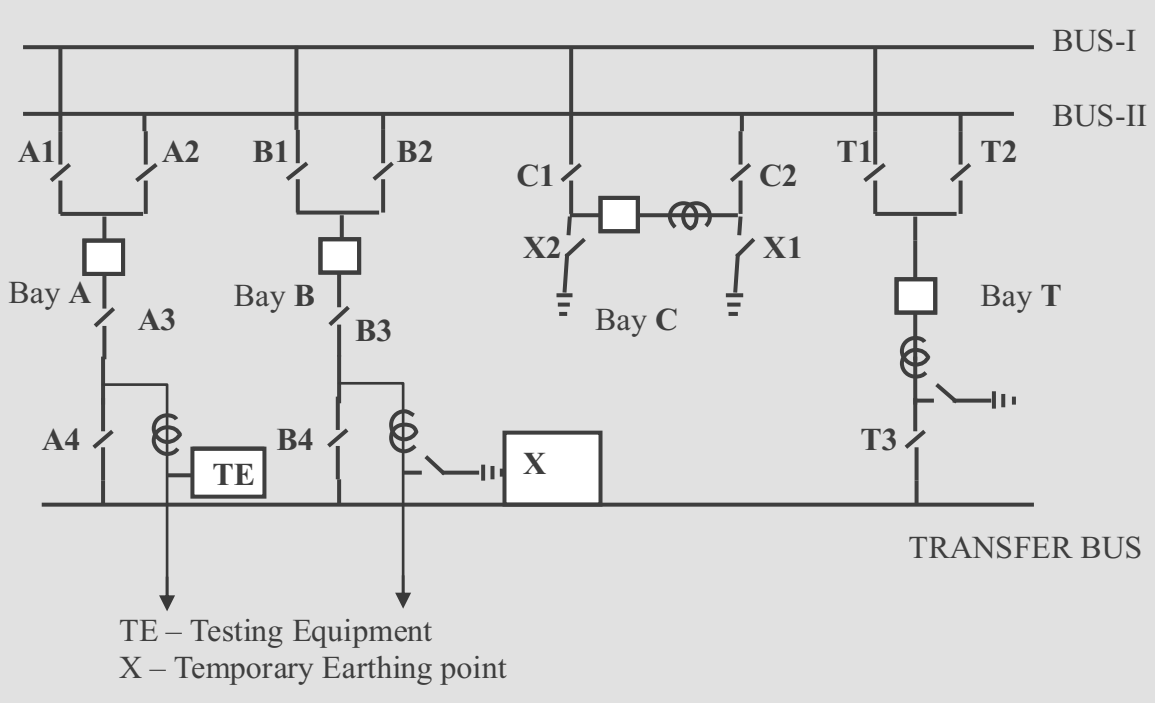
1. Arrange bus bar shutdown for off line testing. Preferably the bus bar isolation should done through bus bar protection trip relay.
2. Insert the test block after shorting the incoming current terminals for on line testing.
3. Test the relays.
4. For off line testing:
   i. Check tripping scheme of bus bar (2 main/ main and check scheme), in case of main and check scheme, operation of one relay should not initiate bus bar trip.
   ii. Check initiation from LBB of corresponding bays of bus bar
   iii. Check initiation of LBB of corresponding bays of bus bar
   iv. Check annunciations and DR triggering as per the drawings
5. After completion of the above checks, normalise the connections and take bus bar into service.



7.7 Double main transfer scheme (400kV/220kV):

For the double main transfer scheme, bus bar protection shall preferably be Main and check zone scheme because of dependency on CT switching between BUS-I & II bus bar protections.

7.7.1 Primary injection and bus bar differential stability test (New Substation):



1. Take one of the bays (**A**) as the reference
2. Select other bay (**B**) for testing the differential stability. Inhibit the tripping of the breakers in bay **A** and **B** from control room due to operation of distance or over current protection caused by primary current injection.
3. Earth the bus bar after CT at X using earth rods on bay **B**.
4. Preferably connect the primary injection testing kit to the CT terminal pad of reference bay (A) after opening the jumper from line side.
5. Ensure that bus or line connected to bay B shall not be earthed other than at X.
6. Close the isolators A1 in bay A, B1 in bay B and Ensure that corresponding CT switching relays operated for checking the bus bar differential stability of BUS-1.
7. Close isolator A3 and breaker in bay A and isolator B3 and breaker in bay B.
8. Measure the resistance of the CT cores (used for main and check zone) towards CT in the CT switching cubicle and it shall be equal to the sum of resistance of the CT core and lead resistance. If the resistance towards CT core is more, then check the CT circuit and corresponding CT switching relay.

9 Inject primary current using primary injection testing kit from bay **A**.

10. Measure the current at both CT marshalling boxes (both cores used for main and check zone) and relay terminals in the control room in case of low impedance protection or measure voltage across cores in CT MB and differential relay terminals incase of high impedance differential protection.

11. The measured spill voltage/current at relay terminals shall be very less compared to the primary current/corresponding voltage (around 2%).

12. If Spill current/voltage is more (almost twice the CT secondary current) at the relay terminals.

    a. Stop injecting the primary current and Check CT paralleling connections after the CT switching relay. If every thing is correct then reverse the secondary terminals of CT at bay '**B'.**

    b. Start injecting primary current and Measures the current/voltage at both CT marshalling boxes and relay terminals at control room and observe the spill current/ voltage magnitude shall be very less compared to the set value (around 2%).

13. Stop injecting primary current and then create in-zone fault in primary side (by providing earthing between two CTs).

14. Start injecting primary current and Measures the current at both CT marshalling boxes (both cores used for main and check zone) and at the relay terminals at control room and observe the spill current/ voltage of considerable magnitude corresponding to the injected primary current.

15. After ensuring the above stop injecting the current and normalize the system.

16. Open isolators A1 on bay A& isolator B1 on bay B and ensure that corresponding CT switching relay got resetted.

17. Close isolators A2 in bay A, B2 in bay B for connecting the feeder to bus-2 and ensure the operation of corresponding CT switching relay for checking the bus bar differential stability of BUS-2.

18. Repeat the above sequence from 9 to 16

19. Open isolators A2 on bay A& isolator B2 on bay B and ensure that corresponding CT switching relays got resetted.

20. Repeat the test for other two phases.

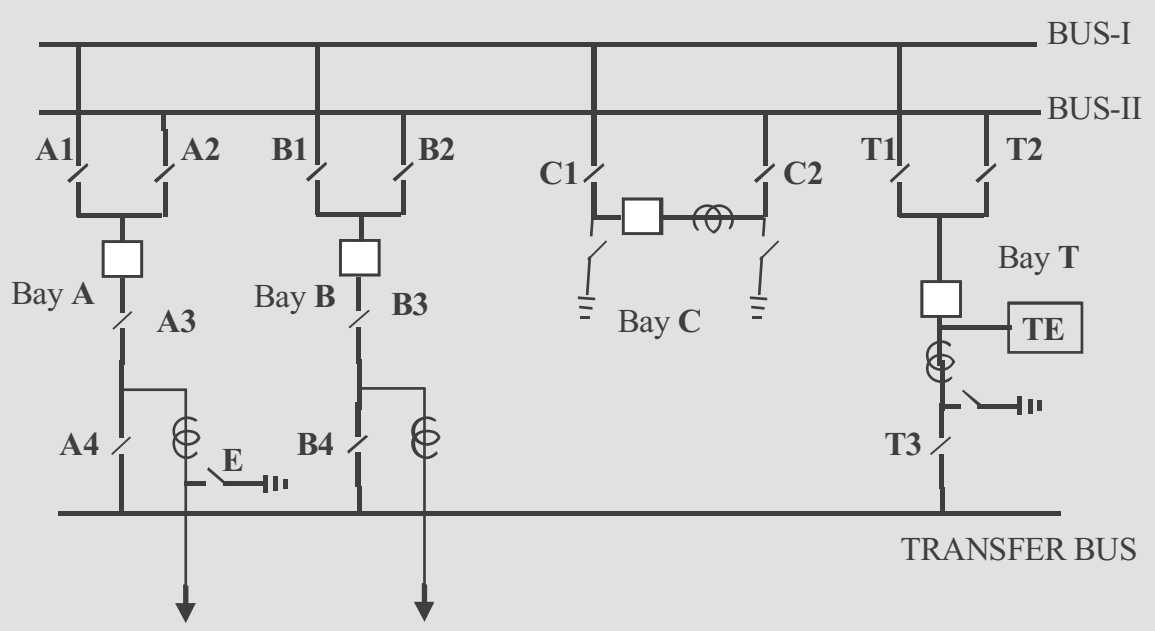
21. Above said procedure shall be carried out between Phase-Phase (R-Y &Y-B) by injecting in one phase and joining with other phase for using it as return path instead of earth return for one set of CTs (Two bays).

22. Repeat the same procedure for other bays including transfer bus coupler bay w.r.t Bus-I & II.

7.7.2 Checking of differential protection stability w.r.t bus coupler:

1. Take one of the bay A as the reference bay
2. Close isolator A1 in bay A to check differential stability of the bus coupler w.r.t Bus-1.
3. Close isolator C1 and breaker in bus coupler bay C and earth at X1 in bay C.
4. Adopt the same procedure as explained above for stability testing of normal bays.
5. Open breaker & isolators A1 in bay **A** and Open breaker & isolator C1 on bay C,
6. Close isolator A2 & breaker in bay **A** and isolator C2 & breaker on bay C to check differential stability of bus coupler CT w.r.t Bus - 2.
7. Earth bay C at X2.
8. Adopt the same procedure as explained above for stability testing of normal bays.
9. Open the breaker and isolator in bay A & bay C and open earthing on bay C and normalize the system.

7.7.3 Checking of differential protection stability w.r.t Transfer bus:



1. Before carrying out this test, ensure that differential protection stability with respect to Bus –I & Bus-II has been carried out on all bays including transfer bus coupler bay.
2. For checking the differential protection stability w.r.t to transfer bus, take one of the bays as reference bay and inject current from transfer bus coupler bay CT.
3. Close isolator T3 and breaker in transfer bus coupler bay T.
4. Close isolator A4 to check stability w.r.t transfer bus and ensure the operation corresponding CT switching relay.
5. Keep the normal/transfer switch of bay A in transfer mode.

6. Measure the resistance of the CT cores towards CT in the CT switching cubicle and it shall be equal to the resistance of the CT core and lead resistance. If the resistance towards CT core is more, then check the CT circuit and corresponding CT switching relay.

7. Inject primary current using primary injection testing kit from bay T.

8. Measure the current at both CT marshalling boxes and relay terminals in the control room in case of low impedance protection or measure voltage across cores in CT MB and differential relay terminals incase of high impedance differential protection.

9. The measured spill voltage/current at relay terminals shall be very less compared to the primary current/corresponding voltage (around 2%).

10. If Spill current/voltage is more (almost twice the CT secondary current) at the relay terminals.

    a. Stop injecting the primary current and Check CT paralleling connections after the CT switching relay. If every thing is correct then reverse the secondary terminals of CT at bay **'T' only while testing first bay.**

    b. Start injecting primary current and Measures the current/voltage at both CT marshalling boxes and relay terminals at control room and observe the spill current/ voltage magnitude shall be very less compared to the set value (around 2%).

11. Stop injecting primary current and then create in-zone fault in primary side (by providing earthing between two CTs)

12. Start injecting primary current and Measures the current at both CT marshalling boxes and at the relay terminals at control room and observe the spill current/ voltage of considerable magnitude corresponding to the injected primary current.

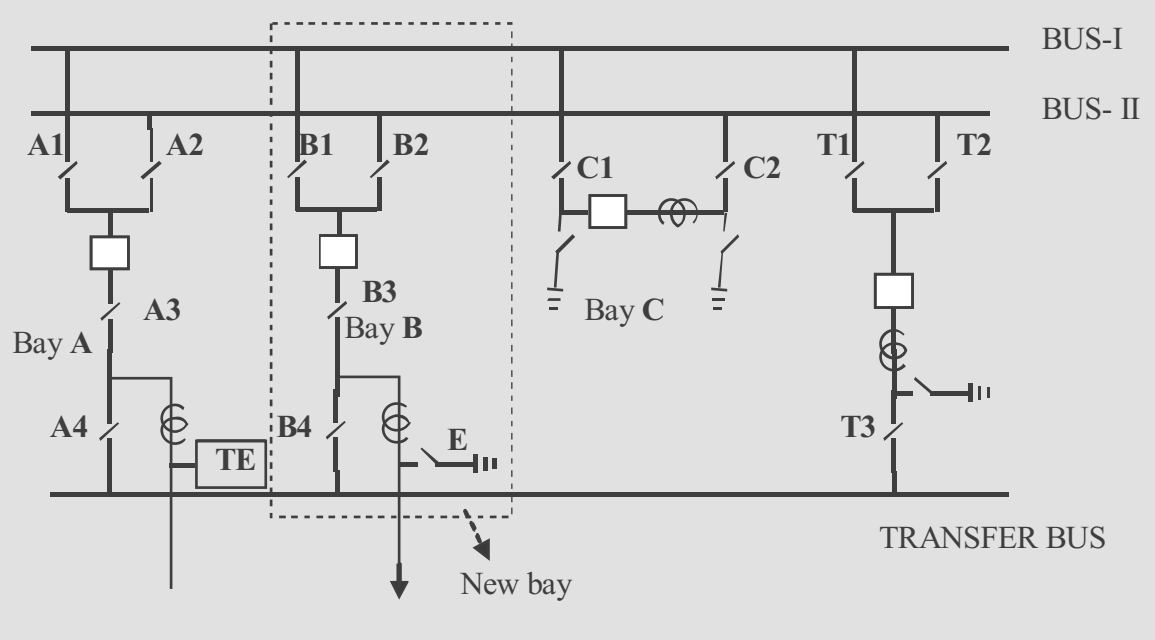
13. After ensuring the above stop injecting the current and normalize the system.

14. Open isolators and earthing which are closed for testing and keep N/T switches in normal position.

15. Repeat the test for other two phases.

16. Repeat the above procedure for other bays to ensure the operation of CT switch relay for transfer bus.

7.7.4 Primary injection and bus bar differential stability test for Bus-I (Bay extension in existing Substation)



1. Arrange the shutdown of the one of the existing feeder or take a bay which is already in out of service as reference bay (A).
2. Arrange shutdown of the bus bar (Bus-I).
3. Close the isolator of new bay B (B1) and ensure the operation of corresponding CT switching relay.
4. Measure the resistance of the CT cores towards CT in the CT switching cubicle and it shall be equal to the resistance of the CT core and lead resistance. If the resistance towards CT core is more, then check the CT circuit and corresponding CT switching relay.
5. Close the isolator B3 and breaker in bay B and isolators A1, A3 and breaker in bay A for connecting the CTs to Bus-I.
6. Inject primary current using primary injection testing kit from bay A.
7. Measure the current at both CT marshalling boxes (both cores used for main and check zone) and relay terminals in the control room in case of low impedance protection or measure voltage across cores in CT MB and differential relay terminals incase of high impedance differential protection.
8. The measured spill voltage/current at relay terminals shall be very less compared to the primary current/corresponding voltage (around 2%).
9. If Spill current/voltage is more (almost twice the CT secondary current) at the relay terminals:

a. Stop injecting the primary current and check CT paralleling connections after the CT switching relay. If every thing is correct then reverse the secondary terminals of CT at bay **'B'.**

b. Start injecting primary current and Measures the current/voltage at both CT marshalling boxes and relay terminals at control room and observe the spill current/ voltage magnitude shall be very less compared to the primary current/corresponding voltage (around 2%).

10. Stop injecting primary current and then create in-zone fault in primary side (by providing earthing between two Cts.

11. Start injecting primary current and Measures the current at both CT marshalling boxes (both cores used for main and check zone) and at the relay terminals at control room and observe the spill current/ voltage of considerable magnitude corresponding to the injected primary current.

12. After ensuring the above stop injecting the current and normalize the system.

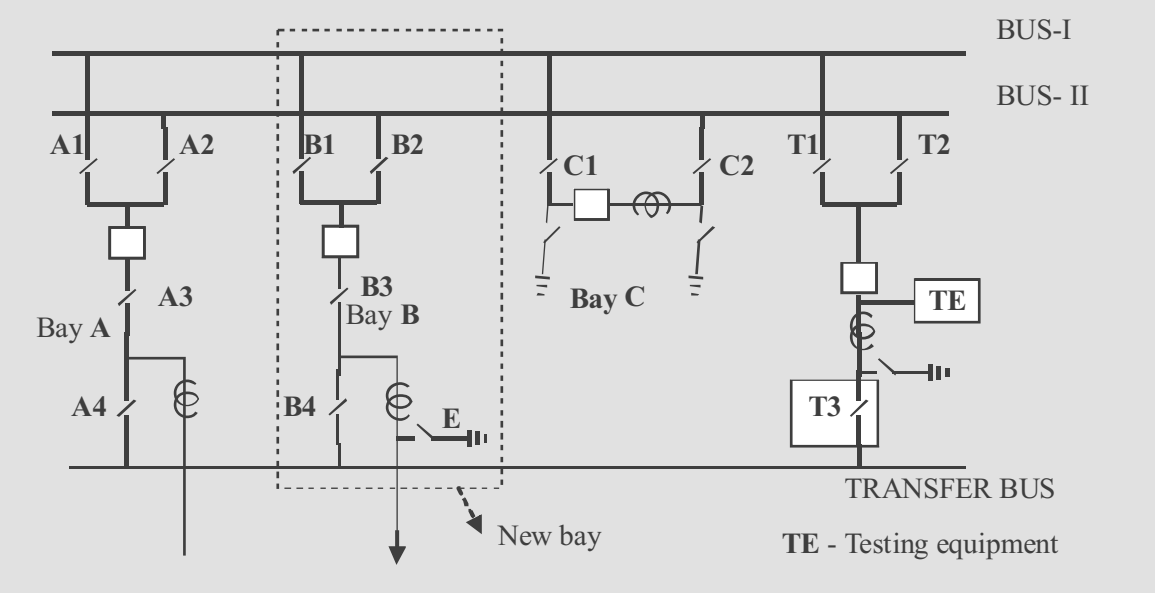
13. Open the breaker and isolator A1 in bay A and breaker and isolator B1 in bay B.

14. Repeat the above procedure for other phases.

15. Repeat the testing of the other newly adding bays (if any) taking this stability tested new bay (B) as the reference bay to avoid outage of old reference bay A for longer periods.

16. Repeat the above procedure of stability testing for new bay w.r.t. Bus-II by selecting of appropriate section (i.e. isolators A2 & B2) with Bus-II shutdown.

7.7.5 Primary injection and bus bar differential stability test w.r.t to transfer bus (Bay extension in existing Substation):



1. Arrange shutdown of transfer bus.
2. Take transfer bus T as reference bus.
3. Close isolator B4 and keep N/T switch in transfer position and ensure the operation of corresponding CT switching relay.
4. Measure the resistance of the CT cores towards CT in the CT switching cubicle and it shall be equal to the resistance of the CT core and lead resistance. If the resistance towards CT core is more, then check the CT circuit and corresponding CT switching relay.
5. Close isolator T3 and breaker in bay T.
6. Inject primary current using primary injection testing kit from bay T.
7. Measure the current at both CT marshalling boxes and relay terminals in the control room in case of low impedance protection or measure voltage across cores in CT MB and differential relay terminals incase of high impedance differential protection.
8. The measured spill voltage/current at relay terminals shall be very less compared to the set value (around 2%).
9. If Spill current/voltage is more (almost twice the CT secondary current) at the relay terminals.
    a. Stop injecting the primary current and Check CT paralleling connections after the CT switching relay.
    b. Start injecting primary current and Measures the current/voltage at both CT marshalling boxes and relay terminals at control room and observe the spill current/ voltage magnitude shall be very less compared to the set value (around 2%).
10. Stop injecting primary current and then create in-zone fault in primary side (by providing earthing between two CTs.
11. Start injecting primary current and Measures the current at both CT marshalling boxes and at the relay terminals at control room and observe the spill current/ voltage of considerable magnitude corresponding to the injected primary current.
12. After ensuring the above stop injecting the current and normalize the system.
13. Start injecting primary current and measure the current/voltage at relay terminals and ensure that its magnitude is very less compared to the primary current.
14. Open isolators and earthing which are closed for testing and keep N/T switches in normal position.
15. Repeat the test for other two phases.

7.8 Scheme checking of bus bar protection & DC trip logic. (New substation & Bay extension)

7.8.1 Two Main protection philosophy

1. Test the relay by secondary injection.
2. Check the tripping of the corresponding selected breakers and bus coupler breaker (in case of Bus-I & Bus-II only) and non tripping of other breakers.
3. Check initiation of LBB relays of the selected breakers corresponding to particular bus.
4. Check blocking of the bus bar protection on operation of CT supervision relay.
5. Ensure that operation of CT supervision relay should not initiate bus bar tripping.
6. Check initiation of bus bar tripping by operation of corresponding breaker LBB relays.(Back Trip feature)
7. Check the direct tripping scheme on operation of bus bar protection.
8. Test CT supervision relays and ensure for triggering control panel annunciation and event logger triggering as per approved scheme.
9. Check bus bar IN/OUT switch for correctness of wiring as per the drawing.

7.8.2 Main and Check zone philosophy

1. Test the both main (i.e. Bus-I, Bus-II and Transfer Bus) and check zone relays by secondary injection.
2. Ensure bus bar should not initiate tripping for operation of either main or check zone alone.
3. For checking the tripping scheme, bypass the check zone contact.
4. Check the tripping of the corresponding selected breakers and bus coupler breaker (in case of Bus-I & Bus-II only) and non tripping of other breakers.
5. Check initiation of LBB relays of the breakers corresponding to particular bus.
6. Check blocking of the bus bar protection on operation of CT supervision relay.
7. Ensure operation of CT supervision relay should not initiate bus bar tripping.
8. Check initiation of bus bar tripping by operation of corresponding breaker LBB relays.(Back Trip feature)
9. Check the direct tripping scheme on operation of bus bar protection.
10. Test CT supervision relays and ensure for triggering control panel annunciation and event logger triggering as per approved scheme.
11. Check bus bar IN/OUT switch for correctness of wiring as per the drawing.
12. Repeat the above for check zone and CT supervision schemes.

7.9 AMP testing of bus bar protection and scheme

1. Arrange bus bar shutdown for off line testing and scheme checking.
2. While switching all the loads from one bus to other bus observe the operation and resetting of corresponding CT switching relays in accordance to the operation of isolators.
3. CT switching discrepancy alarm shall not appear in the control panel.
4. Check tripping scheme of bus bar (2 Main/ Main and check scheme), in case of main and check scheme, operation of one relay should not initiate bus bar trip.
5. Check annunciations and DR triggering as per the drawings
6. After completion of the above checks, normalise the connections and take bus bar into service.
7. Insert the test block after shorting the incoming current terminals for on line testing.
8. Test the relays.

PRE-COMMISSIONING FORMATS FOR TRANSFORMER

I. GENERAL DETAILS

DETAILS	
Region:	**Sub-Station:**
LOA No. :	**Make:**
Sr. No.:	**Type:**
Equipment identification: (For e.g. ICT-I-R phase)	
Year of Manufacture:	**Rating:**
Voltage Ratio :	**Cooling Type:**
Type of Neutral Grounding:	**Oil Make:**
Oil type:	**Oil quantity:**
Quantity of Radiator	**% Impedance details for all tap (To be enclosed in a separate sheet)**
Date of Receipt at site:	**Date of Starting of Erection:**
Date of Completion of Erection and Oil filling:	

II. CHECK LIST OF ELECTRICAL TESTS CARRIED OUT FOR TRANSFORMER

Sl. No.	Name Of Test	Testing Kit Details			Test Results (Ok/Not Ok)
		Make	Rating/ Measuring Range	Date Of Last Calibration	
1	Core Insulation Measurement (To be performed upon arrival)				
2	Insulation Resistance Measurements Of Bushing CTs				
3	Continuity Test Of Bushing CTs				
4	Secondary Winding Resistance Of Bushing CTs				
5	Polarity Test Of Bushing CTs				
6	Current Ratio Test				

Sl. No.	Name Of Test	Testing Kit Details			Test Results (Ok/Not Ok)
		Make	Rating/ Measuring Range	Date Of Last Calibration	
7	Magnetizing Curves Performance				
8	Measurement of Resistance of Earth Pit and Main Grid				
9	Frequency Response Analysis				
10	Magnetization Current of Windings				
11	Vector Group Test & Polarity Check				
12	Short Circuit Impedance Test				
13	Magnetic Balance Test (Not applicable for 1-ø)				
14	Floating Neutral Voltage Measurement				
15	Magnetization Current Test				
16	Voltage Ratio Test				
17	Core Insulation test after oil Circulation				
18	C & Tan δ Measurement Of Bushing				
19	C & Tan δ Measurement Of Windings				
20	Insulation Resistance Measurement of Winding				
21	Insulation Resistance Measurement of Cable				
22	Measurement of Winding Resistance				
23	Protection And Alarm Tests				
24	Stability Test Of Differential And REF Protection				
25	Contact Resistance Measurement				

Comments of Commissioning Team on test Results:

Comments of Corporate-OS on test Results (To be attached separately)

Manufacturer Recommendation on test Results (To be attached separately)

Signature:	**Signature:**	**Signature:**	**Signature:**
Name:	**Name:**	**Name:**	**Name:**
Desgn.:	**Desgn.:**	**Desgn.:**	**Desgn.:**
Organization: (Supplier Representative) (Wherev Applicable)	**(Erection Agency)**	**(POWERGRID Site I/C)**	**(POWERGRID Commg. Team) Members:**

III. CHECKS AFTER RECEIPT OF TRANSFORMER AT SITE :

A) *N2/ Dry Air Pressure & Dew Point Record*

Inspection Action	Date Of Meas.	N2/ Dry Air Pressure	Dew Point	Ambient Temperature	Remarks
During dispatch at factory					
After receipt at site					
Storage at site before commissioning					

Note:

i. Refer **graph 2.1.3 fig.1 in** POWERGRID doc no d-2-03-xx-01-01 rev-01 for maintaining N2/ Dry air pressure and dew point during storage(To be maintained in a separate sheet/ Register)

ii. Any noticeable drop in N2 during storage at site is observed, then matter to be referred to Manufacturer and CC-OS).

iii. If Transformer is received with zero N2 pressure then matter to be referred to Manufacturer and Corporate-OS prior to erection

B) *Impact Recorder Analysis*

No of Impact Recorder installed: _____

Make of Impact Recorder(s) _____

Type of Impact Recorder(s) _____

Date of removal of impact recorder from equipment _____

Sl.No.	Check Points	Status		Remarks
1	Functionality of Impact recorder at the time of dismantling from main unit	**On**	**Off**	
2	Joint data downloading carried out at site immediately after receipt	**Yes**	**No**	
3	Analysis of joint report received from manufacturer before charging	**Yes**	**No**	

Note:

i. Manufacturer to provide necessary software and downloading tools to respective sites so that data downloading can be carried out at site jointly by POWERGRID & Manufacturer

ii. Permissible limit for maximum shock in any direction shall be 3g.

iii. Impact Recorder should be switched off and detached from the Transformer when the main unit has been placed on its foundation.

C) *Core Insulation Test (Immediately after Receipt at Site)*

Shorting link between CC, CL & G to be removed and IR value to be taken between CC-G, CL-G & CC-CL by applying 1 kV DC

Terminals	Insulation Value	Terminals	Insulation Value
CC-G		CC-CL	
CL-G		Semi-shield –G (if provided) at 1 kV	

Note:

i. Permissible value > 500 MΩ
ii. In case core insulation values are less than the permissible limit matter to be referred to OEM for corrective measures and same to be checked during internal inspection for any abnormality
iii. Ensure shorting of CC-CL & G after the completion of the testing

D) ***Internal Inspection***

SL. No.	Internal Inspection	Status	
		Yes	No
1	Details photographs of all visible parts /components are taken during internal inspection.(refer procedure 2.3)		
2	In case of any abnormality observed during internal inspection, matter to be referred to manufacturer, CC-QA & I , CC-ENGG and CC-OS		

Details of abnormality observed during internal inspection (if noticed) _____

_____

_____

IV. TRANSFORMER ERECTION

A) ***Checks / Precautions During Erection :***

Sl. No.	Description	Remarks
1	Total Exposure of Active part of Tr ansformer to atmosphere in hours (To be kept minimum)	
2	Dew point of dry air generator / dry air cylinders, during exposure of active part of Transformer	
3	Available of Oxygen in % before entering in Transformer tank	
4	N2/ Dry air pressure in PSI while Transformer is kept sealed in between different erection activities	
5	Ensure Leakage test of Air cell / bellow carried out	
6	Check Hermitically sealing is intact in all Bushings by OEM / Expert	
7	Storage of blanking plates	

B) ***Evacuating And Oil Filling***

a) Before filling oil, each drum has been physically checked for appearance and presence of water .

Yes	No

b) Details of oil filter machine (As per latest TS of Transformers)

Make _____ Capacity_____

Sl.No	Description Of Works	Remarks / Reading
1	Changing of Lubricating oil of vacuum pump	
2	Cleaning/ Replacement of Filter packs	
3	Flushing of whole filter machine and pipes with fresh oil	
4	Vacuum obtained without load (milli bar)	

c) Vacuum pump for evacuation of transformer

Sl.No	Description of Works	Remarks / Reading
1	Changing of Lubricating oil of vacuum pump	
2	Vacuum obtained without load (milli bar)	
3	Diameter of vacuum hose (50 mm minimum)	
4	Employ of Dry ice chamber	

d) Oil storage tank

Capacity_____ Quantity_____

Sl.No	Description of Works	Remarks / Reading
1	Silica gel breather provided in the tank	
2	Any opening left uncovered	
3	Inside painted or not	
4	Cleanliness of inside of pipes/ hoses to the storage tank	
5	Healthiness of valves /flanges for pipe connection	

e) Exposure during erection

Sl.No	Description of Works	Remarks / Reading
1	First day exposure (in hrs)	
2	Second day exposure (in hrs)	
3	Third Day exposure (in hrs)	
4	N2 pressure applied after each days erection work (in PSI)	
5	Ambient Temperature (in degC)	
6	Average Relative Humidity	
7	Weather Condition(Rainy / Stormy / Cloudy / Sunny)	

Note:

i. Erection activities preferably to be carried out in sunny weather and RH<60%

f) N2/ Dry Air sealing in case of delay in oil filling
(Dry air shall be preferred for human safety)

Sl.No	Description of Works	Remarks / Reading
1	N2/ Dry air admitted from bottom valve	
2	Valve at diametrically oppos ite end at top kept open	
3	No. of Cylinders used for building up to 4- 5 psi(~0.3kg/cm^2)	

g) Leakage Test through pressure

Sl.No	Inspection Actions	Date	Time	Remarks / Reading
1	Fill dry N2/ dry air till pressure of 4- 5psi (~0.3kg/cm^2) achieved			
2	To be kept for 24 Hrs			
3	In case pressure remain same, check for dew point			
4	If dew point is achieved, proceed for evacuation			
5	**In case of drop in pressure, attend the leakages and repeat the pressure test**			
6	If dew point is not OK, dry air/ N2 cycle to be carried out till desired dew point is achieved			

h) Schedule for Vacuum & Tightness Test

Sl.No	Inspection Actions	Date	Time	Remarks / Reading
1	Starting of evacuation on complete unit			
2	Stopping of evacuation below the pressure of 5 kPa (50 mbar)			
3	Pressure P1 in kPa after 1 hour of stopping evacuation			
4	Pressure P2 in kPa after half an hour of reading pressure P1			
5	Leakage = (P2-P1) x V , V= Oil quantity in Cu mtr ***If leakage<3.6, continue evacuating** **If leakage > 3.6, attend leakage and repeat process as per Sr. No. 1 to 4.**			
6	Continue vacuum till 0.13kPa(1 Tor) or below achieved			
7	Break of vacuum *** Vacuum process to be continued after reaching fine vacuum for 24 hrs Up to 145 KV, 48 hrs for 220kV and 72 hrs for 420 kV and above**			

i) Record of drying out process (if carried out)

Sl.No	Activity	Date	Time	Remarks / Reading
1	**First Nitrogen/Dry air purging cycle**			
	Pressure of Nitrogen/Dry air 0.15 kg/cm2			
	Dew Point after 48 Hrs			
	Temperature with heaters on condition around the Transformer Tank(Refer procedure)			
2	**First Vacuum cycle**			
	Vacuum achieved			
	Rate of condensate collection(Hourly basis)			
	Duration of vacuum after achieving 1 to 5 torr			
3	**Second Nitrogen/Dry air purging cycle**			
	Pressure of Nitrogen/Dry air 0.15 kg/cm2			
	Temperature with heaters on condition around the Transformer Tank(Refer procedure)			
	Dew Point after 24 Hrs			

Note:

i. If dew point is within the permissible limit oil filling under vacuum may be started otherwise vacuum/ Nitrogen purging with heating cycle to be continued till desired dew point is achieved.

j) Schedule for Oil filling and Settling

Sl. No	INSPECTION ACTIONS	DATE	TIME	REMARKS / READING
1	Ensure measurement of Particle counts during oil filtration in oil tanks(If specified in the contracts)			
2	Oil Filling in Main Tank			
3	Oil filling in Conservator tank			
4	Oil filling in diverter switch			
5	Hot oil circulation (minimum 2 cycles or depending on oil parameters) at oil temperature 60-65 deg C.			
6	Start of oil settling			
7	End of oil settling *** Minimum settling time to be given 24 hrs for 145 KV , 48 hrs for 220kV and 420kV and 72 hrs for 765 kV & above**			

V. PRE-COMMISSIONING CHECKS:

Sl. No.	Description Of Activity	Status		Deficiencies, If Any
		Yes	No	
1	ICT and its Auxiliaries are free from visible defects on physical Inspection			
2	All fittings as per out line General Arrangement Drawing			
3	Check Main Tank has been provided with double earthing			
4	Check neutral is grounded through separate connections. Ensure metallic requirements as per specification (e.g. Cu) in earthing strips used			
5	Check that Marshalling Box, T/C Driving Gear, Diverter, Radiator Bank Pump & Fan Motor etc. has been earthed			
6	All nuts and bolts are tightened correctly as per specified torque (as per manufacturers recommendation)			
7	Check tightness of Terminal Connectors			
8	Check leveling of Transformer and its accessories			
9	Erection Completion Certificate along with list of outstanding activities reviewed			
10	Any Paint removed / scratched in transit has been touched up			
11	Bushings are clean and free from physical damages			
12	Oil level is correct on all Bushings			
13	Check brazing of all Bushings Leads			
14	Check oil leakage through any Joints / Valves etc.			
15	Check oil drain valves are properly closed and locked			
16	Check oil level in Main / OLTC Conservator tank			
17	Check oil level at conservator matches with oil temperature of transformer			
18	Check Gear box oil level in OLTC (if applicable)			
19	Check OTI and WTI pockets and replenish the oil, if required			
20	Check all valves for their opening & closing sequence			
21	Check the colour of the breather silica gel			
22	Check availability of oil in the breather cup			
23	Check all rollers are locked and tack welded with rails (wherever applicable)			

Sl. No.	Description Of Activity	Status		Deficiencies, If Any
		Yes	No	
24	Check tightness of bolt if main unit placed directly on foundation and not on rollers			
25	Check busing test tap is grounded			
26	Check the operation of flow sensitive shut off valve between main tank & conservator, if any			
27	Check the functioning of SPR (Sudden pressure relay) ,if any			
28	Check no debris, loose T & P and oil strains on and around the Transformer			
29	Check door seals of Marshalling Box is intact and all cable gland plates unused holes are sealed			
30	Check that pressure relief valve is correctly mounted			
31	Ensure unused secondary cores of Bushing CT's, if any, has been shorted			
32	Check CT star point has been formed properly and grounded at one end only as per scheme			
33	Check that permanent and adequate lighting arrangements are ready			
34	Check that labeling and identification is permanent and satisfactory			
35	Check that Buchholz Relay is correctly mounted with arrow pointing towards conservator			
36	Check cables are properly fixed and ensure cable entry at the bottom			
37	Ensure all Power and Control cable Terminals are tightened			
38	Check all cables and Ferrules are provided with Number as per Cable Schedule (Cross Ferruling to be checked)			
39	Check that all cables are correctly glanded			
40	Check external cabling from Junction Box to Relay / Control Panel completed			
41	Check that air has been released from the Radiators and their headers/OLTC Buchholz relay/Main tank/tank/Bushing turrets etc			
42	Check Fire Protection System & Emulsifier systems is adequate & ready			
43	Check that CC-CL & G are shorted			
44	Check that neutral connection has twin conductor in case of single phase unit			
45	Check insulation sleeves are provided in case of tertiary bus arrangement			
46	Check that all radiator bank valves on top and bottom headers are open			

Sl. No.	Description Of Activity	Status		Deficiencies, If Any
		Yes	No	
47	Change over operation of ac supply from source- I to source-II checked			
48	Check the flanges of bushing & OLTC for any crack after fixing			
49	Calibration of OTI & WTI performed as per procedure			
50	Ensure RTCC is commissioned and kept in service			
51	Ensure Remote OTI and WTI data transfer to control room is taking place			
52	Ensure On-Line DGA is commissioned and kept "ON"			
53	Ensure On-Line Dry out system is commissioned and kept "ON"			
54	Check various interlocks provided with Fire Fighting as per the schematic Ref. Drg. No._____	Description of Interlocks		Checked

VI. MEASUREMENT OF EARTH RESISTANCE OF ELECTRODE

Location	Value
With Grid (Earth Pit -1)	
Without Grid (Earth Pit -1) (Neutral Earth)	
With Grid (Earth Pit -2)	
Without Grid (Earth Pit -2) (Neutral Earth)	

Note: Permissible limit $< 1\ \Omega$

VII. PRECOMMISSIONING TESTS AFTER READINESS OF THE TRANSFORMER

A) Frequency Response Analysis (FRA)

Sl.No	Description	Yes	No	Remarks
1	Carried out after completion of all commissioning activities			
2	Factory FRA test report in soft form available at site			
3	Interpretation of test results carried out			
4	Test results matching with the factory results			

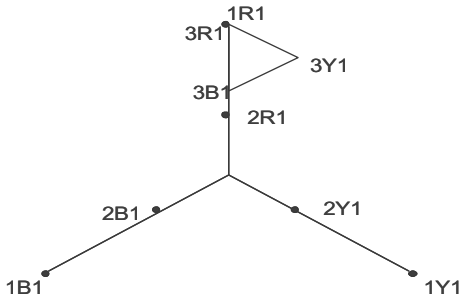
Note:- Measurement to be carried out at Minimum, Maximum and Nominal Tap for all combination of HV & IV and Nomenclature to be made similar as mentioned in the procedure documents

B) Vector Group Test & Polarity Checking

a) Vector Group Checks For 3Φ Transformer And Bank Of 1Φ Transformer After Tertiary Formation

Connect Neutral Point with earth, join 1 RI and 3 R1 Terminals and apply 415 V. 3-phase supply to HV Terminals

Terminals	Voltage Measured (Volts)	Terminals	Voltage Measured (Volts
1R1 – 1Y1		3R1- N	
1Y1 – 1B1		3Y1 – N	
1B1 – 1R1		3B1 – N	
3Y1 – 1B1		2R1- N	
3Y1 – 1Y1		2Y1 – N	
		2B1 – N	

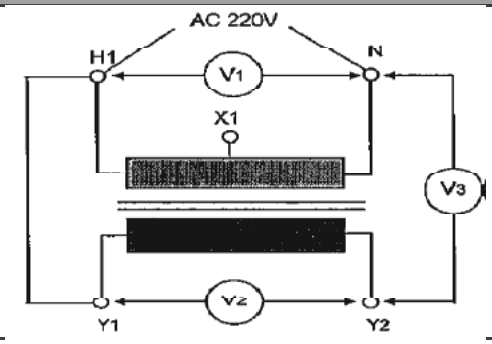


Vector group Ynaod11 is confirmed and polarity verified

If 2R1 – N = 2Y1 – N = 2B1 – N = constant
3R1 -N > 3Y1 - N > 3B1 - N
3Y1 - 1B1 >3Y1 - 1Y1

b) Polarity Checks for 1Ø unit

Apply 1-Ø supply to HV(1.1) and Neutral(2) Terminals

Terminals	Voltage Measured (Volts)	Remarks
HV-N, V1		
LV1(Y1)-LV2(Y2) ,V2		
LV2(Y2)-N,V3		
Remarks :If V1> V3= Subtractive,V1<V3= Additive		

C) Magnetic Balance Test (Not Applicable For Single Phase Units)

Apply single phase 230 V across one phase of HV winding terminal and neutral then measure voltage in other two HV terminals across neutral. Repeat the test for each of the three phases.

Apply 1- 230v Ac Across (1)	Voltage Measured In Volts		Remarks
	Between (2)	Between (3)	
2R1 – N:	2Y1 – N:	2B1 – N:	
2Y1 – N:	2R1 – N:	2B1 – N:	
2B1 – N:	2Y1 – N:	2R1 – N:	

Note:

i. (1)= (2) + (3), Approx.

ii. When outer phase is excited, voltage induced in the center phase shall be 50 to 90% of the applied voltage. However, when the center phase is excited then the voltage induced in the outer phases shall be 30 to 70% of the applied voltage.

D) Floating Neutral Voltage Measurement

a) Disconnect the Transformer neutral from the ground and apply 3 phase 415 Volts to the high voltage winding and make the measurement in the IV winding with respect to neutral and neutral point to ground

Tap Position	HV Winding	Voltage Applied	IV Winding	Voltage Measured	Remarks, If Any
Normal (__)	1R – N		2R – N		
Normal (__)	1Y – N		2Y – N		
Normal (__)	1B – N		2B – N		
			N – Earth		

b) Apply 3 phase 415 Volts to the Intermediate voltage winding and make the measurement in the Tertiary winding with respect to neutral and neutral point to ground

IV Winding	Voltage Applied	LV Winding	Voltage Measured	Remarks, If Any
2R – N		3R – N		
2Y – N		3Y – N		
2B – N		3B – N		
		N – Earth		

Note: Neutral to be reconnected to the ground after the test

E) Magnetization Current Test(At 10kV for 400kV and above transformer)

a) Apply 1 Phase, AC supply on HV Terminals and keep IV and LV open

Tap Position	Voltage Applied (Volts)		Current Measured (mAmps)		Remarks
LOWEST	R - N		R - Ø		
	Y - N		Y - Ø		
	B - N		B - Ø		
NORMAL	R - N		R - Ø		
	Y - N		Y - Ø		
	B - N		B - Ø		
HIGHEST	R - N		R - Ø		
	Y - N		Y - Ø		
	B - N		B - Ø		

b) Apply 1 phase, AC supply on IV Terminal and keep HV & LV open

Tap Position	Voltage Applied (Volts)		Current Measured (mAmp)	
Normal	2R – 2Y		R – Ø	
	2Y – 2B		Y – Ø	
	2R – 2B		B – Ø	

Note:

i. Excitation current < 50 mili-Amperes, then difference between two higher currents should be less than 10%.
ii. Excitation current > 50 mili-Amperes, then difference between two higher currents should be less than 15 %.
iii. Value of center leg should not be more than either outside for a three phase reactor.
iv. Results between similar single phase units should not vary more than 10%.

F) Short Circuit Impedance Test

Ambient Temperature _____ OTI Reading _____

a) HV TO IV

Tap Number	1 R		1Y		1B	
	IV of R Φ and N shorted, LV open		IV of Y Φ and N shorted, LV open		IV of R Φ and N shorted, LV open	
	Voltage (Volt)	Current (Amp)	Voltage (Volt)	Current (Amp)	Voltage (Volt)	Current (Amp)
Lowest						
Nominal						
Highest						

b) IV TO LV

Supply Nominal tap	2U1-N, ……....V	2V1-N,…….V	2W1-N, ……...V
Short all LVs and HV Open and measured current in Amp			

c) HV TO LV

Supply	Short All 3 LV Bushings, HV Open and Measured Current in Amp		
	Nominal tap	Highest tap	Lowest tap
1U1-N, ……....V			
1V1-N,……V			
1W1-N, ……...V			

Note: The measurement is performed in single phase mode.

G) Insulation Resistance Measurement

a) Insulation Resistance Measurement of Cable and others (Using 500 Volt Megger)

Ambient temp in º C _____

Sl. No.	Description	Status		Remarks, If Any
		Yes	No	
1	Control wiring			
2	Tap changer			
	a) Motor			
	b) Control			
3	Cooling System			
	a) Motor Fan			
	b) Motor Pump			
	c) Control wiring			

Note: Permissible limit of IR value should be > 50 M Ω

b) Insulation Resistance Measurement in MΩ(Using 5000 V Megger)

Ambient temp in º C _____

Main Winding	IR Value			Dielectric Absorption Coefficient DAI= 60 Sec / 15 Sec	Polarisation Index PI= 600 Sec / 60 Sec	Remarks
	15 sec	60 sec	600 sec			
Combination for Auto transformer						
a) HV+IV / LV						
b) HV+IV / E						
c) LV / E						
Combination for 3 winding transformer						
a) HV+IV / LV						
b) HV+IV / E						
b) HV+IV+LV / E						

Note:- Permissible limit of IR value should be > 500 M Ω for 66kV & above at 30°C, DAI should be >1.3 and PI should be >1.25

H) Core Insulation Test (After oil circulation)

Shorting link between CC, CL & G to be removed and IR value to be taken between CC-G, CL-G & CC-CL by applying 2 kV DC

Terminals	Insulation Value	Terminals	Insulation Value
CC-G		CC-CL	
CL-G		Semi-shield –G (if provided) at 1 kV	

Note:

i. Permissible value > 500 MΩ
ii. In case core insulation values are less than the permissible limit matter to be referred to OEM for corrective measures and same to bechecked during intern al inspection for any abnormality
iii. Ensure shorting of CC-CL & G afte r the completion of the testing

I) Voltage Ratio Test

a) Turn Ratio : HV / IV

Tap Position	Ratio			Factory Ratio			% Deviation		
	R	Y	B	R	Y	B	R	Y	B
1									
2									

Tap Position	Ratio			Factory Ratio			% Deviation		
	R	Y	B	R	Y	B	R	Y	B
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									
15									
16									
17									
18									
19									
20									
21									
22									
23									
In Reverse order									
For all Tap									

b) Ratio : HV / LV

Tap Position	Voltage Applied			Voltage Measured			Ratio			Factory Ratio			% Deviation		
	1R-N	1Y-N	1B-N	3R-3Y	3Y-3B	3R-3B	R	Y	B	R	Y	B	R	Y	B
Lowest															
Normal															
Highest															

c) Ratio : IV / LV(For all Tap if OLTC is on Neutral side)

Tap Position	Voltage Applied			Voltage Measured			Ratio			Factory Ratio			% Deviation		
	2R-N	2Y-N	2B-N	3R-3Y	3Y-3B	3R-3B	R	Y	B	R	Y	B	R	Y	B
Normal															

Note:

1. The variation of result should be within ± 0.5 % from specified values (i.e. factory test result)
2. Measurement to be done by Automatic Turns ratio meter

J) Tan δ And Capacitance Measurement

a) Tan δ And Capacitance Measurement Of Bushing

BUSHING DETAILS

Details	High Voltage Side			Intermediate Voltage Side		
	R - Ø	Y - Ø	B - Ø	R - Ø	Y - Ø	B - Ø
Make						
Type						
Sl.	No.					
Style No / Drawing No						

DETAILS	LOW VOLTAGE SIDE		
	R - Ø	Y - Ø	B - Ø
Make			
Type			
Sl. No.			
Style No / Drawing No			

Ambient temperature _____

a) HV side

VOLTAGE	CAPACITANCE (MEASURED VALUE)						REMARKS
	R - Ø		Y - Ø		B - Ø		
	SITE	FACTORY	SITE	FACTORY	SITE	FACTORY	
Measurement of C1							
2 K	V						
10 KV							
Measurement of C2							
1 K	V						

VOLTAGE	TAN δ (MEASURED VALUE)						REMARKS
	R - Ø		Y - Ø		B - Ø		
	SITE	FACTORY	SITE	FACTORY	SITE	FACTORY	
Measurement of C1Tan δ							
2 K	V						
10 KV							
Measurement of C2 Tan δ							
1 K	V						

b) IV side

VOLTAGE	CAPACITANCE (MEASURED VALUE)						REMARKS
	R - Ø		Y – Ø		B - Ø		
	SITE	FACTORY	SITE	FACTORY	SITE	FACTORY	
Measurement of C1							
2 K	V						
10 KV							
Measurement of C2							
1 K	V						

VOLTAGE	TAN δ (MEASURED VALUE)						REMARKS
	R - Ø		Y – Ø		B - Ø		
	SITE	FACTORY	SITE	FACTORY	SITE	FACTORY	
Measurement of C1 Tan δ							
2 K	V						
10 KV							
Measurement of C2 Tan δ							
1 K	V						

c) LV side

VOLTAGE	CAPACITANCE (MEASURED VALUE)						REMARKS
	R - Ø		Y - Ø		B – Ø		
	SITE	FACTORY	SITE	FACTORY	SITE	FACTORY	
Measurement of C1							
2 K	V						
10 KV							
Measurement of C2							
1 K	V						

VOLTAGE	TAN δ (MEASURED VALUE)						REMARKS
	R - Ø		Y – Ø		B – Ø		
	SITE	FACTORY	SITE	FACTORY	SITE	FACTORY	
Measurement of C1 Tan δ							
2 K	V						
10 KV							
Measurement of C2 Tan δ							
1 K	V						

b) TAN δ AND CAPACITANCE MEASUREMENT OF WINDING

Ambient temperature _____

VOLTAGE	WINDING COMBINATION	TEST MODE	CAPACITANCE		TAN δ		REMARK
			SITE	FACTORY	SITE	FACTORY	
2 KV	HV-IV/ LV	UST					
10 KV							
2 KV	HV-IV/ LV+G	GST					
10 KV							
2 KV	HV-IV/ LV Guarded	GSTg					
10 KV							
2 KV	LV/ HV-IV	UST					
10 KV							
2 KV	LV/ HV-IV+G	GST					
10 KV							
2 KV	LV/ HV-IV Guarded	GSTg					
10 KV							

Note:

i. C2 values shall be only for record purpose.

ii. For bushing acceptable Limit for Tan δ1 should be comparable (+/- 0.001) with factory value subjected to max of 0.004 & Tan δ2:-0.01

iii. For winding acceptable Limit for Tan δ1 should be comparable (+/- 0.001) with factory value subjected to max of 0.005 & Tan δ2:-0.01

iv. Acceptable Limit for Capacitance -5% to + 10%

K) *Measurement Of Winding Resistance (In mΩ)*

Ambient temperature in ° C_____ OTI Reading _____ WTI reading _____

A) HIGH VOLTAGE SIDE(IN CASE OLTC IS ON LINE SIDE)

Tap Position	Winding Resistance(HV-N)			Resistance At 75° C			Factory Value At 75° C			% Deviation		
	1R1 – 2R1	1Y1 – 2Y1	1B1 – 2B1	1R1 – 2R1	1Y1 – 2Y1	1B1 – 2B1	1R1 – 2R1	1Y1 – 2Y1	1B1 – 2B1	1R1 – 2R1	1Y1 – 2Y1	1B1 – 2B1
1												
2												
3												

Tap Position	Winding Resistance(HV-N)			Resistance At 75° C			Factory Value At 75° C			% Deviation		
	1R1 – 2R1	1Y1 – 2Y1	1B1 – 2B1	1R1 – 2R1	1Y1 – 2Y1	1B1 – 2B1	1R1 – 2R1	1Y1 – 2Y1	1B1 – 2B1	1R1 – 2R1	1Y1 – 2Y1	1B1 – 2B1
4												
5												
6												
7												
8												
9b												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21												
22												
23												

Reverse Order For All Tap Position

Tap Position	Winding Resistance(HV-IV)			Resistance At 75° C			Factory Value At 75° C			% Deviation		
	1R1–2R1	1Y1–2Y1	1B1–2B1	1R1–2R1	1Y1–2Y1	1B1–2B1	1R1–2R1	1Y1–2Y1	1B1–2B1	1R1–2R1	1Y1–2Y1	1B1–2B1
TAP….												
TAP…												
TAP…												
TAP…												

B) INTERMEDIATE VOLTAGE SIDE(FOR ALL TAP IN CASE OLTC IS ON NEUTRAL SIDE)

Between Windings	Resistance	Resistance At 75 °C In Ohms		% Deviation
	Site Value@ ----°C	Factory	Site	
2R1 – N				
2Y1 – N				
2B1 – N				

C) LOW VOLTAGE SIDE

Between Windings	Resistance	Resistance At 75 °C In Ohms		% Deviation
	Site Value@ ----°C	Factory	Site	
3R1 – 3B1				
3Y1 – 3R1				
3B1 – 3Y1				
Across winding (for 1-phase unit)				

NOTE:

i. Formula for calculating the resistance at 75°C: $R_{75} = R_T (235+75)/ (235+T)$, where R_T = Resistance Measured At Winding Temperature T.
ii. Permissible limit: ±5% variation between phases or from Factory test results
iii. LV winding resistance at factory measured without formation of delta. However measurements carried out at site are after formation of delta. Hence a correction factor of 1.5 times to be applied in site results

L) Oil Characteristics

Sample to be taken prior to charging to Transformer and it should fulfill the following:

DATE OF OIL SAMPLING	B.D.V.	MOISTURE	TAN δ	RESISTIVITY	INTERFACIAL TENSION
Permissible Limit	**70KV(min)**	**5 PPM(Max)**	**0.01 at 90°C (Max)**	**6x 10 ^12 Ω - cm at 90° C (Min)**	**0.0 35 N/m at 27°C (Min)**

DISSOLVED GAS ANALYSIS

DISSOLVE GASES	H2	CH4	C2H4	C2H6	C2H2	CO	CO2	O2	N2	TCG
Before Charging										

Note:-

i. TCG should be below 1%
ii. One fresh oil sample per lot (from drum) shall be sent to Lab for carrying out Oxidation Stability test

M) Operational Test and Checks of Other Equipments

a) Test On OLTC

SL. NO	DESCRIPTION	STATUS		REMARKS
		OK	NOT OK	
1	Visual inspection of equipment			
2	Manual operation on all taps (local) with confirmation of the no. of revolutions and locking at extreme taps			
3	Over load device of driving motor			
4	Local operation (electrical)			
5	Remote operation (electrical)			
6	Tap position indicator			
7	Check operation with master follower Scheme (parallel operation)			
8	Out of step relay			
9	Step by step contactor			
10	Limit switch			
11	Winding resistance at all taps			
12	Continuity test of winding during one complete cycle of operation			

b) Checking of cooling Equipments

SL. NO.	DESCRIPTION	STATUS		Remarks
		OK	NOT OK	
1	Rotation direction of Pumps			
2	Rotation direction of Fans			

c) Protection Check

EQUIPMENT FAN NO	SETTING VALUE	PICKUP VALUE	SINGLE PHASING PREVENTION CHECK
1			
2			
3			
-			
-			
Pump No.			
1			
2			
3			
4			

N) Checks on Bushing CT's

(a) Rated Data And Duty

CORE	RATIO	CLASS	BURDEN	KVP	PROTECTION / METERING
Core-I					
Core II					
Core III					
Core IV					
-					

(b) Insulation Resistance Measurement Of Bushing Ct's(Using 500v Megger)

Measurement Between	Unit	HV			IV		
		R – Ø	Y - Ø	B - Ø	R - Ø	Y - Ø	B - Ø
Earth - Core I	M Ω						
Earth - Core II	M Ω						
Earth - Core III	M Ω						
Earth - Core IV	M Ω						

Measurement Between	Unit	LV			Neutral
		R - Ø	Y - Ø	B - Ø	
Earth - Core I	M Ω				
Earth - Core II	M Ω				
Earth - Core III	M Ω				
Earth - Core IV	M Ω				

Measurement Between	Unit	HV			IV		
		R – Ø	Y - Ø	B - Ø	R - Ø	Y - Ø	B - Ø
Core I – Core II	M Ω						
Core I – Core III	M Ω						
Core I – Core IV	M Ω						
Core II – Core III	M Ω						
Core II – Core IV	M Ω						
Core III – Core IV	M Ω						

MEASUREMENT BETWEEN	UNIT	LV		
		R - Ø	Y - Ø	B - Ø
Core I – Core II	M Ω			
Core I – Core III	M Ω			
Core I – Core IV	M Ω			
Core II – Core III	M Ω			
Core II – Core IV	M Ω			
Core III– Core IV	M Ω			

(c) **CONTINUITY TEST OF BUSHING CT'S (in Ω)**

Continuity, Check between Terminals : **OK / NOT OK**

CORE	BETWEEN TERMINAL	HV			IV		
		R - Ø	Y - Ø	B - Ø	R - Ø	Y - Ø	B - Ø
Core – I	1S1–1S2						
Core – II	2S1–2S2						
Core – III	3S1–3S2						
Core – IV	4S1–4S2						

CORE	BETWEEN TERMINAL	LV			NEUTRAL
		R – Ø	Y – Ø	B – Ø	
Core – I	1S1–1S2				
Core – II	2S1–2S2				
Core – III	3S1–3S2				
Core – IV	4S1–4S2				

(d) SECONDARY WINDING RESISTANCE OF BUSHING CT'S (IN OHM)

i. HV side

CORE	BETWEEN TERMINAL	UNIT	R - Ø		Y - Ø		B - Ø	
			FACTORY	SITE	FACTORY	SITE	FACTORY	SITE
Core I	1S1 – 1S2	Ω						
Core II	2S1 – 2S2	Ω						
Core III	3S1 – 3S2	Ω						
Core IV	4S1 – 4S2	Ω						

ii. IV side

CORE	BETWEEN TERMINAL	UNIT	R - Ø		Y - Ø		B - Ø	
			FACTORY	SITE	FACTORY	SITE	FACTORY	SITE
Core I	1S1 – 1S2	Ω						
Core II	2S1 – 2S2	Ω						
Core III	3S1 – 3S2	Ω						
Core IV	4S1 – 4S2	Ω						

iii. LV side

CORE	BETWEEN TERMINAL	UNIT	R - Ø		Y - Ø		B - Ø	
			FACTORY	SITE	FACTORY	SITE	FACTORY	SITE
Core I	1S1 – 1S2	Ω						
Core II	2S1 – 2S2	Ω						
Core III	3S1 – 3S2	Ω						
Core IV	4S1 – 4S2	Ω						

iv. Neutral Side

CORE	BETWEEN TERMINAL	UNIT	FACTORY	SITE
Core I	1S1 – 1S2	Ω		

v. External Neutral CT (if provided)

CORE	BETWEEN TERMINAL	UNIT	FACTORY	SITE
Core I	1S1 – 1S2	Ω		

(e) Polarity Test Of Bushing CT's

With 1.5 V DC supply (Connect +ve at P1 and –ve at P2)

i.

CORE	BETWEEN		HV			IV		
			R - Ø	Y - Ø	B - Ø	R - Ø	Y - Ø	B - Ø
Core I	1S1 (+ve)	1S2 (-ve)						
Core II	2S1 (+ve)	2S2 (-ve)						
Core III	3S1 (+ve)	3S2 (-ve)						
Core IV	4S1 (+ve)	4S2 (-ve)						

ii.

CORE	BETWEEN		LV			NEUTRAL
			R - Ø	Y - Ø	B - Ø	
Core I	1S1 (+ve)	1S2 (-ve)				
Core II	2S1 (+ve)	2S2 (-ve)				
Core III	3S1 (+ve)	3S2 (-ve)				
Core IV	4S1 (+ve)	4S2 (-ve)				

Note: Extra row may be added for additional cores

(f) CURRENT RATIO TEST

Primary Injection through Primary Injection Kit at Primary Terminal P1 – P2
Measure current on the secondary Terminals. In case of factory fitted turret CTs, current ratio may be carried out by CT analyzer

i. HV side R – Phase side

Core S1 - S2	Primary %	Current Actual	Secondary Current	Theoretical Ratio	Actual Ratio	% Of Error
Core I (1S1 – 1S2)	20%					
	80%*					
Core II (2S1 – 2S2)	20%					
	80%*					
Core III (3S1 – 3S2)	20%					
	80%*					
Core IV (4S1 – 4S2)	20%					
	80%*					

ii. HV side Y – Phase

Core S1 - S2	Primary %	Current Actual	Secondary Current	Theoretical Ratio	Actual Ratio	% Of Error
Core I (1S1 – 1S2)	20%					
	80%*					
Core II (2S1 – 2S2)	20%					
	80%*					
Core III (3S1 – 3S2)	20%					
	80%*					
Core IV (4S1 – 4S2)	20%					
	80%*					

iii. HV side B – Phase

Core S1 - S2	Primary %	Current Actual	Secondary Current	Theoretical Ratio	Actual Ratio	% Of Error
Core I (1S1 – 1S2)	20%					
	80%*					
Core II (2S1 – 2S2)	20%					
	80%*					
Core III (3S1 – 3S2)	20%					
	80%*					
Core IV (4S1 – 4S2)	20%					
	80%*					

iv. IV side R – Phase

Core S1 - S2	Primary %	Current Actual	Secondary Current	Theoretical Ratio	Actual Ratio	% Of Error
Core I (1S1 – 1S2)	20%					
	80%*					
Core II (2S1 – 2S2)	20%					
	80%*					
Core III (3S1 – 3S2)	20%					
	80%*					
Core IV (4S1 – 4S2)	20%					
	80%*					

v. IV side Y – Phase

Core S1 - S2	Primary %	Current Actual	Secondary Current	Theoretical Ratio	Actual Ratio	% Of Error
Core I (1S1 – 1S2)	20%					
	80%*					
Core II (2S1 – 2S2)	20%					
	80%*					
Core III (3S1 – 3S2)	20%					
	80%*					
Core IV (4S1 – 4S2)	20%					
	80%*					

vi. IV side B – Phase

Core S1 - S2	Primary %	Current Actual	Secondary Current	Theoretical Ratio	Actual Ratio	% Of Error
Core I (1S1 – 1S2)	20%					
	80%*					
Core II (2S1 – 2S2)	20%					
	80%*					
Core III (3S1 – 3S2)	20%					
	80%*					
Core IV (4S1 – 4S2)	20%					
	80%*					

Note:-*Minimum current shall be 1000A or 80% whichever is achieved. In case of any abnormality, ratio test to be carried out at 40% and 60% also.
Permissible limit: Protection core-±3% and Metering core- ±0.5%

(a) MAGNETISING CURVES PERFORMANCE

(Not to be done for metering Core)
Knee Point Voltage (KVp) = ……..Volt

i. HV Side R – Phase

Voltage		Unit	Current Measurement			
To Be Applied	Actual Value		Core – I 1S1-1S2	Core – II 2S1-2S2	Core – III 3S1-3S2	Core – IV 4S1-4S2
0.25 x KVp		mA				
0.50 x KVp		mA				
0.75 x KVp		mA				
1.00 x KVp		mA				
1.10 x KVp		mA				

ii. HV Side Y – Phase

Voltage		Unit	Current Measurement			
To Be Applied	Actual Value		Core – I 1S1-1S2	Core – II 2S1-2S2	Core – III 3S1-3S2	Core – IV 4S1-4S2
0.25 x KVp		mA				
0.50 x KVp		mA				
0.75 x KVp		mA				
1.00 x KVp		mA				
1.10 x KVp		mA				

iii. HV Side B – Phase

Voltage		Unit	Current Measurement			
To Be Applied	Actual Value		Core – I 1S1-1S2	Core – II 2S1-2S2	Core – III 3S1-3S2	Core – IV 4S1-4S2
0.25 x KVp		mA				
0.50 x KVp		mA				
0.75 x KVp		mA				
1.00 x KVp		mA				
1.10 x KVp		mA				

iv. IV Side R – Phase

Voltage		Unit	Current Measurement			
To Be Applied	Actual Value		Core – I 1S1-1S2	Core – II 2S1-2S2	Core – III 3S1-3S2	Core – IV 4S1-4S2
0.25 x KVp		mA				
0.50 x KVp		mA				
0.75 x KVp		mA				
1.00 x KVp		mA				
1.10 x KVp		mA				

v. IV Side Y – Phase

Voltage		Unit	Current Measurement			
To Be Applied	Actual Value		Core – I 1S1-1S2	Core – II 2S1-2S2	Core – III 3S1-3S2	Core – IV 4S1-4S2
0.25 x KVp		mA				
0.50 x KVp		mA				
0.75 x KVp		mA				
1.00 x KVp		mA				
1.10 x KVp		mA				

vi. IV Side B – Phase

Voltage		Unit	Current Measurement			
To Be Applied	Actual Value		Core – I 1S1-1S2	Core – II 2S1-2S2	Core – III 3S1-3S2	Core – IV 4S1-4S2
0.25 x KVp		mA				
0.50 x KVp		mA				
0.75 x KVp		mA				
1.00 x KVp		mA				
1.10 x KVp		mA				

Note:-

a) Test to be carried out by Automatic CT analyzer

b) CT should not saturate at 110% of Knee Point Voltage (KVp)

c) If Knee Point Voltage is not mentioned then Knee Point Current may be taken into consideration.

O) ***Protection And Alarms***

a)

SL.NO	DEVICE	SET FOR		PROVED	
		ALARM	TRIP	ALARM	TRIP
1	Winding temperature	**100**	**110**		
2	Oil temperature	**90**	**100**		
3	Oil flow failure		NA		NA
4	Pressure relief valve	NA		NA	
5	Main tank Buchholz relay				
6	OLTC Buchholz relay	NA		NA	
7	Fan failure		NA		NA
8	Low oil level (MOG)		NA		NA
9	Differential relay	NA		NA	
10	Over load relay		NA		NA
11	Restricted Earth fault relay (REF)	NA		NA	
12	Back up O/C & EF relay (HV & IV)	NA		NA	
13	Inter trip , if any	NA		NA	
14	Trip free check	NA		NA	
16	Over flux (HV & IV)				
17	SPR relay (if provided)				
18	On line DGA				

b) Protection setting applied as per CC-Engg. approved settings

Yes	No	Remarks

c) Stability test of differential and REF protection

Ok	Not Ok	Remarks

NOTE : Prove the tripping of associated break ers by actual operation of the various devices and relays as per the schemes.

d) Delta formation of single phase units and spare switching arrangement scheme checked

Yes	No	Remarks

P) Final Documentation Review

a) Factory test results are available

Yes	No

b) All electrical test results compared with factory test results & found to be in order

Yes	No

c) Final documents of Pre- Commissioning checks reviewed and approved

Yes	No

d) Document regarding spares equipment, O&M manuals etc available at site

Yes	No

e) After modification, if any, "As built Drawings" are available at site

Yes	No

Q) Checks After Charging of Transformer

Record the following after charging

a) Any abnormal sound emanating from the transformer

Yes	No	Remarks

b) No load current at relay terminal

R - Ø	A
Y - Ø	A
B - Ø	A

c) Temperature at the time of charging

OTI	° C
WTI	° C
AMBIENT	° C

d) Maximum temperature after 24 hours_____° C

e) OLTC electrical operation checked in idle charged condition from minimum position to maximum position & back to normal position

Yes	No	Remarks

f) Thermo vision scanning done at least after 24 hours of loading & repeated after one week.

Yes	No	Remarks

g) Dissolve gas Analysis

DISSOLVE GASES	24 HRS AFTER CHARGING	7 DAYS AFTER CHARGING	15 DAYS AFTER CHARGING	1 MONTH AFTER CHARGING	3 MONTH AFTER CHARGING
H_2					
CH_4					
CO					
CO_2					
C_2H_4					
C_2H_6					
C_2H_2					
O2					
N2					
TCG					

Note: If any abnormal increase in fault gasses observed after 24 Hrs. of charging, immediate oil sampling to be sent to Lab for confirmation and matter shall be referred to OEM

Signature:	**Signature:**	**Signature:**	**Signature:**
Name:	**Name:**	**Name:**	**Name:**
Designation:	**Designation:**	**Designation:**	**Designation:**
Organization: (Supplier Representative) (Wherever Applicable)	**(Erection Agency)**	**(POWERGRID Site I/C)**	**(POWERGRID Commissioning. Team) Members: 1. 2. 3. 4.**

PRE-COMMISSIONING FORMATS FOR REACTOR

I. GENERAL DETAILS

DETAILS	
Region:	**Sub-Station:**
LOA No. :	**Make:**
Sr. No.:	**Type:**
Equipment identification No.:	
Year of Manufacture:	**Rating:**
Voltage Class :	**Cooling Type:**
Type of Neutral Grounding:	**Oil Make:**
Oil type:	**Oil quantity:**
Quantity of Radiator	**Date of Receipt at site:**
Date of Starting of Erection:	**Date of Completion of Erection and Oil filling:**

II. SEQUENCE OF TESTS TO BE CARRIED OUT FOR REACTOR

SL. NO.	NAME OF TEST	TESTING KIT DETAILS			TEST RESULTS Ok/Not Ok
		MAKE	RATING / MEASURING RANGE	DATE OF LAST CALIBRATION	
1	Core Insulation Measurement upon arrival of equipment at site				
2	Insulation Resistance Measurements Of Bushing Cts				
3	Continuity Test Of Bushing Cts				
4	Secondary Winding Resistance Of Bushing Cts				
5	Polarity Test Of Bushing Cts				
6	Current Ratio Test				
7	Magnetizing Curves Performance				
8	Measurement of Resistance of Earth Pit and Main Grid				
9	Frequency Response Analysis				
10	Magnetization Current of Windings				
11	C & Tan δ Measurement Of Bushing				
12	C & Tan δ Measurement Of Windings				
13	C & Tan δ Measurement Of NGR Windings(If any)				

SL. NO.	NAME OF TEST	TESTING KIT DETAILS			TEST RESULTS Ok/Not Ok
		MAKE	RATING / MEASURING RANGE	DATE OF LAST CALIBRATION	
14	Insulation Resistance Measurement of Winding				
15	Insulation Resistance Measurement of Cable				
16	Core Insulation Measurement after oil filling				
17	Measurement of Winding Resistance				
18	Measurement of Winding Resistance of NGR				
19	Protection And Alarm Tests				
20	Stability Test Of Differential And Ref Protection				
21	Contact Resistance Measurement				
22	Vibration Measurement				

Comments of Commissioning Team on test Results:

Comments of Corporate-OS on test Results (To be attached separately)

Manufacturer Recommendation on test Results (To be attached separately)

Signature:	**Signature:**	**Signature:**	**Signature:**
Name:	**Name:**	**Name:**	**Name:**
Desgn.:	**Desgn.:**	**Desgn.:**	**Desgn.:**
Organization: (Supplier Representative) (Wherever Applicable)	**(Erection Agency)**	**(POWERGRID Site I/C)**	**(POWERGRID Commg. Team) Members: 1. 2. 3. 4.**

III. CHECKS AFTER RECEIPT OF REACTOR AT SITE:

A) *N2/ Dry Air Pressure & Dew Point Record*

Inspection Action	Date Of Meas.	N2/ Dry Air Pressure	Dew Point	Ambient Temperature	Remarks
During dispatch at factory					
After receipt at site					
Storage at site before commissioning					

Note:

1. Refer **graph 2.1.3 fig.1 in** POWERGRID doc no d-2-03-xx-01-01 rev-01 for maintaining N2/ Dry air pressure and dew point during storage(To be maintained in a separate sheet/ Register)
2. Any noticeable drop in N2 during storage at site is observed, then matter to be referred to Manufacturer and CC-OS).
3. If Reactor is received with zero N2 pressure then matter to be referred to Manufacturer and Corporate-OS prior to erection

B) *Impact Recorder Analysis*

No of Impact Recorder installed: _____
Make of Impact Recorder(s) _____
Type of Impact Recorder(s) _____
Date of removal of impact recorder from equipment _____

Sl.No.	Check Points	Status		Remarks
1	Functionality of Impact recorder at the time of dismantling from main unit	**On**	**Off**	
2	Joint data downloading carried out at site immediately after receipt	**Yes**	**No**	
3	Analysis of joint report received from manufacturer before charging	**Yes**	**No**	

Note:

1. Manufacturer to provide necessary software and downloading tools to respective sites so that data downloading can be carried out at site jointly by POWERGRID & Manufacturer
2. Permissible limit for maximum shock in any direction shall be 3g
3. Impact Recorder should be switched off and detached from the Reactor when the main unit has been placed on its foundation.

C) *Core Insulation Test (Immediately after Receipt at Site)*

Shorting link between CC, CL & G to be removed and IR value to be taken between CC-G, CL-G & CC-CL by applying 1 kV DC

Terminals	Insulation Value	Terminals	Insulation Value
CC-G		CC-CL	
CL-G		Semi-shield –G (if provided) at 1 kV	

Note:

i. Permissible value > 500 MΩ
ii. In case core insulation values are less than the permissible limit matter to be referred to OEM for corrective measures and same to be checked during internal inspection for any abnormality
iii. Ensure shorting of CC-CL & G after the completion of the testing

D) ***Internal Inspection***

SL. No.	Internal Inspection	Status	
		Yes	No
1	Details photographs of all visible parts /components are taken during internal inspection. (refer procedure 2.3)		
2	Any abnormality observed during internal inspection		
3	Matter referred to manufacturing, CC-QA & I , CC-ENGG and CC-OS		

Details of abnormality observed during internal inspection (if noticed) _____

_____

_____

IV. REACTOR ERECTION

A) ***Checks / Precautions During Erection :***

Sl. No.	Description	Remarks
1	Total Exposure of Active part of Reactor to atmosphere in hours (To be kept minimum)	
2	Dew point of dry air generator / dry air cylinders, during exposure of active part of Reactor	
3	Available of Oxygen in % before entering in Reactor tank	
4	N2/ Dry air pressure in PSI while Reactor is kept sealed in between different erection activities	
5	Ensure Leakage test of Air cell / bellow carried out	
6	Check Hermitically sealing is intact in all Bushings by OEM / Expert	

B) ***Evacuating And Oil Filling***

a) Before filling oil, each drum has been physically checked for free moisture and appearance

Yes	No

b) Details of oil filter machine (As per latest TS of Reactors)

Make _____ Capacity_____

Sl.No	Description Of Works	Remarks / Reading
1	Changing of Lubricating oil of vacuum pump	
2	Cleaning of Filter packs	
3	Flushing of whole filter machine with fresh oil	
4	Vacuum obtained without load (milli bar)	

c) Vacuum pump for evacuation of Reactor

Sl.No	Description of Works	Remarks / Reading
1	Changing of Lubricating oil of vacuum pump	
2	Vacuum obtained without load (milli bar)	
3	Diameter of vacuum hose (50 mm)	
4	Employ of Dry ice chamber	

d) Oil storage tank

Capacity_____ Quantity_____

Sl.No	Description of Works	Remarks / Reading
1	Silica gel breather provided in the tank	
2	Any opening left uncovered	
3	Inside painted or not	
4	Cleanliness of inside of pipes/ hoses to the storage tank	

e) Exposure during erection

Sl.No	Description of Works	Remarks / Reading
1	First day exposure (in hrs)	
2	Second day exposure (in hrs)	
3	Third Day exposure (in hrs)	
4	N2 pressure applied after each days erection work (in PSI)	
5	Ambient Temperature (in degC)	
6	Average Relative Humidity	
7	Weather Condition(Rainy / Stormy / Cloudy / Sunny)	

Note:

i. Erection activities to be carried out in sunny weather and RH<60%

f) N2/ Dry Air sealing in case of delay in oil filling

Sl.No	Description of Works	Remarks / Reading
1	No. of Cylinders used for displacing the air inside the tank	
2	N2 admitted from bottom valve	
3	Valve at diametrically opposite end at top kept open	
4	No. of Cylinders used for building up to 4- 5 psi(.3kg/cm^2)	

g) Leakage Test through pressure

Sl.No	Inspection Actions	Date	Time	Remarks / Reading
1	Fill dry N2/ dry air till pressure of 4- 5psi (.3 kg/cm^2) achieved			
2	To be kept for 24 Hrs			
3	In case pressure remain same, check for dew point			
4	If dew point is achieved, proceed for evacuation			
5	**In case of drop in pressure, attend the leakages and repeat the pressure test**			
6	If dew point is not OK, dry air/ N2 cycle to be carried out till desired dew point is achieved			

h) Schedule for Vacuum & Tightness Test

Sl.No	Inspection Actions	Date	Time	Remarks / Reading
1	Starting of evacuation on complete unit			
2	Stopping of evacuation below the pressure of 5 kPa (50 mbar)			
3	Pressure P1 in kPa after 1 hour of stopping evacuation			
4	Pressure P2 in kPa after half an hour of reading pressure P1			
5	Leakage = (P2-P1) x V , V= Oil quantity in Cu mtr ***If leakage<3.6, continue evacuating** **If leakage > 3.6, attend leakage and repeat process as per Sr. No. 1 to 4.**			
6	Start of Vacuum reaching below 0.13kPa(1 Torr)			
7	Break of vacuum *** Vacuum process to be continued for 24 hrs Up to 145 KV, 48 hrs for 145 to 220kV and 72 hrs for 420 kV and above**			

i) Record of drying out process (if carried out)

Sl.No	Activity	Date	Time	Remarks / Reading
1	**First Nitrogen purging cycle**			
	Pressure of Nitrogen 0.15 kg/cm2			
	Dew Point after 48 Hrs			
	Temperature with heaters on condition around the Reactor Tank(Refer procedure)			
2	**First Vacuum cycle**			
	Vacuum achieved			
	Rate of condensate collection(Hourly basis)			
	Duration of vacuum after achieving 1 to 5 torr			
3	**Second Nitrogen purging cycle**			
	Pressure of Nitrogen 0.15 kg/cm2			
	Temperature with heaters on condition around the Reactor Tank(Refer procedure)			
	Dew Point after 24 Hrs			

Note:

i. If dew point is within the permissible limit oil filling under vacuum may be started otherwise vacuum/ Nitrogen purging with heating cycle to be continued till desired dew point is achieved.

j) Schedule for Oil filling and Settling

Sl.No	INSPECTION ACTIONS	DATE	TIME	REMARKS / READING
1	Ensure measurement of Particle counts during oil filtration in oil tanks(If specified in the contracts)			
2	Oil Filling in Main Tank			
3	Oil filling in Conservator tank			
4	Oil filling in diverter switch			
5	Hot oil circulation (minimum 2 cycles or depending on oil parameters) at oil temperature 55-60 deg C.			
6	Start of oil settling			
7	End of oil settling *** Minimum settling time to be given 12 hrs for 145 KV , 48 hrs for 145 to 420kV and 72 hrs for 765 kV & above**			

V. PRE-COMMISSIONING CHECKS:

Sl. No.	Description Of Activity	Status		Deficiencies, If Any
		Yes	No	
1	REACTOR and its Auxiliaries are free from visible defects on physical Inspection			
2	All fittings as per out line General Arrangement Drawing			
3	Check Main Tank has been provided with double earthing			
4	Check neutral is grounded through separate connections. Ensure metallic requirements as per specification (e.g. Cu) in earthing strips used			
5	Check that Marshalling Box, , Radiator Bank & Fan(if any) etc. has been earthed			
6	All nuts and bolts are tightened correctly as per specified torque (as per manufacturers recommendation)			
7	Check tightness of Terminal Connectors			
8	Check leveling of Reactor and its accessories			
9	Erection Completion Certificate along with list of outstanding activities reviewed			
10	Any Paint removed / scratched in transit has been touched up			
11	Bushings are clean and free from physical damages			
12	Oil level is correct on all Bushings			
13	Check brazing of all Bushings Leads			
14	Check oil leakage through any Joints / Valves etc.			
15	Check oil drain valves are properly closed and locked			
16	Check oil level in Main Conservator tank			
17	Check oil level at conservator matches with oil temperature of Reactor			
18	Check OTI and WTI pockets and replenish the oil, if required			
19	Check all valves for their opening & closing sequence			
20	Check the colour of the breather silica gel			
21	Check availability of oil in the breather cup			
22	Check tightness of bolt of main unit after placed on foundation			
23	Check busing test tap is grounded			
24	Check the operation of flow sensitive shut off valve between main tank & conservator, if any			

Sl. No.	Description Of Activity	Status		Deficiencies, If Any
		Yes	No	
25	Check the functioning of SPR (Sudden pressure relay) ,if any			
26	Check no debris, loose&TP and oil strains on and around the Reactor			
27	Check door seals of Marshalling Box is intact and all cable gland plates unused holes are sealed			
28	Check that pressure relief valve is correctly mounted			
29	Ensure unused secondary cores of Bushing CT's, if any, has been shorted			
30	Check CT star point has been formed properly and grounded at one end only as per scheme			
31	Check that permanent and adequate lighting arrangements are ready			
32	Check that labeling and identification is permanent and satisfactory			
33	Check that Buchholz Relay is correctly mounted with arrow pointing towards conservator			
34	Check cables are properly fixed and ensure cable entry at the bottom			
35	Ensure all Power and Control cable Terminals are tightened			
36	Check all cables and Ferrules are provided with Number as per Cable Schedule (Cross Ferruling to be checked)			
37	Check that all cables are correctly glanded			
38	Check external cabling from Junction Box to Relay / Control Panel completed			
39	Check that air has been released from the Radiators and their headers/ Buchholz relay/Main tank/tank/Bushing turrets etc			
40	Check Fire Protection System & Emulsifier systems is adequate & ready			
41	Check that CC-CL & G are shorted			
42	Check that all radiator bank valves on top and bottom headers are open			
43	Change over operation of ac supply from source- I to source-II checked			
44	Check the flanges of bushing for any crack after fixing			
45	Calibration of OTI & WTI performed as per procedure			
46	Ensure Remote OTI and WTI data transfer to control room is taking place			

Sl. No.	Description Of Activity	Status		Deficiencies, If Any
		Yes	No	
47	Ensure On-Line DGA is commissioned and kept "ON"			
48	Ensure On-Line Dry out system is commissioned and kept "ON"			
49	Check various interlocks provided with Fire Fighting as per the schematic Ref. Drg. No._____	Description of Interlocks		Checked

VI. MEASUREMENT OF EARTH RESISTANCE OF ELECTRODE

Location	Value
With Grid (Earth Pit -1)	
Without Grid (Earth Pit -1) (Neutral Earth)	
With Grid (Earth Pit -2)	
Without Grid (Earth Pit -2) (Neutral Earth)	

***Permissible limit with grid < 1 Ω**

VII. PRECOMMISSIONING TESTS AFTER READINESS OF THE REACTOR

A) Frequency Response Analysis (FRA)

Sl.No	Description	Yes	No	Remarks
1	Carried out after completion of all commissioning activities			
2	Factory FRA test report in soft form available at site			
3	Interpretation of test results carried out			
4	Test results matching with the factory results			

Note:-

a) Measurement to be carried out at Minimum, Maximum and Nominal Tap for all combination of HV & IV and Nomenclature to be made similar as mentioned in the procedure documents

B) Magnetization Current Test

Am bient temperature _____ Temperature of oil_____

Voltage Applied (Volts)		Current Measured (mAmp)		Remark
R - N		R - PH		
Y - N		Y - PH		
B - N		B - PH		
NGR				

Note:

a. **Excitation current < 50 milli-Amperes, then difference between two higher currents should be less than 10%.**
b. **Excitation current > 50 milli-Amperes, then difference between two higher currents should be less than 15 %.**
c. **Value of centre leg should not be more than either outside for a three phase reactor.**
d. **Results between similar single phase units should not vary more than 10%.**

C) Tan δ And Capacitance Measurement

a) Tan δ And Capacitance Measurement of Bushing

BUSHING DETAILS

	R - Ø	Y - Ø	B - Ø	Neutral	NGR
Make					
Type					
Sl. No.					
STYLE NO / DRAWING NO					

Ambient temperature in ºC_____

i. Capacitance & **Tan δ** of bushing

Voltage Applied	Capacitance						Remarks
	R - Ø		Y - Ø		B - Ø		
	Site	Factory	Site	Factory	Site	Factory	
Measurement of C1							
2 K	V						
10 KV							
Measurement of C2							
1 K	V						
Voltage Applied	**Tan δ**						**Remarks**
	R - Ø		**Y - Ø**		**B - Ø**		
	Site	**Factory**	**Site**	**Factory**	**Site**	**Factory**	
Measurement of C1 Tan δ							
2 K	V						
10 KV							
Measurement of C2 Tan δ							
1 K	V						

b) Capacitance & Tan δ of NGR bushing

Voltage Applied	Capacitance		Tan δ	
	Site	Factory	Site	Factory
2 KV				
10 KV				

c) Tan δ And Capacitance Measurement Of Winding

Ambient temperature in ºC _____

Voltage	Winding Combination	Test Mode	Capacitance		Tan δ *		Remark
			Site	Factory	Site	Factory	
2 KV	HV/Tank+Earh	GST					
10 KV							

Capacitance & **Tan δ** of NGR

Voltage	Winding Combination	Test Mode	Capacitance		Tan δ *		Remark
			Site	Factory	Site	Factory	
2 KV	HV/Tank+Earh	GST					
10 KV							

Note:

i. C2 values shall be only for record purpose.
ii. For bushing acceptable Limit for Tan δ1 should be comparable (+/- 0.001) with factory value subjected to max of 0.005 & Tan δ2:-0.01
iii. For winding acceptable Limit for Tan δ1 should be comparable (+/- 0.001) with factory value subjected to max of 0.005 & Tan δ2:-0.01
iv. Acceptable Limit for Capacitance -5% to + 10%

VIII. Insulation Resistance Measurement

a) Insulation Resistance Measurement of Cable and others (Using 500 Volt Megger)

Ambient temp in ºC _____

SL. NO.	DESCRIPTION	STATUS		REMARKS, IF ANY
		YES	NO	
A	Control wiring			
B	Cooling System			
	a) Motor Fan			
	b) Motor Pump			
	c) Control wiring			

*** Permissible limit of IR value should be > 50 M Ω**

b) Insulation Resistance Measurement in MΩ (Using 5000 V Megger)

Ambient temp in º C _____

Main Winding	Ir Value			Dielectric Absorption Coefficient(DAI) = 60 Sec / 15 Sec	Polarisation Index(PI) = 600 Sec / 60 Sec	Remarks
	15 Sec	60 Sec	600 Sec			
a) HV / E						
b)NGR WINDING						

***Permissible limit of IR value should be > 500 M Ω for 66kV & above at 30°C, DAI should be >1.3 and PI should be >1.25**

IX. Measurement Of Winding Resistance (In Ohm)

Ambient temperature in º C_____ OTI Reading _____ WTI reading _____

i. **WINDING RESISTANCE OF REACTOR WINDING**

Winding Resistance(HV-N)			Resistance At 75º C			Factory Value At 75º C			% Deviation		
R	Y	B	R	Y	B	R	Y	B	R	Y	B

ii. **WINDING RESISTANCE OF NGR WINDING**

Winding Resistance(HV-N)			*Resistance At 75º C			*Factory Value At 75º C			% Deviation		
R	Y	B	R	Y	B	R	Y	B	R	Y	B

NOTE:

i. Formula for calculating the resistance at 75°C: R_{75} = RT (235+75)/ (235+T), where RT = Resistance Measured At Winding Temperature T.

ii. Permissible limit: ±5% variation between phases or from Factory test results

X. Core Insulation Test

Shorting link between CC, CL & G to be removed and IR value to be taken between CC-G, CL-G & CC-CL by applying 2 kV DC

Terminals	Insulation Value	Terminals	Insulation Value
CC-G		CC-CL	
CL-G		Semi-shield –G (if provided) at 1 kV	

Note:

i. **Permissible value > 500 MΩ**

ii. Ensure shorting of CC-CL & G after the completion of the testing

XI. Oil Characteristics

(Sample to be taken prior to charging to Reactor and it should fulfill the recommendations as per IS 1865 /IEC 60422)

DATE OF OIL SAMPLING	B.D.V.	MOISTURE	TAN δ	RESISTIVITY	INTERFACIAL TENSION
Permissible Limit →	**70KV(min)**	**5 PPM(Max)**	**0.01 at 90° C (Max)**	**6x 10 ^12 Ω - CM at 90° C (Min)**	**0.0 35 N/m at 27°C (Min)**

DISSOLVE GAS ANALYSIS

Dissolve Gasses	H2	CH4	C2H4	C2H6	C2H2	CO	CO2	O2	N2	TCG

Note:-

i. TCG should be below 1%

ii. One fresh oil sample per lot (from drum) shall be sent to Lab for carrying out Oxidation Stability test

XII. Operational Test Of Other Equipments

i. Checking of cooling Equipments

SL.NO	DESCRIPTION	STATUS		
		OK	NOT OK	
1	Rotation direction of Fans			

XIII. Checks on Bushing CT's

a) Rated Data And Duty

	Core	Ratio	Class	Burden	Kvp	Protection / Metering
HV	Core-I					
	Core II					
	Core III					
	Core IV					
Neutral	Core-I					
	Core II					
	Core III					
	Core IV					

b) Insulation Resistance Measurement Of Bushing CT's(Using 500v Megger)

MEASUREMENT BETWEEN	UNIT	HV		
		R – Ø	Y - Ø	B - Ø
Earth - Core I	M Ω			
Earth - Core II	M Ω			
Earth - Core III	M Ω			
Earth - Core IV	M Ω			

i.

MEASUREMENT BETWEEN	UNIT	HV		
		R – Ø	Y - Ø	B - Ø
Core I – Core II	M Ω			
Core I – Core III	M Ω			
Core I – Core IV	M Ω			
Core II – Core III	M Ω			
Core II – Core IV	M Ω			
Core III – Core IV	M Ω			

c) Continuity Test Of Bushing Ct's (In Ω)

Continuity, Check between Terminals OK / NOT OK

CORE	BETWEEN TERMINAL	HV		
		R - Ø	Y - Ø	B - Ø
Core – I	1S1–1S2			
Core – II	2S1–2S2			
Core – III	3S1–3S2			
Core – IV	4S1–4S2			

d) Secondary Winding Resistance Of Bushing CT's (In Ω)

i. HV side

CORE	BETWEEN TERMINAL	UNIT	R - Ø		Y - Ø		B - Ø	
			FACTORY	SITE	FACTORY	SITE	FACTORY	SITE
Core I	1S1 – 1S2	Ω						
Core II	2S1 – 2S2	Ω						
Core III	3S1 – 3S2	Ω						
Core IV	4S1 – 4S2	Ω						

ii. Neutral Side

CORE	BETWEEN TERMINAL	UNIT	R - Ø	
			FACTORY	SITE
Core I	1S1 – 1S2	Ω		

iii. External Neutral CT

CORE	BETWEEN TERMINAL	UNIT	R - Ø	
			FACTORY	SITE
Core I	1S1 – 1S2	Ω		

e) Polarity Test Of Bushing CT'S

With 1.5 V DC supply (Connect +ve at P1 and –ve at P2)

CORE	BETWEEN		HV		
			R - Ø	Y - Ø	B - Ø
Core I	1S1 (+ve)	1S2 (-ve)			
Core II	2S1 (+ve)	2S2 (-ve)			
Core III	3S1 (+ve)	3S2 (-ve)			
Core IV	4S1 (+ve)	4S2 (-ve)			

f) Current Ratio Test

Primary Injection through Primary Injection Kit at Primary Terminal P1 – P2
Measure current on the secondary Terminals

i. HV side R – Phase side

CORE S1 - S2	PRIMARY %	CURRENT ACTUAL	SECONDARY CURRENT	THEORETICAL RATIO	ACTUAL RATIO	% OF ERROR
Core I (1S1 – 1S2)	20%					
	40%					
	80%					
Core II (2S1 – 2S2)	20%					
	40%					
	80%					
Core III (3S1 – 3S2)	20%					
	40%					
	80%					
Core IV (4S1 – 4S2)	20%					
	40%					
	80%					

ii. HV side Y – Phase

CORE S1 - S2	PRIMARY %	CURRENT ACTUAL	SECONDARY CURRENT	THEORETICAL RATIO	ACTUAL RATIO	% OF ERROR
Core I	20%					
(1S1 – 1S2)	40%					
	80%					
Core II (2S1 – 2S2)	20%					
	40%					
	80%					
Core III (3S1 – 3S2)	20%					
	40%					
	80%					
Core IV (4S1 – 4S2)	20%					
	40%					
	80%					

iii. HV side B – Phase

CORE S1 - S2	PRIMARY %	CURRENT ACTUAL	SECONDARY CURRENT	THEORETICAL RATIO	ACTUAL RATIO	% OF ERROR
Core I (1S1 – 1S2)	20%					
	40%					
	80%					
Core II (2S1 – 2S2)	20%					
	40%					
	80%					
Core III (3S1 – 3S2)	20%					
	40%					
	80%					
Core IV (4S1 – 4S2)	20%					
	40%					
	80%					

g) Magnetising Curves Performance

(Not to be done for metering Core)
Knee Point Voltage (KVp) = ……..Volt

i. HV Side R – Phase

VOLTAGE		UNIT	CURRENT MEASUREMENT			
TO BE APPLIED	ACTUAL VALUE		CORE – I 1S1-1S2	CORE – II 2S1-2S2	CORE – III 3S1-3S2	CORE – IV 4S1-4S2
0.25 x KVp	mA					
0.50 x KVp	mA					
0.75 x KVp	mA					
1.00 x KVp	mA					
1.10 x KVp	mA					

ii. HV Side Y – Phase

VOLTAGE		UNIT	CURRENT MEASUREMENT			
TO BE APPLIED	ACTUAL VALUE		CORE – I 1S1-1S2	CORE – II 2S1-2S2	CORE – III 3S1-3S2	CORE – IV 4S1-4S2
0.25 x KVp	mA					
0.50 x KVp	mA					
0.75 x KVp	mA					
1.00 x KVp	mA					
1.10 x KVp	mA					

iii. HV Side B – Phase

VOLTAGE		UNIT	CURRENT MEASUREMENT			
TO BE APPLIED	ACTUAL VALUE		CORE – I 1S1-1S2	CORE – II 2S1-2S2	CORE – III 3S1-3S2	CORE – IV 4S1-4S2
0.25 x KVp	mA					
0.50 x KVp	mA					
0.75 x KVp	mA					
1.00 x KVp	mA					
1.10 x KVp	mA					

Note: 1.0 CT should not saturate at 110% of Knee Point Voltage (KVp)
2.0 If Knee Point Voltage is not mentioned then Knee Point Current may be taken into consideration.

XIV. Contact Resistance Measurement at 100 Amps

CONTACT RESISTANCE	UNITS	R - Ø	Y - Ø	B - Ø
Across HV Bushing Terminal Joint	μ Ω			
Across Neutral Bushing terminal joint	μ Ω			
NGR terminal connector	μ Ω			

The value of Contact Resistance should not be more than 10 Micro – ohms per Joint / Connector

XV. Protection And Alarms

i.

SL NO	DEVICE	SET FOR		PROVED	
		ALARM	TRIP	ALARM	TRIP
1	EXCESSIVE WINDING TEMPERATURE.				
2	EXCESSIVE OIL TEMPERATURE.				
3	PRESSURE RELIEF VALVE (MAIN TANK)	NA		NA	
4	PRESSURE RELIEF VALVE (NGR)	NA		NA	
5	MAIN TANK BUCHHOLZ RELAY				
6	NGR BUCHHOLZ RELAY				
7	FAN FAILURE\		NA		NA
8	LOW OIL LEVEL (MAIN TANK)		NA		NA
9	LOW OIL LEVEL (NGR)		NA		NA
10	HIGH OIL LEVEL (MAIN TANK)		NA		NA
11	OTI (MAIN TANK)	**90**	**100**		
12	OTI (NGR)				
13	WTI (MAIN TANK)	**100**	**110**		
14	DIFFERENTIAL	NA		NA	
15	BACKUP IMPEDENCE RELAY	NA		NA	
16	EARTH FAULT RELAY (REF)	NA		NA	
17	INTER TRIP , IF ANY	NA		NA	
18	TRIP FREE CHECK	NA		NA	
19	TEED PROTECTION				
20	On Line DGA alarm				

ii. Protection setting applied as per CC-Engg. approved settings

Yes	No	Remarks

iii. Stability test of differential and REF protection (at 10 kV)

Ok	Not Ok	Remarks

iv. Delta formation of single phase units and spare switching arrangement scheme checked

Yes	No	Remarks

NOTE : **Prove the tripping of associated breakers by actual operation of the various devices and relays as per the schemes.**

XVI. Final Documentation Review

i. Factory test results are available

Yes	No

ii. All electrical test results compared with factory test results & found to be in order

Yes	No

iii. Final documents of Pre- Commissioning checks reviewed and approved

Yes	No

iv. Document regarding spares equipment, O&M manuals etc available at site

Yes	No

XVII. Checks After Charging Of Reactor

Yes	No

Record the following after charging

i. Any abnormal sound emanating from the reactor

Yes	No	Remarks

ii. No load current at relay terminal

R - Ø	A
Y - Ø	A
B - Ø	A

iii. Temperature at the time of charging

OTI	° C
WTI	° C
AMBIENT	° C

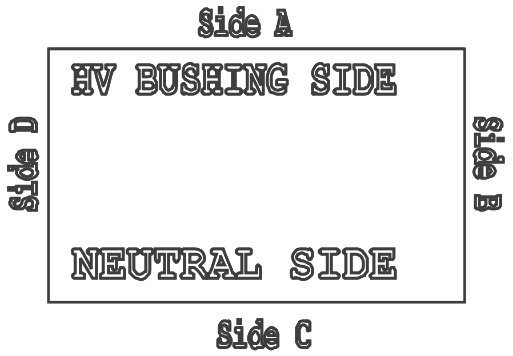
iv. Maximum temperature after 24 hours_____° C

v. Thermo vision scanning done at least after 24 hours of loading & repeated one week.

Yes	No	Remarks

vi. **VIBRATION MEASUREMENT TEST**

a) Vibration measurements are to be carried out after energization of the reactor. This will be a reference data for future Measurements.
b) Various locations are to be shown in the diagram with x,y co-ordinates for easy identification.



SL. NO	DATE OF MEASUREMENT	LOCATION	VALUE	REMARKS

Signature:	Signature:	Signature:	Signature:
Name:	Name:	Name:	Name:
Desgn.:	Desgn.:	Desgn.:	Desgn.:
Organization: (Supplier Representative) (Wherever Applicable)	(Erection Agency)	(POWERGRID Site I/C)	(POWERGRID Commg. Team) Members: 1. 2. 3.

PRE-COMMISSIONING FORMATS FOR CIRCUIT BREAKER

I. General Details

DETAILS	
Region:	**Sub-Station:**
Feeder Name:	**LOA No. :**
Make:	**Year of Manufacture:**
Equipment Designation: **Ex: 452**	
Sr. No.:	**Type:**
Rating:	**Rated Breaking Capacity(kA):**
Operating Voltage:	**Control Voltage (DC) :**
Date of Receipt at site:	**Date of Erection:**
Date of energisation:	

II. Pre-Commissioning Checks:

Sl .No	Description	Status		Remarks
		Yes	No	
1	Equipment is free from dirt/dust/rust/ foreign materials etc.			
2	Equipment is free from all visible defects on physical inspection			
3	Support structures, marshalling box has been provided with double earth			
4	All nuts and bolts are tightened correctly as per specified torque			
5	Equipment erection is complete in all respect & erection completion certificate along with list of outstanding activities reviewed (attach remaining activities, if any)			
6	Permanent pole leveling and identification is done			

Sl .No	Description	Status		Remarks
		Yes	No	
7	Leveling and alignment of structure and base frame is checked			
8	Control box / marshalling kiosk is free from any physical defects			
9	Tightness of nuts bolts of terminal connectors are checked			
10	Auxiliary contacts and relays have been cleaned and free from rust / damage			
11	All spare wires to be kept with ferrules but not terminated at the terminal blocks			
12	Check all the valves in the SF6 pipe line are tightened, DILO coupling are tightened.			
13	Slow and power closing operation and opening done (wherever applicable)			

III. Operating System

Closing		Opening	
Hydraulic		Hydraulic	
Pneumatic		Pneumatic	
Spring		Spring	
Others		Others	

A. Hydraulic system

a) Accumulator

	R Ø	Y Ø	B Ø
Make			
Serial number			
Type			
Year of manufacture			

b) Pump details

Make		Volt	
Serial number		Amperes	
Type		Hp/ kW	
Year of manufacturer		O/L setting (Thermal Over load)	

c) Details of relays/contactors used

Schematic drawing no_____

Circuit Reference	Make	Type	No+Nc
Oil Pressure Switch			
Closing Lockout			
Auto Reclosing Lockout			
Operational Lockout			
Anti Pumping Contactor			
Pole Discrepancy Timer			
SF6 Alarm/Lockout			

d) Operation checks

Date of Hydraulic Oil filling_____

Type of Hydraulic Oil _____

1. Venting of Hydraulic system

Sl .No	Item Description	Status		REMARKS
		Yes	No	
1	Pump			
2	Pilot Valve			
3	Main Valve			
4	Accumulator			
5	Hydraulic Mechanism			

2. Pressurising hydraulic system

Sl.No	Description	Factory Test Value	Site Test Value	Remark Record Deficiencies, If Any
1	Pre-filling pressure of N_2 in accumulator (bar / °C)			
2	Pump running time for charging hydraulic system from initial pressure to working pressure			
3	Checking safety valve (open/close)			
4	Hydraulic pressure drop for 1 hr			
	Breaker on position			
	Breaker off position			
5	Oil pressure monitor			
	Pump on / off bar			
	Pump running time			
6	Auto reclosing lockout (oil) Pressure contact _____ make/break			
7	Closing lockout (oil) pressure Contact _____ make/break			
8	General lockout (oil) Pressure contact _____ make/break			
9	Checking loss of nitrogen Pressure contact _____ make/break			

Factory test report ref no: _____

3. Oil pressure drop during operations and pump running time in seconds

Sl.No	Description	Factory Test Value	Site Test Value
(i)	Pressure before operation(Bar)		
	Pressure after closing operation(Bar)		
	Pump running time(Sec)		
(ii)	Pressure before operation(Bar)		
	Pressure after opening operation(Bar)		
	Pump running time(Sec)		
(iii)	Pressure before operation(Bar)		
	Pressure after close/open operation (Bar)		
	Pump running time in sec		
(iv)	Pressure before operation(Bar)		
	Pressure after open-close-open operation(Bar)		
	Pump running time(Sec)		

Factory test report ref no: _____

B. Pneumatic System

a) Operating system details

	R - Ø	Y - Ø	B - Ø	Remarks
Air receiver no.				
Control block no.				
Pneumatic drive no.				
Magnetic ventil no.				

b) Motor details

Make		Volt	
Serial number		Amperes	
Type		Hp/ kW	
Year of manufacturer		O/L setting (Thermal Over load)	

c) ICU Details

Make	
Serial number	
Type	
Discharge	
Capacity	
Year of manufacturer	

d) Details of Relays / Contactors used

Schematic drawing no_____

Circuit Reference	Make	Type	NO+NC
Air Pressure Monitor			
Closing Lockout			
Auto Reclosing Lockout			
General Lockout			
Pole Discrepancy Timer			
Auxiliary			
Power Contactor in ICU			
SF6 Alarm/Lockout			

e) Pressure Switch setting

Circuit Reference	Factory Setting Value		Site Setting Value		Make	Remarks	
	Block	De-block	Block	De-block			
Operation lockout -1							
Operation lockout -2							
Closing lockout							
Auto reclosing ckt							
Low/high pressure							
Alarm circuit							
Compressor start/stop setting							
Compressor safety valve							

Factory test report ref. no: _____

f) Pressure drop during operation : (in kg/ sq.cm -bar)

Sl No	Description	Factory Setting Value	Site Setting Value
1	Tripping through TC-I		
2	Tripping through TC- II		
3	Closing circuit		
4	Close-open operation		
5	Open - close - open		

Factory test report ref no: _____

g) **Air pressure drop in 24 hrs**

	Drop In Pressure In Kg/Sq.Cm Or Bar
Breaker "**On**"	
Breaker "**Off**"	

C. Spring Operating System

a) Motor details

Make		Volt	
Sl no		Amperes	
Type		Hp/kw	
Year of Manufacture		Setting (thermal overload)	
Current taken by motor for charging the spring (amp)		IR of spring charging motor	

b) Details of relays/contactors used : schematic drawing no

Circuit Reference	Make	Serial No.	Type	No+Nc
Closing lockout				
Auto reclosing lockout				
General lockout				
Pole discrepancy timer				

c) Spring operating time

Details	R- Ø				Y- Ø				B- Ø			
	Factory		Site		Factory		Site		Factory		Site	
Charging Time												

Factory test report ref no: _____

IV. SF6 DENSITY MONITOR DETAILS

A.

	R- Ø		Y- Ø		B- Ø	
	R1 Ø	R2 Ø	Y1 Ø	Y2 Ø	B1 Ø	B2 Ø
Make						
Model						
Sl.no						
Year of manufacture						
Final filling pressure						

B. SF6 density monitor settings

SF6 gas filled at _____ bar at _____ deg. C on ___/___/___

Phase (Ø)	Details	Blocking		De-blocking	
		Factory	Site	Factory	Site
R1 Ø (Bus side)	Low Pressure alarm				
	Lock out pressure				
R2 Ø (Line side)	Low Pressure alarm				
	Lock out pressure				
Y1 Ø (Bus side)	Low Pressure alarm				
	Lock out pressure				
Y2 Ø (Line side)	Low Pressure alarm				
	Lock out pressure				
B1 Ø (Bus side)	Low Pressure alarm				
	Lock out pressure				
B2 Ø (Line side)	Low Pressure alarm				
	Lock out pressure				

Factory test report ref no: _____

C. Measurement of dew point of Sf6 gas

Sl. No	Measured Value	Measurement Pressure
1	R1 Ø (Bus side)	
2	R2 Ø (Line side)	
3	Y1 Ø (Bus side)	
4	Y2 Ø (Line side)	
5	B1 Ø (Bus side)	
6	B2 Ø (Line side)	

Note: Dew point measurement of SF6 gas needs to be done pole wise in close loop method without any wastage of SF6 gas

D. Leakage check

SL.NO	INTERVALS	UNIT	
A	Initial filling of SF6 gas at ____deg C (As per temp. Correction chart)	BAR	
B	Drop in sf6 gas pressure in 24 hrs :	BAR	
C	Final SF6 pressure at _____deg. C after all testing	BAR	
D	Additional leakage test by covering individual joint with polythene	YES	NO

V. COIL RESISTANCE MEASUREMENT

COIL DETAILS	MEASURED IR VALUE IN Ω					
	R1- Ø	R2- Ø	Y1- Ø	Y2- Ø	B1- Ø	B2- Ø
TRIP COIL- I						
TRIP COIL-II						
CLOSE COIL						

VI. CIRCUITRY / OPERATIONAL CHECKS

Sl No	Circuit Reference	Circuitry Check		Operational Check	
		Local	Remote	Local	Remote
A	Tripping Through TC-I				
B	Tripping Through TC-II				
C	Closing Circuit				
D	Anti-hunting Feature				
	(Close Open Operation)				
E	Pole Discrepancy Feature				
F	Breaker Position Indication				
G	Heater In Switch Cubicle				
H	Heater In Control Cubicle				
I	Illum. In Switch Cubicle				
J	Illum. In Control Cubicle				

Note: In case wiring for remote operation is not ready, please indicate terminal number along with wire ferrule number in switch cubicle where remote cables shall be terminated. Remote operation can be checked from these terminals.

VII. OPERATING TIME (IN MILLI-SECONDS)

Phase (Ø)	Break	Close (Max 150ms)	Trip (Max 25ms 400kV& 765 kV,35ms 220kV, 40ms 132kV/66kV)		Close Trip (Min. 35 ms)	
			Trip - I	Trip - II	Trip - I	Trip - II
R- Ø main contact	Break -1					
R- Ø PIR						
Auxiliary contact						
R - Ø main contact	Break -2					
R - Ø PIR						
Auxiliary contact						
R - Ø main contact	Break -3					
R - Ø PIR						
Auxiliary contact						
R - Ø main contact	Break -4					
R - Ø PIR						
Auxiliary contact						

Phase (Ø)	Break	Close (Max 150ms)	Trip (Max 25ms 400kV& 765 kV,35ms 220kV, 40ms 132kV/66kV)		Close Trip (Min. 35 ms)	
			Trip - I	Trip - II	Trip - I	Trip - II
Y- Ø main contact	Break -1					
Y- Ø PIR						
Auxiliary contact						
Y - Ø main contact	Break -2					
Y - Ø PIR						
Auxiliary contact						
Y - Ø main contact	Break -3					
Y - Ø PIR						
Auxiliary contact						
Y - Ø main contact	Break -4					
Y - Ø PIR						
Auxiliary contact						
B - Ø main contact	Break -1					
B - Ø PIR						
Auxiliary contact						
B - Ø main contact	Break -2					
B - Ø PIR						
Auxiliary contact						
B - Ø main contact	Break -3					
B - Ø PIR						
Auxiliary contact						
B - Ø main contact	Break -4					
B - Ø PIR						
Auxiliary contact						

NOTE: for 765 kV, take measurements for four breaks

VIII. IR VALUE OF CONTROL CIRC UIT(USING 500 VOLT MEGGER)

Coil Details	Unit	Measurement Value	
		Pole - I	Pole - II
R – Ø TRIP COIL - I	MΩ		
R – Ø TRIP COIL - II	MΩ		
R – Ø CLOSE COIL	MΩ		
Y – Ø TRIP COIL - I	MΩ		
Y – Ø TRIP COIL - II	MΩ		
Y – Ø CLOSE COIL	MΩ		
B – Ø TRIP COIL - I	MΩ		
B – Ø TRIP COIL - II	MΩ		
B – Ø CLOSE COIL	MΩ		

CAUTION: Isolate necessary dc for trip coil-I and trip coil-II , closing coil before meggaring.

IX. IR VALUE WITH BREAKER OP EN(USING 5000 VOLT MEGGER)

PHASE	ACROSS OPEN CONTACT BREAK 1	ACROSS OPEN CONTACT BREAK 2	ACROSS OPEN CONTACT BREAK 3	ACROSS OPEN CONTACT BREAK 4
R				
Y				
B				

MINIMUM VALUE 1000 M Ω

X. IR VALUE WITH RESPECT TO EART H WITH BREAKER CLOSED, EARTH SWITCH AND ISOLATOR OPEN

MEASURED IR VALUE INMΩ					
R1 Ø -G	R2 Ø -G	Y1 Ø -G	Y2 Ø -G	B1Ø - G	B2Ø-G

MINIMUM VALUE 1000 M Ω

XI. MINIMUM PICKUP VOLTAGE OF COILS

COIL DETAILS	PICKUP VOLTAGE IN VOLTS					
	R1- Ø	R2- Ø	Y1- Ø	Y2- Ø	B1- Ø	B2- Ø
TRIP COIL-I						
TRIP COIL -II						
CLOSING COIL						

XII. GRADING CAPACITOR

i. Details

Details	Interrupter 1			Interrupter 2		
	R	Y	B	R	Y	B
MAKE						
SERIAL NO.						
CAPACITANCE VALUE						
FACTORY VALUE						
YEAR OF MANUFAC.						

ii. Capacitance And Tan Delta Measurement (To Be Done In UST Mode)

Capacitance	Interrupter 1			Interrupter 2		
	R	Y	B	R	Y	B
SITE						
-FACTORY						
% DEVIATION						
TAN DELTA						
SITE						
-FACTORY						
% DEVIATION						

Permissible Limits

a) Tan delta of grading capacitors 0.005 (max.)

b) Capacitance of grading capacitors within ±5% of the rated value

XIII. CONTACT RESISTANCE MEASUREMENT (MICRO Ω)

PHASE	ACROSS EACH POLE		PHASE	ACROSS EACH POLE	
	FACTORY	SITE		FACTORY	SITE
R 1 - Ø			Y 3 - Ø		
R 2 - Ø			Y 4 - Ø		
R 3 - Ø			B 1 - Ø		
R 4 - Ø			B 2 - Ø		
Y 1 - Ø			B 3 - Ø		
Y 2 - Ø			B 4 - Ø		

a) Contact Resistance of CB (in Micro-Ω)

765 kV	400kV	220kV	132kV
75 µΩ/ break	75 µΩ/ break	75 µΩ	100 µΩ

b) Contact Resistance of CB terminal connector 10 Micro-Ω per connector

Factory test report ref no :_____

XIV. BREAKER OPERATION COUNTER READING

Counter Type	Put • Mark
ELECTRICAL	
MECHANICAL	

Sl.No	Phase	Reading	Date
A	R-Ø		
B	Y-Ø		
C	B-Ø		

XV. CHECK FOR ANNUNCIATION IN CONTROL ROOM AS PER THE FOLLOWING FORMATS AND RECORD THE READING

Sl No	Description Of Test	Source Of Initiation	Window Description	Result		Remark
				O K	NOT OK	
A	Switch off the dc switch in Control cubicle	Control cubicle dc Switch on/off	Source I/II dc fail / ac fail			
B	Switch off the ac Switch in control Cubicle	Control cubicle ac	Source I/II dc fail / ac fail			
		Switch on/off				
C	Short the alarm contacts of sf6 Gas density monitor (R-Ø)	Density monitor	Sf6 gas density low			
D	Short the alarm contacts of sf6 Gas density monitor (Y-Ø)	Density monitor	Sf6 gas density low			
E	Short the alarm contacts of sf6 Gas density monitor (B-Ø)	Density monitor	Sf6 gas density low			
F	Remove the cable connected to density monitor (R-Ø)	Density monitor	Operation/closing lockout			
G	Remove the cable connected to density monitor (Y-Ø)	Density monitor	Operation/closing lockout			
H	Remove the cable connected to density monitor (B-Ø)	Density monitor	Operation/closing lock out			
I	Give tripping command to R-ph only and check the operation of pole discrepancy relay	Pole discrepancy relay at breaker Cubicle	Breaker pole discrepancy			
J	Give tripping command to Y-Ø Only and check the operation of pole discrepancy relay	Pole discrepancy relay at breaker Cubicle	Breaker pole discrepancy			
K	Give tripping Command to B-ph only and check the operation of pole discrepancy relay	pole discrepancy relay at breaker cubicle	Breaker pole discrepancy			
L	Check other alarms as per plant Circuit diagram					
M	Close the breaker and trip through Protection which are applicable	protection relay as per scheme	Breaker auto trip			

NOTE : The tripping details are to be checked as per the Scheme approved by engineering.

XVI. DYNAMIC CONTACT RESISTANCE & TRAVEL MEASUREMENT

Phase (Ø)	Factory	Site	Remarks	Approval From CC/OS Obtained
R				
Y				
B				

XVII. OPERATION TIME MEASUREMENT OF POLE DISCREPANCY RELAY

Pole discrepancy relay	Setting	Actual

Note- 2.5 Sec for CBs with Auto Reclose Function & 0.5 Sec for CBs without Auto Reclose Function.

CONTROLLED SWITCHING RELAY (If provided)

Make: **Model:** **Date of installation:**

Application: Reactor/ Transformer

Settings	Trip Operation	Close Operation
R- Ø		
Y- Ø		
B- Ø		

XVIII. MECHANICAL CLOSE INTERLOCK CHECKED (WHEREVER APPLICABLE)

Yes	No

XIX. FINAL DOCUMENTATION REVIEW

i. Factory test results are available

Yes	No

ii. Final documents of Pre- Commissioning checks reviewed and approved

Yes	No

iii. Docum ent regarding spares equipment, O&M manuals etc available at sit for O&M purpose

Yes	No

iv. After modification, if any, "As built Drawings" are available at site

Yes	No

v. CC-OS approved DCRM signatures available

Yes	No

Signature:	Signature:	Signature:	Signature:
Name:	Name:	Name:	Name:
Designation:	Designation:	Designation:	Designation:
Organization: (Supplier Representative) (Wherever Applicable)	(Erection Agency)	(POWERGRID Site I/C)	(POWERGRID Commissioning. Team) Members: 1. 2. 3. 4.

PRE-COMMISSIONING FORMATS FOR CURRENT TRANSFORMER

I. General Details

DETAILS	
Region:	**Sub-Station:**
LOA No. :	**Make:**
Sr. No.: **R Ø:-** **YØ:-** **BØ:-**	**Type:**
Year of Manufacture: **R Ø:-** **YØ:-** **BØ:-**	**Rating:**
Date of Receipt at site: **R Ø:-** **YØ:-** **BØ:-**	**Date of Erection:** **R Ø:-** **YØ:-** **BØ:-**
Date of energisation	

II. Rated Data And Duty

Core	Ratio	Class	Burden	KVp	Protection / Metering
Winding I					
Winding II					
Winding III					
Winding IV					
Winding V					

KVp: Knee Point Voltage In Volts

III. Pre-Commissioning Checks:

Sl. No	Description	Status		Remark
		Yes	No	Record Deficiencies, If Any
1	Equipment is cleaned and free from dust / dirt foreign materials etc.			
2	Equipment is free from all visible defects on physical inspection			
3	Check ct tank has been provided with double earthing (dead tank CT's)			
4	Check that ct junction box is earthed.			
5	All nuts and bolts are tightened correctly as per specified torque			
6	Check tightness of terminal connector			
7	All fittings as per out line general arrangement drawing.			
8	Leveling and alignment of structure and base frame is checked			
9	Erection completion certificate along with list of outstanding activities reviewed			
10	Any paint removed / scratched in transit has been touched up			
11	Check primary polarity of CTs erected as per relevant drawing.			
12	Check hermetically sealing is intact			
13	Check the oil level and leakage through any joints / sec. Terminals			
14	Check oil drain valve is properly closed and locked.			
15	Oil level & oil sampling			
16	N2 pressure checked (wherever applicable)			
17	Oil level on top chamber gauge glass			
18	BDV of oil sample taken from tank bottom drain valve (only if Nitrogen pressure is measured zero)			
19	All the cable identification tags provided and all cores are provided with identification ferrules at MB.			
20	Check secondary cable end box is properly fixed and ensure cable entry at the bottom and unused holes sealed			
21	Ensure interpole cabling is completed and check the continuity.			
22	Check the ir value of secondary cable			
23	Check external cabling from junction- box to relay / control panel completed			
24	Ensure unused secondary cores, if any, has been shorted and earthed			
25	Check star point has been formed properly and grounded at one end only			
26	Check spark gap setting in p1 terminal (wherever provided/ possible) permanent Pole leveling and identification markings made			
27	Check tan delta test tap is properly earthed			
28	Check that lugs used in secondary circuit are of ring type			
29	Check direction of primary (P1/ P2) w.r.t. Bus/ line on erection			
30	Provision of bimetallic strips (cu +al) ensured wherever applicable			
31	Physically open the bellow cover and check the oil in bellow			
32	Ensure the proper sealing of the CT MB against moisture ingress			

IV. Insulation Resistance Measurement

a) Insulation Resistance Measurement (Using 5000Volt Megger)

Make & Sl. No of testing kit _____

Date of last calibration of the kit _____

Ambient temp in º C _____

Remove the connected earthing to system involving ct under test and disconnect the connected terminals of ct marshalling box.

Core	Unit	Phase		
		R	Y	B
PRIMARY - CORE I	M Ω			
PRIMARY - CORE II	M Ω			
PRIMARY - CORE III	M Ω			
PRIMARY - CORE IV	M Ω			
PRIMARY - CORE V	M Ω			
PRIMARY - CORE VI	M Ω			
PRIMARY - EARTH	M Ω			

*** Permissible limit of IR value should be > 1000 M Ω**

b) Insulation Resistance Measurement in MΩ (Using 500 V Megger)

Make & Sl. No of testing kit _____

Date of last calibration of the kit _____

Ambient temp in º C _____

Between	Unit	Phase		
		R Ø	Y Ø	B Ø
SECONDARY CORE I - EARTH	M Ω			
SECONDARY CORE II - EARTH	M Ω			
SECONDARY CORE III - EARTH	M Ω			
SECONDARY CORE IV - EARTH	M Ω			
SECONDARY CORE V - EARTH	M Ω			
SECONDARY CORE V - EARTH	M Ω			

***Permissible limit of IR value should be > 50 M Ω**

c)

Between	Unit		Phase	
		R Ø	Y Ø	B Ø
CORE I - CORE II	M Ω			
CORE I - CORE III	M Ω			
CORE I - CORE IV	M Ω			
CORE I - CORE V	M Ω			
CORE I - CORE VI	M Ω			
CORE II - CORE III	M Ω			
CORE II - CORE IV	M Ω			
CORE II - CORE V	M Ω			
CORE II - CORE V	M Ω			
CORE III - CORE IV	M Ω			
CORE III- CORE V	M Ω			
CORE III- CORE VI	M Ω			
CORE IV - CORE V	M Ω			
CORE IV - CORE VI	M Ω			
CORE V- CORE VI	M Ω			

d) Check IR value between tan delta point and earth at 1 kv in secondary box

R Ø	Y Ø	B Ø

V. Measurement Of Secondary Winding Resistance (In Ohm)

Make of testing kit _____
Date of calibration_____
Ambient temperature _____

Core	Terminal	Unit	R Ø		Y Ø		B Ø	
			Factory	Site	Factory	Site	Factory	Site
CORE I	1S1 - 1S2	Ω						
	1S1 - 1S3	Ω						
	1S1 - 1S4	Ω						
CORE II	2S1 - 2S2	Ω						
	2S1 - 2S3	Ω						
	2S1 - 2S4	Ω						
CORE III	3S1 - 3S2	Ω						
	3S1 - 3S3	Ω						
	3S1 - 3S4	Ω						
CORE IV	4S1 - 4S2	Ω						
	4S1 - 4S3	Ω						
	4S1 - 4S4	Ω						
CORE V	5S1 - 5S2	Ω						
	5S1 - 5S3	Ω						
	5S1 - 5S4	Ω						
CORE VI	6S1 - 6S2	Ω						
	6S1 - 6S3	Ω						
	6S1 - 6S4	Ω						

VI. POLARITY TEST

With 1.5 Volt connect +ve at P1 and –ve at P2

Core	Between		Phase		
			R Ø	Y Ø	B Ø
CORE I	1S1 (+VE)	1S2 (-VE)			
	1S1 (+VE)	1S3 (-VE)			
	1S1 (+VE)	1S4 (-VE)			
CORE II	2S1 (+VE)	2S2 (-VE)			
	2S1 (+VE)	2S3(-VE)			
	2S1 (+VE)	2S4 (-VE)			
CORE III	3S1 (+VE)	3S2(-VE)			
	3S1 (+VE)	3S3(-VE)			
	3S1 (+VE)	3S4(-VE)			
CORE IV	4S1 (+VE)	4S2(-VE)			
	4S1 (+VE)	4S3(-VE)			
	4S1 (+VE)	4S4(-VE)			

Core	Between		Phase		
			R Ø	Y Ø	B Ø
CORE V	5S1 (+VE)	5S2(-VE)			
	5S1 (+VE)	5S3(-VE)			
	5S1 (+VE)	5S4(-VE)			
CORE VI	6S1 (+VE)	6S2(-VE)			
	6S1 (+VE)	6S3(-VE)			
6S1	(+VE)	6S4(-VE)			

VII. Tan Delta And Capacitance Measurement

Make of testing kit _____

Date of calibration _____

Ambient temperature _____

Capacitance

Across Stack	Pre Commissioning Values			Factory Values			% Deviation		
	R Ø	Y Ø	B Ø	R Ø	Y Ø	B Ø	R Ø	Y Ø	B Ø
2kV									
10 kV									

Tan Delta

Across Stack	Pre Commissioning Values			Factory Values			% Deviation		
	R Ø	Y Ø	B Ø	R Ø	Y Ø	B Ø	R Ø	Y Ø	B Ø
2kV									
10 kV									

Permissible Limits Tan δ 0.005 (max.) and Rate of rise in Tan Delta 0.001 per year (max)
Deviation of Capacitance value from factory value should be within ± 5% of the rated value

Factory Test Report Ref. No:_____

VIII. Current Ratio Test

Make of testing kit _____

Date of calibration _____

Primary Injection through Primary Injection Kit at Primary Terminal P1 – P2
Measure the current on the secondary Terminals

R Phase-

Core	Primary Current		Secondary Current	Theoret-ical Ratio	Actual Ratio	% Of Error
	%	ACTUAL				
CORE I (1S1 - 1S2)	20 %					
	40 %					
	80 %					
CORE II (2S1 - 2S2)	20 %					
	40 %					
	80 %					

Core	Primary Current		Secondary Current	Theoret-ical Ratio	Actual Ratio	% Of Error
	%	ACTUAL				
CORE III (3S1 - 3S2)	20 %					
	40 %					
	80 %					
CORE IV (4S1 - 4S2)	20 %					
	40 %					
	80 %					
CORE V (5S1 - 5S2)	20 %					
	40 %					
	80 %					
CORE VI (6S1 - 6S2)	20 %					
	40 %					
	80 %					
CORE I (1S1 - 1S3)	20 %					
	40 %					
	80 %					
CORE II (2S1 - 2S3)	20 %					
	40 %					
	80 %					
CORE III (3S1 - 3S3)	20 %					
	40 %					
	80 %					
CORE IV (4S1 - 4S3)	20 %					
	40 %					
	80 %					
CORE V (5S1 - 5S3)	20 %					
	40 %					
	80 %					
CORE VI (6S1 - 6S3)	20 %					
	40 %					
	80 %					
CORE I (1S1 - 1S4)	20 %					
	40 %					
	80 %					
CORE II (2S1 - 2S4)	20 %					
	40 %					
	80 %					
CORE III (3S1 - 3S4)	20 %					
	40 %					
	80 %					
CORE IV (4S1 - 4S4)	20 %					
	40 %					
	80 %					

Core	Primary Current		Secondary Current	Theoret-ical Ratio	Actual Ratio	% Of Error
	%	ACTUAL				
CORE V (5S1 - 5S4)	20 %					
	40 %					
	80 %					
CORE VI (6S1 - 6S4)	20 %					
	40 %					
	80 %					

Y Phase

CORE I (1S1 - 1S2)	20 %					
	40 %					
	80 %					
CORE II (2S1 - 2S2)	20 %					
	40 %					
	80 %					
CORE III (3S1 - 3S2)	20 %					
	40 %					
	80 %					
CORE IV (4S1 - 4S2)	20 %					
	40 %					
	80 %					
CORE V (5S1 - 5S2)	20 %					
	40 %					
	80 %					
CORE VI (6S1 - 6S2)	20 %					
	40 %					
	80 %					
CORE I (1S1 - 1S3)	20 %					
	40 %					
	80 %					
CORE II (2S1 - 2S3)	20 %					
	40 %					
	80 %					
CORE III (3S1 - 3S3)	20 %					
	40 %					
	80 %					
CORE IV (4S1 - 4S3)	20 %					
	40 %					
	80 %					
CORE V (5S1 - 5S3)	20 %					
	40 %					
	80 %					
CORE VI (6S1 - 6S3)	20 %					
	40 %					
	80 %					

Core	Primary Current		Secondary Current	Theoret-ical Ratio	Actual Ratio	% Of Error
	%	ACTUAL				
CORE I (1S1 - 1S4)	20 %					
	40 %					
	80 %					
CORE II (2S1 - 2S4)	20 %					
	40 %					
	80 %					
CORE III (3S1 - 3S4)	20 %					
	40 %					
	80 %					
CORE IV (4S1 - 4S4)	20 %					
	40 %					
	80 %					
CORE V (5S1 - 5S4)	20 %					
	40 %					
	80 %					
CORE VI (6S1 - 6S4)	20 %					
	40 %					
	80 %					

B Phase

CORE I (1S1 - 1S2)	20 %					
	40 %					
	80 %					
CORE II (2S1 - 2S2)	20 %					
	40 %					
	80 %					
CORE III (3S1 - 3S2)	20 %					
	40 %					
	80 %					
CORE IV (4S1 - 4S2)	20 %					
	40 %					
	80 %					
CORE V (5S1 - 5S2)	20 %					
	40 %					
	80 %					
CORE VI (6S1 - 6S2)	20 %					
	40 %					
	80 %					
CORE I (1S1 - 1S3)	20 %					
	40 %					
	80 %					
CORE II (2S1 - 2S3)	20 %					
	40 %					
	80 %					

Core	Primary Current		Secondary Current	Theoret-ical Ratio	Actual Ratio	% Of Error
	%	ACTUAL				
CORE III (3S1 - 3S3)	20 %					
	40 %					
	80 %					
CORE IV (4S1 - 4S3)	20 %					
	40 %					
	80 %					
CORE V (5S1 - 5S3)	20 %					
	40 %					
	80 %					
CORE VI (6S1 - 6S3)	20 %					
	40 %					
	80 %					
CORE I (1S1 - 1S4)	20 %					
	40 %					
	80 %					
CORE II (2S1 - 2S4)	20 %					
	40 %					
	80 %					
CORE III (3S1 - 3S4)	20 %					
	40 %					
	80 %					
CORE IV (4S1 - 4S4)	20 %					
	40 %					
	80 %					
CORE V (5S1 - 5S4)	20 %					
	40 %					
	80 %					
CORE VI (6S1 - 6S4)	20 %					
	40 %					
	80 %					

Note: Primary current to be injected as per given % or 1500 Amps whichever is maximum

IX. Magnetising Curves Performance

Knee Point Voltage (KVp) = ……..Volt

R – Phase

Voltage		Unit	Current Measurement			
To Be Applied	Actual Value		CORE – I 1S1-1S2	CORE – II 2S1-2S2	CORE – III 4S1-4S2	CORE – IV 5S1-5S2
0.25 x KVp		mA				
0.50 x KVp		mA				
0.75 x KVp		mA				
1.00 x KVp		mA				
1.10 x KVp		mA				

Y – Phase

Voltage		Unit	Current Measurement			
To Be Applied	Actual Value		CORE – I 1S1-1S2	CORE – II 2S1-2S2	CORE – III 4S1-4S2	CORE – IV 5S1-5S2
0.25 x KVp		mA				
0.50 x KVp		mA				
0.75 x KVp		mA				
1.00 x KVp		mA				
1.10 x KVp		mA				

B – Phase

Voltage		Unit	Current Measurement			
To Be Applied	Actual Value		CORE – I 1S1-1S2	CORE – II 2S1-2S2	CORE – III 4S1-4S2	CORE – IV 5S1-5S2
0.25 x KVp		mA				
0.50 x KVp		mA				
0.75 x KVp		mA				
1.00 x KVp		mA				
1.10 x KVp		mA				

X. Contact Resistance Measurement

Make of testing kit _____

Date of calibration _____

Contact Resistance	Units	R - Ø	Y - Ø	B - Ø
Across Terminal P1	μ Ω			
Across Terminal P2	μ Ω			

The value of Contact Resistance should not be more than 10 Micro – ohms per Joint / Connector

XI. Dissolve Gas Analysis

Duration	H2	CH4	C2H4	C2H6	C2H2	CO	CO2	O2	N2	TCG
After one month of charging										
Before completion of one year of charging										

XII. SF6 Gas and Density Monitor Test

In Case of SF6 gas filled CT

	Set Value			Measured		
	R	Y	B	R	Y	B
Loss of SF6 Alarm						
SF6 lockout/ trip						

a) **Measurement of dew point of sf6 gas**

Phase	Measured Value	Measurement Pressure
R Phase		
Y Phase		
B Phase		

XIII. Shock Indicator impact values (in G)

R Phase	
Y Phase	
B Phase	

Note : Shock recorder value to be filled in case digital recorder or in case of mechanical indicator type shock recorder OK/Not OK to be mentioned.

XIV. Check of SF6 gas purity

R Phase	
Y Phase	
B Phase	

XV. Final Documentation Review

i. Final documents of Pre- Commissioning checks reviewed and approved

Yes	No

ii. Document regarding spares equipment, O&M manuals etc available at site for O&M purpose

Yes	No

iii. After modification, if any, "As built Drawings" are available at site

Yes	No

Signature:	Signature:	Signature:	Signature:
Name:	Name:	Name:	Name:
Designation:	Designation:	Designation:	Designation:
Organization: (Supplier Representative) (Wherever Applicable)	(Erection Agency)	(POWERGRID Site I/C)	(POWERGRID Commissioning. Team) Members: 1. 2. 3. 4.

PRE-COMMISSIONING FORMATS FOR CAPACITIVE VOLTAGE TRANSFORMER

I. General Details

DETAILS	
Region:	**Sub-Station:**
Feeder name	**LOA No. :**
Make:	**Type:**
Sr. No.: **R Ø:-** **YØ:-** **BØ:-**	**Primary Voltage rating**
Secondary Voltage rating: **Winding-I** **Winding-II** **Winding III**	**Secondary Voltage Burden:** **Winding-I** **Winding-II** **Winding III**
Voltage Class: **Winding-I** **Winding-II** **Winding III**	**Purpose of** **Winding-I** **Winding-II** **Winding III**
Rating:	**Feeder name:**
Year of Manufacture: **R Ø:-** **YØ:-** **BØ:-**	**Date of Receipt at site:** **R Ø:-** **YØ:-** **BØ:-**
Date of Erection: **R Ø:-** **YØ:-** **BØ:-**	**Date of energisation**

II. Pre-Commissioning Checks:

Sl. No	Description	Status		Remarks Record Deficiencies, If Any
		YES	NO	
1	Equipment is cleaned and free from dust / dirt foreign materials etc.			
2	Equipment is free from all visible defects on physical inspection			
3	Check CVT tank has been provided with double earthing			
4	Check that CVT marshalling box is earthed correctly as per specified torque			
5	All nuts and bolts are tightened			
6	Check tightness of terminal connector			
7	All fittings as per outline general arrangement drawing.			
8	Labeling and identification marking is carried out			
9	Leveling and alignment of structure and base frame is checked			

Sl. No	Description	Status		Remarks Record Deficiencies, If Any
		YES	NO	
10	Erection completion certificate along with list of outstanding activities reviewed			
11	Any paint removed / scratched in transit has been touched up			
12	Sl. No of HV capacitor identical to the sl.no mentioned on rating & dig. Plate			
13	Ensure brass vent plug between stacks of CVT's is removed			
14	Check the oil level and leakage through any joints / sec. Terminals			
15	Check oil drain valve is properly closed and locked.			
16	Oil level on tank gauge glass			
17	BDV of oil sample taken from tank bottom drain valve			
18	Check secondary cable end box is properly fixed and ensure cable entry at the bottom.			
19	Ensure HF terminal of unused phases has been earthed and no load on HF terminal bushing			
20	Check rating / healthiness of fuses at CVT marshaling.b and CVT terminal box.			
21	Check that the neutral point is earthed			
22	Ensure interpole cabling is completed and check the continuity.			
23	Check the IR value of secondary cable (> 50 m ohms for control cables)			
24	Check external cabling from m.b to relay / control panel completed			
25	All the cable identification tags provided and all cores are provided with identification ferrules at m.b.			
26	Check all the fuse/ MCB			

III. Continuity Of Winding
(After removing Earth Link 1, 2 & 3)

i. Between terminals 1a - 1n

Yes	No

ii. Between terminals 2a - 1n

Yes	No

iii. Between terminals 3a - 1n

Yes	No

IV. Insulation Resistance Measurement

USING A MEGGER OF 5KV/ 10 KV

Between	Unit	Measured Value		
		R Ø	Y Ø	B Ø
Primary - secondary core 1	MΩ			
Primary - secondary core 2	MΩ			
Primary - secondary core 3	MΩ			
Primary - earth Ω	M			

Permissible Limit should be MIN 1000 MΩ

V. Secondary Winding Resistance

Phase	Core 1		Core 2		Core 3		Remarks
	Factory	Site	Factory	Site	Factory	Site	
R Ø							
Y Ø							
B Ø							

Factory test report ref. No: _____

VI. INSULATION RESISTANCE MEASUREMENT

Using A Megger Of 500 Volt

Between	Unit	Measured Value		
		R Ø	Y Ø	B Ø
Secondary core 1 - earth	MΩ			
Secondary core 2 - earth	MΩ			
Secondary core 3 - earth	MΩ			
Core 1 - core 2	MΩ			
Core 1 - core 3	MΩ			
Core 2 - core 3	MΩ			

Permissible Limit should be MIN 50 MΩ

VII. VOLTAGE RATIO TEST

Phase	Primary Voltage	Secondary Voltage		Theoretical Ratio	Actual Ratio		%
		Between	Value		Factory	Site	Error
R		1a – 1 n					
		2a – 2 n					
		3a – 3 n					
Y		1a – 1 n					
		2a – 2 n					
		3a – 3 n					
B		1a – 1 n					
		2a – 2 n					
		3a – 3 n					

Permissible Limit should be min ± 5 % for protection cores and ± 0.5 % for metering cores

Note:-

a) Apply voltage of the order of 10 kV across line capacitor (top flange) to earth link
b) Ensure all earth links connected

VIII.

i. All terminal blocks closed in the secondary after all testing

Yes	No

ii. Phasing (phase relationship) of CVT by measuring voltage between R-phase, Y-phase and B-phase at incoming terminal in control cubicle, for one circuit of the checked CVT and output terninals R-phase, Y-phase and B-ph of a reference circuit (existing CVT) with known phasing

Reference Circuit	Measured Value		
	R Ø	Y Ø	B Ø
R Ø			
Y Ø			
B Ø			

IX. TAN δ AND CAPACITANCE MEASUREMENT

Make of testing kit _____

Date of calibration _____

Ambient temperature _____

Capacitance

Across Stack	Pre Commissioning Values			Factory Values			% Deviation		
	R Ø	Y Ø	B Ø	R Ø	Y Ø	B Ø	R Ø	Y Ø	B Ø
TOP									
MIDDLE 1									
MIDDLE 2									
MIDDLE 3									
BOTTOM									
TOTAL									

TAN δ

Across Stack	Pre Commissioning Values			Factory Values			% Deviation		
	R Ø	Y Ø	B Ø	R Ø	Y Ø	B Ø	R Ø	Y Ø	B Ø
TOP									
MIDDLE 1									
MIDDLE 2									
MIDDLE 3									
BOTTOM									
TOTAL									

Permissible Limits Tan δ 0.005 (max.)
Deviation of Capacitance value from factory value should be within ± 5% of the rated value
For bottom stack, the measured values shall be considered as base value and may not match factory test results.

Factory Test Report Ref. No:_____

X. Final Documentation Review

i. Final documents of Pre- Commissioning checks reviewed and approved

Yes	No

ii. Document regarding spares equipment, O&M manuals etc available at sit for O&M purpose

Yes	No

iii. After modification, if any, "As built Drawings" are available at site

Yes	No

Signature:	Signature:	Signature:	Signature:
Name:	Name:	Name:	Name:
Designation:	Designation:	Designation:	Designation:
Organization: (Supplier Representative) (Wherever Applicable)	(Erection Agency)	(POWERGRID Site I/C)	(POWERGRID Commissioning Team) Members: 1. 2. 3. 4.

PRE-COMMISSIONING FORMATS FOR BAY / FEEDER

I. GENERAL DETAILS

DETAILS	
Region	**Sub-Station**
Feeder Name	**Voltage Level**
Date of Starting of Erection	**Date of Completion of Erection and Oil filling**

II. DETAILS OF EQUIPMENT INVOLVED

EQUIPMENT	R - PHASE		Y - PHASE		B - PHASE		MAKE
	ID NO	SL NO	ID NO	SL NO	ID NO	SL NO	
CT							
CVT							
LA							
BREAKER							
TRANSFORMER							
REACTOR							
ISOLATOR							

EQUIPMENT	R - PHASE		Y - PHASE		B - PHASE		MAKE
	ID NO	SL NO	ID NO	SL NO	ID NO	SL NO	
EARTH SWITCH							
LINE TRAP							

III. DETAILS OF CR PANEL AND PLCC

PANEL DETAILS	IDENTIFICATION		IDENTIFICATION		IDENTIFICATION		MAKE
	NAME	NUMBER	NAME	NUMBER	NAME	NUMBER	
Control Panel							
Relay Panel							
PLCC Panel							
RTU Panel							

RECORDING INSTRUMENTS	IDENTIFICATION	
	NAME	NUMBER
Fault Locator		
Event Logger		
Disturbance Recorder		
Time Syncronisation		
Strip Chart Recorder		

IV. PROTOCOL DOCUMENTATION

EQUIPMENT	IDENTIFICATION NO	ALL PRE-COMM TESTS CARRIED OUT AS PER FQP YES/ NO	ALL TEST RESULTS ARE WITHIN THE LIMIT OF TOLERANCE YES/ NO	JOINT PROTOCOLS OF THE EQUIPMENT INVOLVED IN CHARGING ARE DOCUMENTED AND SIGNED BY ALL CONCERNED YES/NO	REMARKS
CT					
CVT					
LA					
BREAKER					

EQUIPMENT	IDENTIFICATION NO	ALL PRE-COMM TESTS CARRIED OUT AS PER FQP YES/ NO	ALL TEST RESULTS ARE WITHIN THE LIMIT OF TOLERANCE YES/ NO	JOINT PROTOCOLS OF THE EQUIPMENT INVOLVED IN CHARGING ARE DOCUMENTED AND SIGNED BY ALL CONCERNED YES/NO	REMARKS
REACTOR					
ISOLATOR					
EARTH SWITCH					
LINE TRAP					
CONTROL PANEL					
RELAY PANEL					

EQUIPMENT	IDENTIFICATION NO	ALL PRE-COMM TESTS CARRIED OUT AS PER FQP YES/ NO	ALL TEST RESULTS ARE WITHIN THE LIMIT OF TOLERANCE YES/ NO	JOINT PROTOCOLS OF THE EQUIPMENT INVOLVED IN CHARGING ARE DOCUMENTED AND SIGNED BY ALL CONCERNED YES/NO	REMARKS
PLCC					
RTU PANEL					

V. CHECK OF BAY MARSHALLING KIOSK

Identification No_____

DETAILS	STATUS			REMARKS,IFANY
	OK/NOT OK	OK/NOT OK	OK/NOT OK	
ILLUMINATION AND HEATER				
5 /15 AMP SOCKET				
ALL SPECIFIED FUSES IN POSITION				
EARTHING AT 2 LOCATION				
ALL CABLES TIGHTNESS				
ALL CABLES ARE PROPERLY GLANDED				
ALL CABLES HAVE IDENTIFICATION NO				
ALL CORES HAVE IDENTIFICATION NO				
SHIELDING WIRES ARE EARTHED				
FREE FROM DUST AND DAMAGE				
DOOR HINGES AND LOCKING				
PAINTS				
UNUSED HOLES ARE SEALED				

VI. AVAILABILITY OF THE FOLLOWING

SL. NO.	DESCRIPTION OF ACTIVITY	STATUS		REMARK DEFICIENCIES/TEMPORARY ARRANAGEMENT IF ANY
		YES	NO	
1	Fire fighting system commissioned			
2	Fire protection including alarms			
3	Fire hydrant system			
4	Fire deluge (spinkler) system			
5	Portable fire extinguishers are in position			

SL. NO.	DESCRIPTION OF ACTIVITY	STATUS		REMARK DEFICIENCIES/TEMPORARY ARRANAGEMENT IF ANY
		YES	NO	
6	Fire tenders can be made available for any eventuality			
7	All equipment erection as per general arrangement drawing issued by engg.			
8	Equipment identification name plate are properly fixed			
9	All bus post insulators are cleaned and free from dust / dirt foreign materials etc.			
10	All earthing points have been earthed			
11	All nuts and bolts of bus bar are tightened correctly as per specified torque			
12	All clamps and connectors are as per the drawings issues by Engineering. department and correctly tightened as per specified torque			
13	Any paint removed / scratched in yard equipments have been touched up			
14	Bay identification and designation plate are on position with R,Y,B phase marking			
15	Gravel filling in the yard (if designed) has been done			
16	The ladders / tools / vehicles / work bench/ temporary earthing etc. Removed from the area which is to be energized			
17	DC emergency light in operation and in auto			
18	DG set is available and in operation			
19	Switching sequences with procedures are documented and available in the control room			
20	Regular operation in the control room is manned round the clock with regular operation staff			
21	All PTW issued earlier are cancelled and nothing are pending			
22	Operation data log sheets, PTW and other standard formats of Powergrid are available for regular operation			
23	Confirm color coding of all equipments and phase marking			
24	Check star points of CT & CVT secondary and associated links if any			
25	Check that treated earth pits are covered and numbered			
26	Check the tightness of the connecting links of treated earth pits			

SL. NO.	DESCRIPTION OF ACTIVITY	STATUS		REMARK DEFICIENCIES/TEMPORARY ARRANAGEMENT IF ANY
		YES	NO	
27	Core wise secondary injection test for both CTs and PTs inputs from secondary terminal box of CT/PT done to detect any mixing/ interchanging of cores/ phases			
28	Fuse fail protection checked for m1, m2, backup impedance etc			
29	Necessary clearances as applicable have been obtained			
30	Charging clearance is received from grid operation CPCC / IOCC / REB vide msg no :_____ Time_____Dated_____			

VII. MEASUREMENT OF EARTH RESISTANCE

SL.NO	LOCATION DESCRIPTION	DISTANCE BETWEEN ELECTRODE	RESISTANCE
LOCATION – 1			
LOCATION - 2			
LOCATION - 3			
LOCATION - 4			
LOCATION - 5			
LOCATION - 6			

Permissible limit = 1.0 Ω (MAX)

VIII. CONTACT TIGHTNESS CHECK BY PRIMARY CURRENT INJECTION

CURRENT INJECTION AT	CURRENT MEASURED AT	CURRENT INJECTED	CURRENT MEASURED	REMARKS ON CONTACT HEALTHINESS

IX. MEASUREMENT OF SOIL RESISTIVITY DONE EARLIER PRIOR TO COMMISSIONING

DATE	DISTANCE BETWEEN ELECTRODE	SOIL RESISTIVITY	REMARK

X. CHECK THE MINIMUM CLEARANCE BETWEEN LIVE PARTS W.R.T GROUNG AND BETWEEN LIVE PARTS

VOLTAGE	PHASE TO GROUND	PHASE TO PHASE	REMARK , IF ANY
132 kV	1270 mm	1473 mm	
220 kV	2082 mm	2368 mm	
400 kV	3065 mm	5750 mm	
765 KV	6400 mm	9400 mm	

Note : All the clearance between phases & phase to ground are to be checked as per the drgs. issued by Engg. Dept.

XI. CHECKING OF INTERLOCKS

i. Please refer the relevant plant circuit diagram for checking the interlocks of various equipments to be energized.

ii. All isolators and ground switches Inter locking checked as per the Document no CF/ISO/08

Yes	No	Remarks

XII. TRIP TEST

All breakers are tested and all the trip test as per the required plant circuit diagrams are carried out as per the document No CF/CB/05

Yes	No	Remarks

XIII. STABILITY TEST FOR BUSBAR

Details of kit used:
To be done in line with approved scheme

i. Bus earth switch open

PHASE	PRIMARY INJECTION BETWEEN CTs	CURRENT VALUE	SPILL CURRENT VALUE	REMARKS
R				
Y				
B				
R				
Y				
B				
R				
Y				
B				

ii. Bus earth switch closed

PHASE	PRIMARY INJECTION BETWEEN CTs	CURRENT VALUE	SPILL CURRENT VALUE	REMARKS
R				
Y				
B				
R				
Y				
B				
R				
Y				
B				

XIV. FINAL TRIPM TEST

The trip test must be repeated prior to energization as per approved scheme.

Tripping operation to be checked for both the trip coils from local/ remote/ protection

i. DC source 1 off

SL. NO	PROTECTION TYPE	SIMULATION METHOD	CB TRIP RESPONSE		REMARK
			MAIN	TIE	
I	Main - I				
II	Main - II				
III	Over voltage				
IV	Carrier inter tripping				
V	LBB				
VI	Bus bar				
VII	Tee differential				
VIII	Differential				
IX	Restricted earth fault				
X	Back up o/c & e/f				
XI	Over fluxing				
XII	OTI trip				
XIII	WTI trip				
XIV	Buchholz trip (main)				
XV	Buchholz trip (OLTC)				
XVI	PRD				
XVII	Auto-reclose - R ø				
XVIII	Auto-reclose - Y ø				
XIX	Auto-reclose - B ø				

ii. DC source 2 off

SL. NO	PROTECTION TYPE	SIMULATION METHOD	CB TRIP RESPONSE		REMARK
			MAIN	TIE	
I	Main - I				
II	Main - II				
III	Over voltage				
IV	Carrier inter tripping				
V	LBB				
VI	Bus bar				
VII	Tee differential				
VIII	Differential				
IX	Restricted earth fault				
X	Back up o/c & e/f				
XI	Over fluxing				
XII	OTI trip				
XIII	WTI trip				
XIV	Buchholz trip (main)				
XV	Buchholz trip (OLTC)				
XVI	PRD				
XVII	Auto-reclose - R ø				
XVIII	Auto-reclose - Y ø				
XIX	Auto-reclose - B ø				

Operational Constraints if any

_____

_____

_____

_____

_____

XV. FINAL DOCUMENTATION REVIEW

i. Final documents of Pre- Commissioning checks reviewed and approved

Yes	No

ii. Document regarding spares equipment, O&M manuals etc available at sit for O&M purpose

Yes	No

iii. After modification, if any, "As built Drawings" are available at site

Yes	No

iv. The above Bay/Feeder is cleared for high voltage energisation

Yes	No

Signature:	Signature:	Signature:	Signature:
Name:	Name:	Name:	Name:
Designation:	Designation:	Designation:	Designation:
Organization: (Supplier Representative) (Wherever Applicable)	(Erection Agency)	(POWERGRID Site I/C)	(POWERGRID Commissioning Team) Members: 1. 2. 3. 4.

PRE-COMMISSIONING FORMATS FOR ISOLATOR AND GROUNDING SWITCH

I. General Details

DETAILS	
Region:	**Sub-Station:**
Feeder name	**LOA No. :**
Make:	**Type:**
Sr. No.: **R Ø:-** **YØ:-** **BØ:-**	**Operating Voltage rating**
Control Volatge:	**Current Carrying capacit y:**
Year of Manufacture: **R Ø:-** **YØ:-** **BØ:-**	**Date of Receipt at site:** **R Ø:-** **YØ:-** **BØ:-**
Date of Erection: **R Ø:-** **YØ:-** **BØ:-**	**Date of energisation**

II. Pre-Commissioning Checks

Sl.No	Description	Status		Remark / Record Deficiencies, If Any
		YES	NO	
1	Equipment is free from dirt/dust foreign materials etc.			
2	Equipment is free from all visible defects on physical inspection			
3	Support structures, marshalling box has been provided with two earthing pads / points			
4	All nuts and bolts are tightened correctly as per specified torque			
5	Equipment erection is complete in all respect as per instruction Manual (attach remaining activities, if any)			
6	Permanent isolator lavelling and identification is done			
7	Leveling and alignment of structure and base frame is checked			
8	Control box / marshalling kiosk is free from any physical defects			
9	Tightness of nuts bolts of terminal connectors are checked			
10	Auxiliary contacts and relays have been cleaned and free from rust / damage			

Sl.No	Description	Status		Remark / Record Deficiencies, If Any
		YES	NO	
11	Corona rings are provided and properly fixed			
12	Cable termination and tightness checked and unused holes sealed			
13	External cabling is completed in all respect			
14	All the cable identification tags provided and all cores are provided with Identification ferrules at m.b.			
15	All moving parts are lubricated			
16	Alignment of isolator already made and locking bolt provided, if any			
17	Freeness of manual operation is ok			
18	Greasing has been made on the main contacts according to the manufacturers instruction			
19	Functional ckecking of auxiliary contacts for indications and interlocks			
20	Erection completion certificate along with list of Outstanding activities reviewed			
21	All spare wires to be kept with ferrules but not terminated at the terminal blocks			
22	Earth switch connected to earth through braided wires			
23	Interlocks checked as per approved scheme with all combinations			
24	Check that earth switch blade alignment in condition is at sufficient distant from isolator			
25	Check that operation and positioning of the limit switch & the auxiliary contacts assembly are ok			
26	Check that all three phase isolators are closing & opening at a time			
27	Check all 3 earth switches close at the same time			
28	Provision of bimetallic strips ensured wherever applicable			

III. Motor Details

	R - Ø	Y - Ø	B - Ø
Make			
Serial number			
Type			
Year of manufacturer			
Volt			
Amperes			
Hp/ kW			
O/L setting (Thermal Over load)			

IV. Insulation Resistance Measurement

Make of testing kit _____

Date of calibration _____

Ambient temperature _____

Using 500 volt megger measure resistance between the winding of motor and earth

Sl. No	Between	Phase		
		R Ø	Y Ø	B Ø
1	Winding to Earth			

PERMISSIVE VALUE > 50 M.OHM

V. Operational Checks

i. Operate the isolator and record the motor current

Isolator Operation	Motor Current					
	R - Ø		Y - Ø		B - Ø	
	Factory	Site	Factory	Site	Factory	Site
Close						
Open						

ii. Operation of isolator from local / remote Ok/Not Ok

Isolator Operation	Control Panel	
	Local	Remote
Close		
Open		

iii. Measurement of operating time

Operation	Unit	Phase		
		R - Ø	Y - Ø	B - Ø
Opening Time				
Closing Time				

iv. Auxillary Contacts Checking

ISOLATOR OPERATION	AUXILLARY RELAY TYPE	OPERATION TIME					
		R - Ø		Y - Ø		B - Ø	
		NO	NC	NO	NC	NO	NC
CLOSE							

ISOLATOR OPERATION	AUXILLARY RELAY TYPE	OPERATION TIME					
		R - Ø		Y - Ø		B - Ø	
		NO	NC	NO	NC	NO	NC
OPEN							

Reference drawing no:

v. Operation On Under Voltage Condition

Condition	Coil	Unit	Phase		
			R - Ø	Y - Ø	B - Ø
PICK UP VOLTAGE	CLOSING	VOLT DC			
	OPENING	VOLT DC			
	INTERLOCK	VOLT DC			
DROP VOLTAGE	CLOSING	VOLT DC			
	OPENING	VOLT DC			
	INTERLOCK				

VI. Insulation Resistance Measurement (By 5kV Megger)

Make of testing kit _____

Date of calibration _____

Ambient temperature _____

Isolator open condition

Between	Phase		
	R Ø	Y Ø	B Ø
MALE SIDE TO GROUND			
FEMALE SIDE TO GROUND			
MALE SIDE TO FEMALE SIDE			

PERMISSIVE VALUE > 1000 M.OHM

VII. CONTACT RESISTANCE MEASUREMENT
(To be measured after 50 operations)

Make of testing kit _____

Date of calibration _____

i. Isolator Close condition

Contact Resistance	Units	R - Ø	Y - Ø	B - Ø
Connector 1	μ Ω			
Connector2	μ Ω			
Main Contact 1	μ Ω			
Main Contact 2	μ Ω			

The value of Contact Resistance should not be more than 10 Micro – ohms per / Connector
The value of Contact Resistance should not be more than 150 Micro – ohms per / break

ii. Isolator Open condition and grounding switch close condition

Contact Resistance	Units	R - Ø	Y - Ø	B - Ø
Main Contact(Male & Female) Ground Switch	μ Ω			

The value of Contact Resistance should not be more than 150 Micro – ohms per / break

VIII.

i. Resistance of open coil _____

ii. Resistance of close coil _____

iii. Resistance of interlocking coil_____

IX. Final Documentation Review

i. Final documents of Pre- Commissioning checks reviewed and approved

Yes	No

ii. Document regarding spares equipment, O&M manuals etc available at sit for O&M purpose

Yes	No

iii. After modification, if any, “As built Drawings” are available at site

Yes	No

Signature:	Signature:	Signature:	Signature:
Name:	Name:	Name:	Name:
Designation:	Designation:	Designation:	Designation:
Organization: (Supplier Representative) (Wherever Applicable)	(Erection Agency)	(POWERGRID Site I/C)	(POWERGRID Commissioning Team) Members: 1. 2. 3. 4.

PRE-COMMISSIONING FORMATS FOR SURGE ARRESTOR

I. General Details

DETAILS	
Region:	**Sub-Station:**
Feeder name	**LOA No. :**
Make:	**Type:**
Sr. No.: **R Ø:-** **YØ:-** **BØ:-**	**Voltage rating**
Rating:	**Feeder name:**
Year of Manufacture: **R Ø:-** **YØ:-** **BØ:-**	**Date of Receipt at site:** **R Ø:-** **YØ:-** **BØ:-**
Date of Erection: **R Ø:-** **YØ:-** **BØ:-**	**Date of energisation**

II. Pre-Commissioning Checks:

Sl.No	Description	Status		Remark Record Deficiencies, If Any
		Yes	No	
1	Equipment is free from dirt / dust foreign materials etc.			
2	Equipment is free from all visible defects on physical inspection			
3	Support structures have been provided with double earth			
4	All nuts and bolts are tightened correctly as per specified torque			
5	Equipment erection is complete in all respect (attach remaining activities, if any)			
6	Permanent la leveling and identification is done			
7	Leveling and alignment of structure and base frame is checked			
8	All insulators & surge counter are free from any physical defects			
9	Tightness of nuts bolts of terminal connectors are checked			
10	Erection completion certificate along with list of outstanding activities reviewed			

Sl.No	Description	Status		Remark Record Deficiencies, If Any
		Yes	No	
11	Check one end of surge counter is connected to the bottom of la stack and one end of surge counter has been earthed			
12	The direction of the exhaust vent ports away from the protected equipment and other arrester poles			
13	Clearance from the arrester to earthed objects and from the arrester pole to another arrester pole maintained as per outline drawing and all erection has been done as per drawing issued by engg. Dept.			
14	Operation of la counter checked by applying appropriate voltage			
15	Check the serial no. And sequence of la parts for erection in multi stack la			
16	Check the alignment of corona ring			
17	Check on charging, the surge counter pointer is in green zone			

III. Insulation Resistance Measurement : (Using 5kV Megger)

Sl. No	Between	Unit	Phase		
			R Ø	Y Ø	B Ø
1	1st stack	MΩ			
2	2nd stack	MΩ			
3	3rd stack	MΩ			
4	4th stack	MΩ			
5	5th stack	MΩ			
6	Total from top to earth	MΩ			

MIN VALUE > 1000 M OHMS

IV. Surge Counter Reading

Sl.No	Reading	R Ø	Y Ø	B Ø
1	Counter sr. No.			
2	Counter make			
3	Counter reading			

V. Capacitance & Tan Delta Measurement

Stack	Capacitance	Tan Delta	Remarks
Top			
Middle 1			
Middle 2			
Bottom			

The Tan delta and capacitance value shall be considered as base value for future monitoring. However, Tan delta value of different stack shall be comparable.

VI. Checking Of Healthiness Of Surge Monitor

Refer manufacturer's catalogue for detail checking of surge monitor

Yes	No

VII. Third Harmonic Resistive Current Measurement

Ambient Temperature _____ System Voltage_____

Phase	Total Current	3rd Harmonic Resistive Current (I3 R) In A	Remarks
R Ø			
Y Ø			
B Ø			

The value of third harmonic current shall be less than 30 μA (for 400 kV & below) & 50 μA (for 765 kV).

VIII. Final Documentation Review

i. Final documents of Pre- Commissioning checks reviewed and approved

Yes	No

ii. Document regarding spares equipment, O&M manuals etc available at sit for O&M purpose

Yes	No

iii. After modification, if any, "As built Drawings" are available at site

Yes	No

Signature:	Signature:	Signature:	Signature:
Name:	Name:	Name:	Name:
Designation:	Designation:	Designation:	Designation:
Organization: (Supplier Representative) (Wherever Applicable)	(Erection Agency)	(POWERGRID Site I/C)	(POWERGRID Commissioning Team) Members: 1. 2. 3. 4.

PRE-COMMISSIONING FORMATS FOR WAVE TRAP

I. General Details

Details	
Region:	**Sub-Station:**
Feeder name	**LOA No. :**
Make:	**Type:**
Sr. No.: **R Ø:-** **YØ:-** **BØ:-**	**Voltage rating**
mH Rating:	**Current Rating:**
Band Width:	
Year of Manufacture: **R Ø:-** **YØ:-** **BØ:-**	**Date of Receipt at site:** **R Ø:-** **YØ:-** **BØ:-**
Date of Erection: **R Ø:-** **YØ:-** **BØ:-**	**Date of energisation**

II. Pre-Commissioning Checks

Sl No	Description	Status		Record Deficiencies, If Any
		Yes	No	
1	Equipment is free from dirt / dust foreign materials etc.			
2	Equipment is free from all visible defects on physical inspection			
3	Support structures has been provided with double earth			
4	All nuts and bolts are tightened correctly as per specified torque			
5	Permanent lavelling and identification is done			
6	Leveling and alignment of structure and base frame is checked			
7	All insulators & line matching unit are free from any physical defects			
8	Tightness of nuts / bolts of terminal connectors are checked			
9	Erection completion certificate along with list of outstanding Activities reviewed			
10	Check that the tuning unit and arrestor are properly tightened and free from any damage			
11	Tuning unit connection as per PLCC frequency			

III. Insulation Resistance Measurement

Make of testing kit _____

Date of calibration _____

Ambient temperature _____

Sl. No	Between	Megger	Phase			Permissive Value
			R Ø	Y Ø	B Ø	
1	UPPER TEMINAL AND EARTH	5000 V				> 1000 M.OHM
2	LA OF THE WAVE TRAP	500 V				> 1 M.OHM

IV. Contact Resistance Measurement

Make of testing kit _____

Date of calibration _____

Contact Resistance	Units	R - Ø	Y - Ø	B - Ø
Across Terminal P1	μ Ω			
Across Terminal P2	μ Ω			

The value of Contact Resistance should not be more than 5 Micro – ohms per Joint / Connector

V. Final Documentation Review

i. Final documents of Pre- Commissioning checks reviewed and approved

Yes	No

ii. Document regarding spares equipment, O&M manuals etc available at sit for O&M purpose

Yes	No

iii. After modification, if any, “As built Drawings” are available at site

Yes	No

Signature:	Signature:	Signature:	Signature:
Name:	Name:	Name:	Name:
Designation:	Designation:	Designation:	Designation:
Organization: (Supplier Representative) (Wherever Applicable)	(Erection Agency)	(POWERGRID Site I/C)	(POWERGRID Commissioning Team) Members: 1. 2. 3. 4.

PRE-COMMISSIONING FORMATS FOR CONTROL & PROTECTION INCLUDING PLCC

LINE PROTECTION

General Details

Region:	**Sub-Station:**
Feeder Name:	**LOA No. :**
Date of testing:	**Date of Energisation:**

Main-I/II Protection Panel

1. Main-I /II Distance relay: (separate for Main-I & II Relays)

i		Check for proper programming of Input / Output contacts of the relay as per approved schematics		Ok/ Not Ok
ii	a	Check for proper programming of LED's(if applicable) of the relay and check that stickers are provided as per the configuration.		Ok/ Not Ok
	b	Check Configuration / Programmable Scheme Logic of relay according to scheme (applicable for numerical relays)		Ok/ Not Ok
	c	Get the print out of Configuration / PSL		Ok/ Not Ok
iii		Get a print of relay settings		Ok/ Not Ok
iv		Compare with the recommended setting		Ok/ Not Ok
v		Check for Reach Setting : Zone- I, II, III,IV		Ok/ Not Ok
vi		Check time of operation : Zone- I, II, III,IV		Ok/ Not Ok
vii		Test results of (iii) & (iv) enclosed		Yes/ No
viii		Check polarity of send & receive for PLCC command (If Digital Channel/ Under FET operation)		Ok/ Not Ok
ix		Check Permissive tripping by Carrier command receive and measure & record relay operation time for carrier aided trip. Also check Carrier Send command on relay tripping		Ok/ Not Ok
		Verify Respective Counter Advancement In Each Channel		
		Send	Recv	
	Main-I	CH….. Code……	CH….. Code……	Ok/ Not Ok
		CH….. Code……	CH….. Code……	Ok/ Not Ok
	Main-II	CH….. Code……	CH….. Code……	Ok/ Not Ok
		CH….. Code……	CH….. Code……	Ok/ Not Ok

x	Check Blocking scheme (if applicable) along with carrier command for both send & receive.			Ok/ Not Ok
	Verify Respective Counter Advancement In Each Channel			
	Send		Recv	
	Main-I	CH….. Code……	CH….. Code……	Ok/ Not Ok
		CH….. Code……	CH….. Code……	Ok/ Not Ok
	Main-II	CH….. Code……	CH….. Code……	Ok/ Not Ok
		CH….. Code……	CH….. Code……	Ok/ Not Ok
xi	Check SOTF Logic. Check Control switch(TCS) & wirings on Control panel to Relay Input for SOTF(if provided)			Ok/ Not Ok
xii	Check Weak-end in-feed logic			Ok/ Not Ok
xiii	Check Selective Phase tripping(R Ph fault to R-Ph Trip etc) for each phase separately			Ok/ Not Ok
xiv	Check Power swing blocking feature (if available)			Ok/ Not Ok
xv	Check trip Block in case of CVT Fuse Failure			Ok/ Not Ok
xvi	Check Auto Reclose Initiation Contacts for			
	a	Transient Single Phase Earth fault(Zone-1&Zone-2+CR)		Ok/ Not Ok
	b	Non initiation for 1 phase fault in Zone II		Ok/ Not Ok
	c	Transient Ph-Ph Fault		Ok/ Not Ok
	d	Transient 3 Phase Faults		Ok/ Not Ok
	e	Permanent Faults(Prepare 3Ph Trip)		Ok/ Not Ok
	f	Check for dead time and reclaim time setting		Ok/ Not Ok
	g	Check single phase auto reclosure for all three phases one by one.		Ok/ Not Ok
xvii	Check for tripping command directly to CB & correct operation of tripping relays and auxiliary relays			Ok/ Not Ok
xviii	Check Communication to PC keeping adjacent relay IN&OUT of service (If available)			Ok/ Not Ok
xix	Check PLCC carrier Switch Operation(In/Out).			Ok/ Not Ok
xx	Check Time synchronizing by altering Time Zone. Restore on confirmation			Ok/ Not Ok
xxi	Check Self-diagnostic feature of the relay (if provided)			Ok/ Not Ok
xxii	Check metering function of the relay (if provided)			Ok/ Not Ok
xxiii	Verify automatic downloading feature as per Tech spec.			Ok/ Not Ok
xxiv	Verify open delta voltage in DR channel			Ok/ Not Ok
xxv	Verify availability of configuration tool at site.			Ok/ Not Ok
xxvi	Verify Main & Tie CT circuits by primary injection			Ok/ Not Ok
xxvii	Check directionality of the relay after synchronization of the line			Ok/ Not Ok
xxviii	Check for DEF protection and its contacts (if applicable)			Ok/ Not Ok
xxix	Check all the contacts of relay for proper operation & rating			Ok/ Not Ok

2. Overvoltage Stage-I/II

i	Check Operate Value/Reset Value/Operate timing for all phases.	Ok/ Not Ok
ii	Check whether it trips Main/Tie CB & sends Direct trip to remote end	Yes/ No

3. Stub protection (4 CT scheme)

i	Check scheme logic	Ok/ Not Ok
ii	Check operation at set value	Ok/ Not Ok
iii	Check Direct Trip send & receive circuit with carrier command. Verify counter advancement in each channel	Ok/ Not Ok

4. TEE Differential-I/II (5 CT scheme)

i	Check Operate Value/Reset Value/Operate Timing for all phases	Ok/ Not Ok
ii	Check tripping of Main/Tie CB & send Direct trip to remote end	Ok/ Not Ok
iii	Check stability for out zone fault	Ok/ Not Ok
iv.	**If Biased differential,** check Biasing percentage for all phases	Ok/ Not Ok

5. Fault Locator

Feed FL & Distance relay with same Voltage & Current from test Kit. Simulate Zone-I/II, Single Ph/Ph-Ph/3Ph Fault to Main-I/II Distance relay.

i	Check initiation by Distance relay	Ok/ Not Ok
ii	Compare Fault location by calculating the Set Vale on test Kit	Ok/ Not Ok
iii	Repeat the above up to 99% in steps	Ok/ Not Ok
iv.	Check healthiness of mutual compensation circuit	Ok/ Not Ok

6. Disturbance Recorder

i	Check analog & digital channels are connected as per approved nomenclature	Ok/ Not Ok
ii	Check threshold value of analog triggering (including open delta voltage).	Ok/ Not Ok
iii	Check triggering on digital inputs	Ok/ Not Ok
iv	Check automatic downloading feature	Ok/ Not Ok
v	Check time synchronizing feature	Ok/ Not Ok
vi	Verify open delta voltage in DR channel	Ok/ Not Ok
vii	Check diagnostic feature(if provided)	Ok/ Not Ok

7. Final Documentation Review

S.No.	Description	Status (Yes/ No)	Remarks(Record deficiencies, if any)
1.	Final document of Pre-commissioning checks reviewed and approved		
2.	Documents regarding spares, equipment, factory reports, O&M manuals etc. available at site for O&M purpose		
3.	After modification, if any, "As built drawing are available at site		

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Desgn.:	Desgn.:	Desgn.:	Desgn.:
Organization:			
(Supplier Representative) (Wherever Applicable)	(Erection Agency)	(POWERGRID Site I/C)	(POWERGRID Commg. Team) Members: 1, 2. 3. 4.

CIRCUIT-BREAKER PANEL

General Details

Region:	**Sub-Station:**
Feeder Name:	**LOA No. :**
Date of testing:	**Date of Energisation:**

1. **Auto-reclose Scheme:** (Checks applicable for distance protection scheme with auto re-closure function as well)

i		Check auto reclose initiation/Block contacts for	
	a	Transient Single Phase Earth fault	Ok/ Not Ok
	b	Non initiation for 1 phase fault in Zone II	Ok/ Not Ok
	c	Transient Ph-Ph Fault	Ok/ Not Ok
	d	Transient 3 Phase Faults	Ok/ Not Ok
	e	Permanent Faults	Ok/ Not Ok
ii		Simulate Zone-I ,Single Ph Transient E/F to Main-I/II Distance relay Check AR for all 3 Phases,one by One	Ok/ Not Ok
iii		Loop CS & CR, Simulate Zone-II ,Single Ph Transient E/F to Main-I/II Distance relay Check AR for all 3 Phases, one by One	Ok/ Not Ok
iv		Check settings & operation of Synchronizing/DLC relays	Ok/ Not Ok
v		Measure Dead Time setting …….ms	
vi		Measure Reclaim Timer setting	Ok/ Not Ok
vii		Check AR does not take place within reclaim time	Ok/ Not Ok
viii		Check AR does not take place in case of fault on Line Charging.	Ok/ Not Ok
ix		Check AR does not take place in case of Failure of PLCC Carriers	Ok/ Not Ok
x		Further, check AR Interlocking in case of	
	a	Pole discrepancy	Ok/ Not Ok
	b	Direct trip received	Ok/ Not Ok
	c	Over-voltage stage-I/II trips	Ok/ Not Ok
	d	Reactor protection trips	Ok/ Not Ok
	e	CB Troubles	Ok/ Not Ok
	f	Zone-2 & 3 time delayed faults	Ok/ Not Ok
xi		In a one & half / Two CB scheme, Check AR does not take place for any one of the CBs under S/D. Check Memory Circuit Contact status(CB Closed/Opened conditions). Check Memory Circuit Timer setting.	Ok/ Not Ok
xii		Check Logics of AR switch Operation (NA/1Ph/2Ph/3Ph).	Ok/ Not Ok
xiii		Check priority circuitry. Priority circuit of Tie CB should be bypassed is any of the main CB is kept in Non Auto mode due to shutdown or outages	Ok/ Not Ok
xiv		A/R should not take place in NON AUTO mode	Ok/ Not Ok

2. Local Breaker Back Up Protection:

i	Check Operate Value/Reset Value/Operate Timing for all phases	Ok/ Not Ok
ii	Check adjacent CB's as well as concerned Bus-Bar Trip relays operate during operation of LBB relay	Ok/ Not Ok
iii	Check Direct trip Transfer takes place only for feeder under testing during LBB operation	Ok/ Not Ok

3. Under-voltage Relay

i	Check Operate Value/Reset Value/Operate Timing for all phases	Ok/ Not Ok
ii	Check E/S interlock operation under relay energized condition & vice versa	Ok/ Not Ok

4. Direct Trip Transfer

a. Check Direct trip transfer in case of:

i	Over-voltage relay operations	Ok/ Not Ok
ii	Reactor trip operations.	Ok/ Not Ok
iii	Manual trip to One CB(Main/Tie) when another CB(Tie/Main) in same dia is under open condition	Ok/ Not Ok
iv	LBB relay Trip: for both the main & tie CB's	Ok/ Not Ok
v	Busbar Trip to One CB(Main/Tie) when another CB(Tie/Main) in same dia is under open condition	Ok/ Not Ok
vi	TEE Diff/ STUB Protection trip	Ok/ Not Ok
vii	Direct trip Transfer thr' 1st Chanel	Ok/ Not Ok
viii	Direct trip Transfer thr' 2nd Chanel	Ok/ Not Ok
ix	Check DT is not resulted by 1st Chanel permissive trip	Ok/ Not Ok
x	Check DT is not resulted by 2nd Chanel permissive trip	Ok/ Not Ok

b. Summary of Code Transfer for PLCC

Ch-1 Code-I…… Ch-1 Code-2 …… Ch-2 Code-I …… Ch-2 Code-2 ……

i	Check individual Code Transfer to be as per scheme	Ok/ Not Ok
ii	Ch-1 Code-I	Ok/ Not Ok
iii	Ch-1 Code-2	Ok/ Not Ok
iv	Ch-1 Code-3	Ok/ Not Ok
v	Ch-2 Code-I	Ok/ Not Ok
vi	Ch-2 Code-2	Ok/ Not Ok
vii	Ch-2 Code-3	Ok/ Not Ok
viii	Check if signal through One code is not transferred to another at Remote end	Ok/ Not Ok

5. CB Troubles

i	Check whether All relays are given elaborative nomenclatures. If not, Paste descriptions (CB LOW Air/Oil pressure, Pole discrepancy etc.)	Ok/ Not Ok
ii	Check Operations of individual Relays by actuating initiating Contacts from field	Ok/ Not Ok
iii	Check facia/Event Logger Input Contacts for the same	Ok/ Not Ok

6. Final Documentation Review

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(Supplier Representative) (Wherever Applicable)	(Erection Agency)	(POWERGRID Site I/C)	(POWERGRID Commg. Team) Members: 1, 2. 3. 4.

LINE REACTOR PROTECTION

General Details

Region:	**Sub-Station:**
Feeder Name:	**LOA No. :**
Date of testing:	**Date of Energisation:**

1. Differential Protection

i	CT secondary Circuitry Checked & Diff current is Nil by Primary Injection for all Phases	Ok/ Value….
ii	Check connection of stabilizing resistance & metrosil (wherever applicable)	Ok/ Not Ok
iii	If fed from Turret CT's from both sides of Phase Windings. Check Operate Value/Reset Value/Operate Timing for all phases	Ok/ Not Ok
iv	Measure differential pick up current	Ok/ Not Ok
v	Carry out stability test by simulating external and internal faults and measure spill currents in Differential circuit	Ok/ Not Ok
vi	Check Biasing percentage, Operate Value/Reset Value/Operate including High set feature if applicable	Ok/ Not Ok
vii	Timing for all phases(if biased / percentage differential)	Ok/ Not Ok
viii	Check Blocking of tripping on Harmonic Restraints Feature (2^{nd} & 5^{th} harmonics)	Ok/ Not Ok
ix	Check DR feature (if available)	Ok/ Not Ok

2. Restricted Earth-Fault Protection:

i	Check Operate Value/Reset Value/Operate Timing for all phases	Ok/ Not Ok
ii	CT secondary Circuitry Checked & Diff current is Nil by Primary Injection for all Phases	Ok/ Value….
iii	Check connection of stabilizing resistance & metrosil (wherever applicable)	Ok/ Not Ok
iv	Check CT Circuits so that summation of same phases(R-R, Y-Y, B-B) is taking place (Sometimes R-B & B-R summations are observed due to wrong Wirings).	Ok/ Not Ok
v	If fed from Turret CT's from both sides of Phase Windings. Check Operate Value/Reset Value/Operate Timing for all phases	Ok/ Not Ok
vi	Measure differential pick up current	Ok/ Not Ok
vii	Carry out stability test by simulating external and internal faults by primary injection and measure spill currents in REF relay	Ok/ Not Ok

3. **Back-Up Impedance Relay** Type :……

i	Get a print of relay settings(wherever applicable)	Ok/ Not Ok
ii	Compare with recommended setting	Ok/ Not Ok
iii	Check for Reach Setting	Ok/ Not Ok
iv	Check time of operation	Ok/ Not Ok
v	Test results of (iii) & (iv) enclosed	Yes/No
vi	Check Selective Phase tripping(R Ph fault to R-Ph Trip etc)	Ok/ Not Ok
vii	Check trip Block in case of CVT Fuse Failure.	Ok/ Not Ok
viii	Check Communication to PC(If available)	Ok/ Not Ok
ix	Check Time synchronizing by altering Time Zone. Restore on confirmation	Ok/ Not Ok
x	Check Self-diagnostic feature of the relay (if provided)	Ok/ Not Ok
xi	Check metering function of the relay (if provided)	Ok/ Not Ok
xii	Verification of Directionality	Ok/ Not Ok

4. Electromechanical Relays : Check operation of:

i	Buchholz Alarm & trip	Ok/ Not Ok
ii	WTI Alarm & trip	Alarm……Trip……..
iii	OTI Alarm & trip	Alarm……Trip……..
iv	PRD Trip	Ok/ Not Ok
v	MOG(LOL/Low Oil Level) Alarm	Ok/ Not Ok

5. Direct Trip Transfer

i	In all cases of above trippings, Direct trip to remote end is sent along with tripping of Main/Tie CB's	Ok/ Not Ok
ii	Direct trip **:** From line Reactor LBB in case of switchable reactor	Ok/ Not Ok

6. Voltage selection for Protection & Metering

i	Ensure Voltage inputs at specific terminals from		
	a	Line CVT	Ok/ Not Ok
	b	Bus-I CVT(say connected to CB-1)	Ok/ Not Ok
	c	Bus-II CVT(say connected to CB-2)	Ok/ Not Ok
ii	Check NO/NC Contacts from CB-1 & CB-2 for voltage selection		Ok/ Not Ok
		Open Line Isolator: Close CB-1 : Bus-I CVT supply will be selected. Check CVT Supply at selected CVT Terminals for Metering & Protection. Trip CB-1	Ok/ Not Ok
		Close CB-2 : Bus-II CVT supply will be selected. Check CVT Supply at selected CVT Terminals for Metering & Protection. Trip CB-2.	Ok/ Not Ok
		Close Line Isolator: Line CVT supply will be selected. Close CB-1 & 2, No change in status of Selection relays.	Ok/ Not Ok

7. Check RWTI on Control panel

i	RWTI checked on control panel	Ok/ Not Ok

8. Final Documentation Review

S.No	Description	Status (Yes/ No)	Remarks(Record Deficiencies, If Any)
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BUS REACTOR PROTECTION

General Details

Region:	**Sub-Station:**
Feeder Name:	**LOA No. :**
Date of testing:	**Date of Energisation:**

1. Differential Protection

i	CT secondary Circuitry Checked & Diff current is Nil by Primary Injection for all Phases	Ok/ Value….
ii	Check connection of stabilizing resistance & metrosil (wherever applicable)	Ok/ Not Ok
iii	Check CT Circuits so that summation of same phases(R-R, Y-Y, B-B) is taking place (Sometimes R-B & B-R summations are observed due to wrong Wirings)	
iv	If fed from Turret CT's from both sides of Phase Windings. Check Operate Value/Reset Value/Operate Timing for all phases	Ok/ Not Ok
v	Measure differential pick up current	Ok/ Not Ok
vi	Carry out stability test by simulating external and internal faults and measure spill currents in Differential circuit	Ok/ Not Ok
vii	Check Biasing percentage, Operate Value/Reset Value/Operate including High set feature if applicable	Ok/ Not Ok

2. Restricted Earth-Fault Protection:

i	Check Operate Value/Reset Value/Operate Timing for all phases	Ok/ Not Ok
ii	CT secondary Circuitry Checked & Diff current is Nil by Primary Injection for all Phases	Ok/ Value….
iii	Check connection of stabilizing resistance & metrosil (wherever applicable)	Ok/ Not Ok
iv	Check CT Circuits so that summation of same phases(R-R, Y-Y, B-B) is taking place (Sometimes R-B & B-R summations are observed due to wrong Wirings).	Ok/ Not Ok
v	If fed from Turret CT's from both sides of Phase Windings. Check Operate Value/Reset Value/Operate Timing for all phases	Ok/ Not Ok
vi	Measure differential pick up current	Ok/ Not Ok
vii	Carry out stability test by simulating external and internal faults by primary injection and measure spill currents in REF relay	Ok/ Not Ok

3. **Back-Up Impedance Relay** Type :…….

i	Get a print of relay settings(wherever applicable)	Ok/ Not Ok
ii	Compare with recommended setting	Ok/ Not Ok
iii	Check for Reach Setting	Ok/ Not Ok
iv	Check time of operation	Ok/ Not Ok
v	Test results of (iii) & (iv) enclosed	Yes/No
vi	Check trip Block in case of CVT Fuse Failure.	Ok/ Not Ok
vii	Check Communication to PC(If available)	Ok/ Not Ok
viii	Check Time synchronizing by altering Time Zone. Restore on confirmation	Ok/ Not Ok
ix	Check Self-diagnostic feature of the relay (if provided)	Ok/ Not Ok
x	Check metering function of the relay (if provided)	Ok/ Not Ok
xi	Verification of Directionality	Ok/ Not Ok

4. Electromechanical Relays

i	Buchholz Alarm & trip	Ok/ Not Ok
ii	WTI Alarm & trip	Alarm……Trip……..
iii	OTI Alarm & trip	Alarm……Trip……..
iv	PRD Trip	Ok/ Not Ok
v	MOG(LOL/Low Oil Level) Alarm	Ok/ Not Ok

5. Direct Trip Transfer

i	In all cases of above trippings, Direct trip to remote end is sent along with tripping of Main/Tie CB's	Ok/ Not Ok
ii	Direct trip**:** From line Reactor LBB in case of switchable reactor	Ok/ Not Ok

6. Voltage selection for Protection & Metering

i	Ensure Voltage inputs at specific terminals from		
	a	Line CVT	Ok/ Not Ok
	b	Bus-I CVT(say connected to CB-1)	Ok/ Not Ok
	c	Bus-II CVT(say connected to CB-2)	Ok/ Not Ok
ii	Check NO/NC Contacts from CB-1 & CB-2 for voltage selection		Ok/ Not Ok
		Open Line Isolator: Close CB-1 : Bus-I CVT supply will be selected. Check CVT Supply at selected CVT Terminals for Metering & Protection. Trip CB-1	Ok/ Not Ok
		Close CB-2 : Bus-II CVT supply will be selected. Check CVT Supply at selected CVT Terminals for Metering & Protection. Trip CB-2.	Ok/ Not Ok
		Close Line Isolator: Line CVT supply will be selected. Close CB-1 & 2, No change in status of Selection relays.	Ok/ Not Ok

7. Check RWTI on Control panel

i	RWTI checked on control panel	Ok/ Not Ok

8. Final Documentation Review

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(Supplier Representative) (Wherever Applicable)	**(Erection Agency)**	**(POWERGRID Site I/C)**	**(POWERGRID Commg. Team) Members: 1, 2. 3. 4.**

AUTO-TRANSFORMER PROTECTION

General Details

Region:	**Sub-Station:**
Feeder Name:	**LOA No. :**
Date of testing:	**Date of Energisation:**

1. Differential Protection

i	CT secondary Circuitry Checked & Diff current is Nil by Primary Injection for all Phases	Ok/ Value….
ii	Check connection of stabilizing resistance & metrosil (wherever applicable)	Ok/ Not Ok
iii	Check CT Circuits so that summation of same phases(R-R, Y-Y, B-B) is taking place (Sometimes R-B & B-R summations are observed due to wrong Wirings)	Ok/ Not Ok
iv	If fed from Turret CT's from both sides of Phase Windings. Check Operate Value/Reset Value/Operate Timing for all phases	Ok/ Not Ok
v	Measure differential pick up current	Ok/ Not Ok
vi	Carry out stability test by simulating external and internal faults and measure spill currents in Differential circuit	Ok/ Not Ok
vii	Check Biasing percentage, Operate Value/Reset Value/Operate including High set feature if applicable	Ok/ Not Ok

2. Restricted Earth-Fault Protection

i	Check Operate Value/Reset Value/Operate Timing for all phases	Ok/ Not Ok
ii	CT secondary Circuitry Checked & Diff current is Nil by Primary Injection for all Phases	Ok/ Value….
iii	Check connection of stabilizing resistance & metrosil (wherever applicable)	Ok/ Not Ok
iv	Check CT Circuits so that summation of same phases(R-R, Y-Y, B-B) is taking place (Sometimes R-B & B-R summations are observed due to wrong Wirings).	Ok/ Not Ok
v	If fed from Turret CT's from both sides of Phase Windings. Check Operate Value/Reset Value/Operate Timing for all phases	Ok/ Not Ok
vi	Measure differential pick up current	Ok/ Not Ok
vii	Carry out stability test by simulating external and internal faults by primary injection and measure spill currents in REF relay	Ok/ Not Ok

3. Electromechanical Relays:

Check Operations of:

i	Buchholz Alarm & trip	Ok/ Not Ok
ii	WTI Alarm & trip	Alarm……Trip……..
iii	OTI Alarm & trip	Alarm……Trip……..
iv	PRD Trip	Ok/ Not Ok
v	MOG(LOL/Low Oil Level) Alarm	Ok/ Not Ok
vi	Oil surge relay	Ok/ Not Ok
vii	OLTC Protections	Ok/ Not Ok

4. Direct Trip Transfer

i	In all cases of above trippings, Direct trip to remote end is sent along with tripping of Main/Tie CB's	Ok/ Not Ok

5. Voltage selection for Protection & Metering

i	Ensure Voltage inputs at specific terminals from		
	a	Line CVT	Ok/ Not Ok
	b	Bus-I CVT(say connected to CB-1)	Ok/ Not Ok
	c	Bus-II CVT(say connected to CB-2)	Ok/ Not Ok
ii	Check NO/NC Contacts from CB-1 & CB-2 for voltage selection		Ok/ Not Ok
		Open Line Isolator: Close CB-1 : Bus-I CVT supply will be selected. Check CVT Supply at selected CVT Terminals for Metering & Protection. Trip CB-1	Ok/ Not Ok
		Close CB-2 : Bus-II CVT supply will be selected. Check CVT Supply at selected CVT Terminals for Metering & Protection. Trip CB-2.	Ok/ Not Ok
		Close Line Isolator: Line CVT supply will be selected. Close CB-1 & 2, No change in status of Selection relays.	Ok/ Not Ok

6. Check RWTI on Control panel

i	RWTI checked on control panel	Ok/ Not Ok

7. Over Flux Relay

i	Checking of Pick up drop off value(Alarm)	Ok/ Not Ok
ii	Checking of Pick up drop off value(Trip)	Ok/ Not Ok

8. Transformer Overload Relay

i	Check Operation of alarm Function	Ok/ Not Ok
ii	Operate Value of Current in secondary Terms	……
iii	Check time of operations	Ok/ Not Ok
iv	Check if trip is provided on O/L Provided/ Not provided	

9. Directional Back-Up O/C & E/F Relay

i	Check Voltage-Current Circuit (Ir –V……., Iy - V……., Ib - V……)	
ii	Check Voltage/Current summation for E/F relay	Ok/ Not Ok
iii	Check Directional element Operation	Ok/ Not Ok
iv	Check time of operation with different operating current	Ok/ Not Ok
v	Attach Graph for IDMT operation for future ref.	Ok/ Not Ok

10. Final Documentation Review

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CONTROL PANEL

General Details

Region:	**Sub-Station:**
Feeder Name:	**LOA No. :**
Date of testing:	**Date of Energisation:**

1. Check metering circuit along with transducers first by secondary injection and there by Primary injection with Standard Voltage & Currents(as per scheme)

i	With Voltmeter Selector switch at various positions R-Y Y-B B-R RN YN BN	Ok/ Not Ok
ii	With Ammeter selector switch at various positions R Y B	Ok/ Not Ok
iii	MW /MVAR Meters	Ok/ Not Ok
iv	Check metering circuits with Primary injection for each phase separately	Ok/ Not Ok
v	Check for frequency Meters	Ok/ Not Ok

2. Check Isolator Interlocks

i	Isolator Operation when Adjacent CB Open	Ok/ Not Ok
ii	Isolator Operation when Adjacent CB Close	Locked/ Unlocked
iii	Check for all Bay/Line/Transformer/reactor isolators with reference to interlock scheme	Ok/ Not Ok

3. Check for Bus isolator Interlock

i	Check Status of E/S interlock of Bus-I/II	Ok/ Not Ok
ii	Isolator Operation when Bus is earthed	Ok/ Not Ok
iii	Isolator Operation when Bus is Not earthed (Checking can be done with engaging/Disengaging Contact Multiplication relay.)	Locked/ Unlocked

4. Check for E/S Interlock(Line)

i	Check E/S Mech. interlock in case Line isolator is closed	Ok/ Not Ok
ii	U/V relay Operate/Reset Voltage	……
iii	E/S Operation when U/V relay de-energized	Ok/ Not Ok

5. Check for E/S Interlock(Bay)

i	Check E/S Mech. interlock in case isolator is closed	Ok/ Not Ok
ii	Check E/S interlock in case isolator in same bay is closed	……
iii	Check E/S Aux. Contact for Local CB Close I/P	Ok/ Not Ok

6. Synchronization Check

i	Check DC supply at Specific Points on Synchro-Check Plug/Socket	Ok/ Not Ok
ii	Check CVT supply at incoming running & earth Points on Syncro-Check Plug/Socket	Ok/ Not Ok
iii	DC(+ve) to be extended to Closing Coil of CB by Synchro-Trolley	Ok/ Not Ok
iv	No close Operation of CB W/O connecting & putting on Synchro-Trolley	Ok/ Not Ok
v	Trip Operation is unbound	Ok/ Not Ok
vi	Check Incoming/running voltage selection and same phase must be selected for a particular sub-station	Ok/ Not Ok
vii	Synchronizing socket pin configuration must be same for trolly and control panel for all bays	Ok/ Not Ok
viii	Voltage selection: Verify operati ng as well as resetting logic (both logic should be mutually inverted)	Ok/ Not Ok

7. Checking of Isolator Indications

Isolator No……..

i	Checking of Isolator Close Indication	Ok/ Not Ok
ii	Checking of Isolator Open Indication	Ok/ Not Ok
iii	Check Semaphore for E/S Close for Isolator	Ok/ Not Ok
iv	Check Semaphore for E/S Open for Isolator	Ok/ Not Ok
v	Check Operation if adjacent CB closed	Ok/ Not Ok
vi	Check Operation if adjacent CB Opened	Ok/ Not Ok
vii	Check all NO/NC status as per scheme	Ok/ Not Ok
viii	Check all interlock status as per scheme	Ok/ Not Ok

8. Checking of CB Indications

CB No……..

i	Checking of CB Close Indication	Ok/ Not Ok
ii	Checking of CB Open Indication	Ok/ Not Ok
iii	Check DC healthy indication	Ok/ Not Ok
iv	Check Local Closing I/L as per scheme	Ok/ Not Ok
v	Check Aux. Contact for CVT selection	Ok/ Not Ok
vi	Check Aux. Contact for Direct trip (In series with TCS of adjacent CB)	Ok/ Not Ok
vii	Check Aux. Contact for Sync circuit	Ok/ Not Ok
viii	Check all Annunciations Points for CB Troubles	Ok/ Not Ok
ix	Pole Discrepancy Timing set & Checked	Ok/ Not Ok
x	Pole Discrepancy Operation Checked	Ok/ Not Ok
xi	All Pressure switch settings/contacts checked	Ok/ Not Ok
xii	Check Anti-Hunting Operation	Ok/ Not Ok

9. Checking of Isolator Control Switch

Isolator No……..

i	Wiring & Status of Contacts as per Scheme	Ok/ Not Ok

10. Checking of CB Control Switch

CB No……..

i	Wiring & Status of Contacts as per Scheme	Ok/ Not Ok
ii	Annunciation & Facia All Working properly	Ok/ Not Ok

11. Control Panel

i	Check for control fuse failure	Ok/ Not Ok
ii	Check that the control fuse failure alarm is reported to station ser by removing one of the +ve/-ve fuse in control ckt.	Ok/ Not Ok
iii	Check that control DC is free from earthing	Ok/ Not Ok
iv	Check there is no mixing of source I & II	Ok/ Not Ok

12. Facia Checking

i	Checking for proper functioning of Annunciation Facia with individual elements of scheme	Ok/ Not Ok
ii	Indication for AC supply failure	Ok/ Not Ok

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BUSBAR PROTECTION

General Details

Region:	**Sub-Station:**
Feeder Name:	**LOA No. :**
Date of testing:	**Date of Energisation:**
Relay Name Zone-I…… Zone-II…… Check Zone……..	

i	Check Operate Value/Reset Value/Operate Timing for all phases	Ok/ Not Ok
	Zone-I	Ok/ Not Ok
	Zone-II	Ok/ Not Ok
	Check Zone	Ok/ Not Ok
	Block Auto-reclose for all CB's Connected Zone-I	Ok/ Not Ok
	Zone-II	Ok/ Not Ok
ii	If directional Element provided ,Relay tested & Direction found O.K	Ok/ Not Ok
iii	Test results enclosed & accepted	
iv	Zone-I Tripping extended to :	
	Trip relay Location …… for CB No……. LBB Initiated	Yes/ No
	PLCC/D.T.	Yes/ No
	Trip relay Location …… for CB No……. LBB Initiated	Yes/ No
	PLCC/D.T.	Yes/ No
v	Zone-II Tripping extended to :	
	Trip relay Location …… for CB No……. LBB Initiated	Yes/ No
	PLCC/D.T.	Yes/ No
	Trip relay Location …… for CB No……. LBB Initiated	Yes/ No
	PLCC/D.T.	Yes/ No
vi	LBB/BFR trip checked & extended to Zone-I	
	From CB No……..	Ok/ Not Ok
	From CB No……..	Ok/ Not Ok
	From CB No……..	Ok/ Not Ok
vii	LBB/BFR trip checked & extended to Zone-II	
	From CB No……..	Ok/ Not Ok
	From CB No……..	Ok/ Not Ok
	From CB No……..	Ok/ Not Ok
viii	Transfer Bus Trip Checked	Ok/ Not Ok
ix	Close Interlock in case of BB Trip Checked for all applicable CB's	
x	RESET Working properly	Yes/ No
xi	DC selection working properly for DC-I & II	Yes/ No
xii	Carry out stability test by simulating external and internal faults by primary injection and measure spill currents in Bus bar diff. relay	Ok/ Not Ok
xiii	Verify stabilizing resistor & Metrosil connection(wherever applicable)	Ok/ Not Ok
xiv	Check for CT switching relay operation, in case of DMT scheme by closing respective isolators. Also inject current at the relay panel entry point and measure current at Bus Bar protection relay terminals after operating respective CT switching relay	Ok/ Not Ok

OTHERS

Region:	Sub-Station:
Feeder Name:	LOA No.:
Date of testing:	Date of Energisation:
Relay Name Zone-I…… Zone-II……. Check Zone……..	

1. Disturbance recorder

i	Check communication to PC/Terminals/Printers	Ok/ Not Ok
ii	Check All Analog Inputs (R-Y-B-residual Voltages & R-Y-B-Neutral currents)	Ok/ Not Ok
iii	Check Conversion(Primary to secondary ratio) settings are programmed as per scheme	Ok/ Not Ok
iv	Check contacts status of all digital inputs	Ok/ Not Ok
v	Normally six I/P's are from Two CB's. check Selective phase operation for RYB Poles for both the CB's. Ensure proper show of Phase/Pole	Ok/ Not Ok
vi	Check Analog threshold setting	Ok/ Not Ok
vii	Check whether all digital Inputs are programmed for initiation of recording Disturbance as well as right status(NO/NC). Also check the sequence of digital channels as per Technical specifications	Ok/ Not Ok
viii	Run self-diagnostic program & get a print for future reference. Otherwise, note down various Voltages at Monitoring points	Ok/ Not Ok
ix	Simulate a disturbance by shorting contacts of a Digital I/P. Check recording in progress. Print the same	Ok/ Not Ok
x	Repeat the above for all digital I/P Contacts	Ok/ Not Ok
xi	For analog threshold values (if provided), connect to Standard test kit to DR & test Threshold Value initiation of recording by Varying Voltages & Frequencies(Voltage Threshold, Frequency thresholds & DF/DT thresholds)	Ok/ Not Ok
xii	Check Time synchronizing by altering Time Zone in TSE. Restore on confirmation. Also check time stamping in the relays by externally triggering DR and record the error w.r.t. GPS time	Ok/ Not Ok
xiii	Check all analogue & digital inputs are configured as per power grid standard list	Ok/ Not Ok
xiv	Compare/Check analog value displayed on PC with the injected input analog value	Ok/ Not Ok
xv	Take a print out of DR settings & keep for future reference	Ok/ Not Ok
xvi	Check for availability of proper software	Ok/ Not Ok

2. Sequential Event Recorder

i	Check communication to PC/Terminals/Printers	Ok/ Not Ok
ii	Check contacts status of all digital inputs	Ok/ Not Ok
iii	Check whether all digital Inputs are programmed with right status(NO/NC)	Ok/ Not Ok
iv	Selective checking of each & every contacts is to be done in sequences. Print-Out/Display is to be compared	Ok/ Not Ok
v	Normally six I/P's are from Two CB's. check Selective Phase operation for RYB Poles for both the CB's. Ensure proper show of Phase/Pole.	Ok/ Not Ok
vi	Check Time synchronizing by altering Time Zone. Restore on confirmation	Ok/ Not Ok
vii	Take a print out of plant status (if available) and compare with the actual status	Ok/ Not Ok
viii	Check for availability of proper software & site programmability of event text	Ok/ Not Ok

3. OLTC/RTCC for Transformer

i	OLTC Operation checked from	
	Local Panel	Ok/ Not Ok
	Remote Panel	Ok/ Not Ok
	Super/Control Panel	Ok/ Not Ok
ii	Tap Position Display	Ok/ Not Ok
iii	Correct Tap position display at local panel & at remote display with respective OLTC indicator.	Ok/ Not Ok
iv	All Indicating lamps checked	Ok/ Not Ok
v	Tap Position Discrepancy Trip	Ok/ Not Ok
vi	Master/Follower scheme Checked for Master :Xformer-1	Ok/ Not Ok
	Master :Xformer-2	Ok/ Not Ok
	Master :Xformer-3	Ok/ Not Ok
vii	Check auto supply changeover feature for OTLC/Transformer (If available)	Ok/ Not Ok

4. General

i	Many a time, different Auxiliary voltages are used for drive power of DR & EL.For example, relay DC is 220 V, DR has it's isolated optical I/P , EL has 50 V drive DC. Conscious effort is to be put to keep all voltage contacts of relay, DR & EL isolated from each other	Ok/ Not Ok
ii	In case any changes are to be made in terminal designation, corresponding change in ferruling	Done/ Not done
iii	In each & every panel & Marshalling Boxes/Kiosks, CT & CVT Circuits must be provided with **Disconnecting stud** type terminals	Ok/ Not Ok
iv	20% spare TB's provided in all types	Ok/ Not Ok
v	Close Interlock of CB: In case trip relay is energized, Close command not forwarded. Normally, Manual Close command from CP must be in series with One set of NC contact of the Trip relay	Ok/ Not Ok

vi	CB in OFF Condition Selective checking of Trip-CKT Supervision relay of all CB's.by Opening wire from TC, one by One.Repeat the same with CB in On Condition	
vii	Permissive Tripping command thr' PLCC Main-I Main-II 1st CH. Return Time …….. mS ……. mS 2nd CH. Return Time ……. mS ……. mS	
viii	If substantial difference noted in above, reason for the difference	……..
ix	Any Prospect for reduction of Diff. in Time	Yes/ No
x	Hanging of RTU reported in Event logger	Yes/ No
xi	Reporting of communication failure of each channel in SER	Yes/ No
xii	Any data error encountered during isolator operation	Yes/ No
xiii	Suggestion for improvement……..	

5. General

i	Single point earthing must be ensured for CT&PT circuit	Yes/ No
ii	In case of four CT scheme ensure summation of Main/Tie/ Reactor CTs secondary to input of relay/ meters	Yes/ No

6. Final Documentation Review

S.No.	Description	Status (Yes/ No)	Remarks(Record deficiencies, if any)
1.	Final document of Pre-commissioning checks reviewed and approved		
2.	Documents regarding spares, equipment, factory reports, O&M manuals etc. available at site for O&M purpose		
3.	After modification, if any, "As built drawing are available at site		

Signature:	Signature:	Signature:	Signature:
Name:	Name:	Name:	Name:
Desgn.:	Desgn.:	Desgn.:	Desgn.:
Organization: (Supplier Representative) (Wherever Applicable)	(Erection Agency)	(POWERGRID Site I/C)	(POWERGRID Commg. Team) Members: 1, 2. 3. 4.

CHECKS FOR PLCC

Region:	**Sub-Station:**
Feeder Name:	**LOA No. :**
Date of testing:	**Make:**
Direction:	**Frequency:**
Cabinet No.	**Eqpt Sr. No.**

1. General test

i	End to end Return Loss Measured (Attach separate sheet of results)	Yes/ No
ii	End to end attenuation Tests done (Attach separate sheet of results)	Yes/ No
iii	Composite loss (attenuation) measured for HF cable coupling device	Yes/ No
iv	Composite loss and return loss on coupling device using dummy load	Yes/ No
v	Measurement of AF frequency response (end to end) for the entire 4Khz bandwidth for speech and tele-protection channels	Yes/ No
vi	Measurement of Signal to Noise ratio with line energized condition.	Yes/ No
vii	Transmission time for tele-protection and other data channels	Yes/ No
viii	Observation of Tx/Rx levels (test tone) for each channel at both ends by sequential switching on/off parallel channels using dummy load and also with transmission line	Yes/ No
ix	Observation of end to end and trunk dialing performance	Yes/ No
x	Observation of unwarranted commands sent & received during switchyard operations	Yes/ No

2. Carrier SET Check List

a. Power Supply (Voltage as applicable)

i	48V POWER SUPPLY	Ok/ Not Ok
ii	60V POWER SUPPLY	Ok/ Not Ok
iii	+12V POWER SUPPLY	Ok/ Not Ok
iv	(-)12V POWER SUPPLY	Ok/ Not Ok
v	+5V POWER SUPPLY	Ok/ Not Ok

b. Ripple test

i	+12 V Ripplettes	Ok/ Not Ok
ii	(-) 12 V Ripple test	Ok/ Not Ok
iii	+5V Ripple test	Ok/ Not Ok

c. Freq generation check

i	System clock checked	Ok/ Not Ok
ii	Tx carrier Hz checked	Ok/ Not Ok
iii	Rx carrier Hz checked	Ok/ Not Ok
iv	Pilot freq. checked	Ok/ Not Ok

3. Transmitter

a.	**AF signal level**		
	i	Pilot	Ok/ Not Ok
	ii	Check Pressing test button	Ok/ Not Ok
	iii	Test tone checked	Ok/ Not Ok
b.		**Tx RF setting done**	Yes/ No
c.		Output Power/ Boosting checked	Ok/ Not Ok
d.		Tx alarm threshold checked	Ok/ Not Ok
e.		Tx alarm indication checked	Ok/ Not Ok

4. Receiver

i	Standard AGC setting done	Ok/ Not Ok
ii	Af rx level setting done	Ok/ Not Ok
iii	AGC test done	Ok/ Not Ok
iv	Remote Loop check done	Ok/ Not Ok
v	Rx alarm indication(interrupting RF Line)	Ok/ Not Ok

5. Telephony

i.	**TX Level Check**	Ok/ Not Ok
a.	4 wire IN Checked	Ok/ Not Ok
b.	2Wire in Checked	Ok/ Not Ok
ii.	**RX Level Check Feeding from Opposite Station**	Ok/ Not Ok
a.	4 wire Out Checked at 600Ohm	Ok/ Not Ok
b.	4 wire Out Checked at 600Ohm	Ok/ Not Ok
iii	Dialing Chanel Checked	Ok/ Not Ok
iv	Service Telephone checked	Ok/ Not Ok
v	Frequency Response across 600 Ohm (Attach separate sheet of results)	Ok/ Not Ok
vi	**Tele-operation:**	
a.	TX Level Check Done	Ok/ Not Ok
b.	Rx Level check done	Ok/ Not Ok

6. Protection Coupler Check

a. Measurements

i	All LED Indicator Checked	Ok/ Not Ok
ii	Transmit Level checked	Ok/ Not Ok
iii	Boost ratio Measured Boost ratio……	Ok/ Not Ok
iv	Muting of Speech Checked	Ok/ Not Ok

b. Command Transmission checking

i	RX Trip A	
	Command Transmission Time	……..ms
	Command Prolongation Time	……..ms

ii	Aux A Command Transmission Time	……..ms
iii	RX Trip B	
	Command Transmission Time	……..ms
	Command Prolongation Time	……..ms
iv	Aux B Command Transmission Time	……..ms
	Same for Trip C & D	
v	Trip Counters checked	Ok/ Not Ok
vi	All Alarms Checked	Ok/ Not Ok
vii	Loop test Done	Ok/ Not Ok
viii	End to End test Done	Ok/ Not Ok

7. Final Documentation Review

S.No.	Description	Status (Yes/ No)	Remarks(Record deficiencies, if any)
1.	Final document of Pre-commissioning checks reviewed and approved		
2.	Documents regarding spares, equipment, factory reports, O&M manuals etc. available at site for O&M purpose		
3.	After modification, if any, "As built drawing are available at site		

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Name:	Name:	Name:	Name:
Desgn.:	Desgn.:	Desgn.:	Desgn.:
Organization: (Supplier Representative) (Wherever Applicable)	(Erection Agency)	(POWERGRID Site I/C)	(POWERGRID Commg. Team) Members: 1, 2. 3. 4.

SUB-STATION AUTOMATION SYSTEM (SAS)

Region:	**Sub-Station:**
Feeder Name:	**LOA No. :**
Date of testing:	**Make:**
Direction:	**Frequency:**
Cabinet No.	**Eqpt Sr. No.**

1. Availability of Items

i.	Check availability of all the IEDs, GPS Clock, Gateway, Computers & Servers, Periferals, Network Switches, Modems and various communication hardware etc. as per Scheme	Ok/ Not Ok
ii.	Check avaiability of all the orignal softwares for PC/ Servers (OS + Application Softwares), IEDs, Switches, Gateway etc. as per the scheme	Ok/ Not Ok
iii.	Check the originality/ authenticity of all the hardware & software items for POWERGRID approval.	Ok/ Not Ok
iv.	Check the validity of license of softwares/ hardware keys.	Ok/ Not Ok

2. Communication Setup

i	Check laying & termination of optical fiber as per approved scheme.	Ok/ Not Ok
ii	Check the proper tagging of optical fiber cable for identifying the origin and termination.	Ok/ Not Ok
iii	Check the LAN switches for proper installation & configuration as per scheme e.g. IP address is entered correctly, ports of Network switches are correctly configured as per requirement, satisfactory working of all the ports etc. Keep the records of all IP addresses.	Ok/ Not Ok
iv	Check dual DC power supply to all Network switches.	Ok/ Not Ok
v	Check all the PCs & printers are connected over Ethernet LAN and functioning properly.	Ok/ Not Ok
vi	Check the satisfactory working of dual LAN as per scheme	Ok/ Not Ok
vii	Check for the alarm if any link failure(fiber cut)	Ok/ Not Ok
viii	Check communication of all IEDs through Network switches as per the allocated IP address.	Ok/ Not Ok
ix	Check the functionality & running of original NMS software.	Ok/ Not Ok
x	Check the NMS software is monitoring the healthiness of Network switches/ IEDs.	Ok/ Not Ok
xi	Check communication between GATEWAY & SAS PC.	Ok/ Not Ok
xii	Check the communication between GATEWAY and PLCC data channel.	Ok/ Not Ok
xiii	Check the communication of each IED with Both SAS PCs individually.	Ok/ Not Ok
xiv	Check communication of each IED with DR PC.	Ok/ Not Ok
xv	Check the availability of spare cores in the armoured fiber optic cable as per specifications.	Ok/ Not Ok

3. Time Synchronization

i	Check proper installation and configuration of GPS and associated hardware like antenna etc	Ok/ Not Ok
ii	Check the availability of Time Synchronization Signal in the LAN through SNTP	Ok/ Not Ok
iii	Check the synchronizing of each IED /Server with GPS.	Ok/ Not Ok
iv	Check for alarm in case of failure of time synchronizing	Ok/ Not Ok

4. IED Setup

i	Check the availability of list of names of IEDs and their front/rear port address	Ok/ Not Ok
ii	Check IP address of all IEDs correctly entered.	Ok/ Not Ok
iii	Check the proper installation and configuration of all IEDs (as per their proprietary softwares) and Preparation of their ICD files for integration in the S/S SCD file.	Ok/ Not Ok
iv	Check the GOOSE function(Analog/Binary) for each IEDs and correctness of the same.	Ok/ Not Ok
v	Check SLD in IED HMI for correctness of same as per approved drawing.	Ok/ Not Ok
vi	Check each IED(for line/transformer/reactor/Bus-Bar/BCU) are correctly tested for every protection requirement of scheme.	Ok/ Not Ok
vii	Check loading of setting through local as well as remote.	Ok/ Not Ok
viii	Check availability of all setting address as per the relay setting received from CC-engg.	Ok/ Not Ok
ix	Check the operation of protection system and subsequent alarm at remote Local/HMI.	Ok/ Not Ok
x	Check the availabilty of alarms/events as per the POWERGRID requirement.	Ok/ Not Ok
xi	Check the Auto-downloading of DR Fault file in case of disturbance.	Ok/ Not Ok

5. Interlocking & Logic Setup (Through concerned BCUs)

i	Check configuration & working of all soft interlocks for CBs, Isolators, Earth Switches including Bus Isolators as per protection schemes.	Ok/ Not Ok
ii	Check configuration & working of all soft logics for Synchronization (DLDB, LLDB, LLLB, DLLB), Voltage Selection, Protection Transfer for DMT, Auto-sequencing etc. as per protection schemes.	Ok/ Not Ok

6. SCADA Setup

i	Check the proper integration of all IEDs and their ICD files in the S/S SCD file.	Ok/ Not Ok
ii	Check the building up of database as per approved point list	Ok/ Not Ok
iii	Check the correctness of HMI SLD for all bays/ feeders in both SAS PCs.	Ok/ Not Ok
iv	Check the correctness of operation of CB,Isolators &Tap changing operation through HMI SLD of both SAS PCs.	Ok/ Not Ok
v	Check that the status of CB,Isolators should change immediately in HMI after performing operation.	Ok/ Not Ok
vi	Check raising of audio alarm with SCADA alarm state for each breaker opening operation at HMI.	Ok/ Not Ok
vii	Check the PLCC,CB operation counters are correctly changing with operation.	Ok/ Not Ok
viii	Check the blocking of operation of bay equipments in case of issue of PTW through both SAS HMIs.	Ok/ Not Ok
ix	Check the availability of SLD of LT switchgear and operation of the same through local/remote.	Ok/ Not Ok
x	Check all measurement functions (Current,Voltage,MW,MVA) and their correctness in local/remote HMI.	Ok/ Not Ok
xi	Check the availability of OTI, WTI readings of ICTs on HMI & correctness of same.	Ok/ Not Ok
xii	Check the availability of voltage & current of both auxiliary DC systems sources .	Ok/ Not Ok
xiii	Check the DG alarm/trip & fire fightning signals are coming in SAS HMI.	Ok/ Not Ok
xiv	Check the monitoring of Kiosk AC/ kiosk temperature through both SAS HMI.	Ok/ Not Ok
xv	Check the colour coding of measurement parameters (Voltage,current,MW,MVAr,f etc.) if the values increases above a pre-set value with generation of audio/visual alarm.	Ok/ Not Ok
xvi	Check colour coding of SLD i.e. energized section will be in one colour and un-energized section will be in different colour.	Ok/ Not Ok
xvii	Check supervision of each IED on HMI of SAS PCs.	Ok/ Not Ok
xviii	Check Hot-stand by function availability between the SAS PCs.	Ok/ Not Ok
xix	Check after restoring of Master server, all the data must be transferred to Master server from slave server in a quick time as per HOT STAND By feature.	Ok/ Not Ok
xx	Check there should not be missing of any events during transfer from both Main to STANDBY and STANDBY to Main.	Ok/ Not Ok
xxi	Check provision of auto data backup & storage of monthly data backup.	Ok/ Not Ok
xxii	Check the correctness of alarm list and event list and proper sequencing of alarms/events.	Ok/ Not Ok
xxiii	Check weather all the events in event list are timely punched with milli second data.	Ok/ Not Ok
xxiv	Check the alarm/events of Auxiliary system are included in alarm/event list.	Ok/ Not Ok

xxv	Check that the SAS configuration tool should be password protected.	Ok/ Not Ok
xxvi	Check for any error signal while operating/running any software or performing any operation on SAS PC.	Ok/ Not Ok
xxvii	Check that basic training has been given to local operation staff so that in case of emergency they will be able to start the SAS PC in case of shut-down.	Ok/ Not Ok
xxviii	Check there should be no interruption in availability test.	Ok/ Not Ok
xxix	Check the Acknowledged alarms should shift to acknowledge window & persisting alarms should be in red colour with blinking of the same.	Ok/ Not Ok
xxx	Check the colour code of the acknowledged but persisting alarm.	Ok/ Not Ok
xxxi	Check the nomenclature of events and alarms for user friendliness.	Ok/ Not Ok
xxxii	Check the availability of backup of latest version configuration for ICD, SCD files, IED basic configuration, HMI server database etc.	Ok/ Not Ok
xxxiii	Ensure creation of appropriate restore points for each workstation in the substation after completion of commissioning.	Ok/ Not Ok

7. Trends & Reports Setup

i	Check all the operation formats are as per POWERGRID formats.	Ok/ Not Ok
ii	Check the reports generated by SAS PC are as per the requirement like max. & min. readings of voltage, MW, MVAR, MVA, Frequency, current etc. for a 24 hour period.	Ok/ Not Ok
iii	Check the reports/trends can be selected/filtered for any time period (datewise) specified by user.	Ok/ Not Ok
iv	Check the availability of measurements reports at desired interval of (15, 30,45 & 60 minutes) & correctness of the same.	Ok/ Not Ok
v	Check the trend display for each parameter(MW,MVA,MVAr,f,V,I etc.) at any time and at a interval selected by user.	Ok/ Not Ok

8. Remote Operation & RLDC reporting

i	Check that Gateway has been installed and configured properly and is working satisfactorily.	Ok/ Not Ok
ii	Check the Gateway Configuration as per approved interoperability profile of RLDC.	Ok/ Not Ok
iii	Check the healthiness of communication between Gateway and RLDC for both channels	Ok/ Not Ok
iv	Verify the data transfer to RLDC by point to point checking as well as at local level through Protocol Analyser	Ok/ Not Ok
v	Check that the online perameters on local/remote SLD like current,voltage,MW,MVAr,frequency etc are getting updated.	Ok/ Not Ok
vi	Check the operation of equipments/alarms/events for remote controlled ss.	Ok/ Not Ok
vii	Check the satus of CBs & Isolators should be available at RLDC and if any link fails then alarm should be generated.	Ok/ Not Ok
viii	If SAS S/S has to be remote controlled then check authenticity of operation from Local & remote end(i.e When control is in hand of	Ok/ Not Ok

	RCC, all local operation should be blocked and vice versa)	
ix	Check that in case of failure of one channel, changeover at remote end happens automatically and no interruption in data flow to Remote end occurs.	Ok/ Not Ok
x	Check for availability of final approved signal list for 101 communication with all details.	Ok/ Not Ok

9. Final Documentation Review

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Signature:	Signature:	Signature:	Signature:
Name:	Name:	Name:	Name:
Desgn.:	Desgn.:	Desgn.:	Desgn.:
Organization:			
(Supplier Representative) (Wherever Applicable)	(Erection Agency)	(POWERGRID Site I/C)	(POWERGRID Commg. Team) Members: 1, 2. 3. 4.

Annexure-1

INTEGRITY PACT

Between

Bharat Heavy Electricals Ltd. (BHEL), a company registered under the Companies Act 1956 and having its registered office at "BHEL House", Siri Fort, New Delhi - 110049 (India) hereinafter referred to as "The Principal", which expression unless repugnant to the context or meaning hereof shall include its successors or assigns of the ONE PART

and

_____, (description of the party along with address), hereinafter referred to as "The Bidder/ Contractor" which expression unless repugnant to the context or meaning hereof shall include its successors or assigns of the OTHER PART

Preamble

The Principal intends to award, under laid-down organizational procedures, contract/s for _____

_____

_____ (hereinafter referred to as "Contract"). The Principal values full compliance with all relevant laws of the land, rules and regulations, and the principles of economic use of resources, and of fairness and transparency in its relations with its Bidder(s)/ Contractor(s).

In order to achieve these goals, the Principal will appoint panel of Independent External Monitor(s) (IEMs), who will monitor the tender process and the execution of the contract for compliance with the principles mentioned above.

Section 1- Commitments of the Principal

1.1 The Principal commits itself to take all measures necessary to prevent corruption and to observe the following principles: -

1.1.1 No employee of the Principal, personally or through family members, will in connection with the tender for, or the execution of a contract, demand, take a promise for or accept, for self or third person, any material or immaterial benefit which the person is not legally entitled to.

1.1.2 The Principal will, during the tender process treat all Bidder(s) with equity and reason. The Principal will in particular, before and during the tender process, provide to all Bidder(s) the same information and will not provide to any Bidder(s) confidential/ additional information through which the Bidder(s) could obtain an advantage in relation to the tender process or the contract execution.

1.1.3 The Principal will exclude from the process all known prejudiced persons.

1.2 If the Principal obtains information on the conduct of any of its employees which is a penal offence under the Indian Penal Code 1860 and Prevention of Corruption Act 1988 or any other statutory penal enactment, or if there be a substantive suspicion in this regard, the Principal will inform its Vigilance Office and in addition can initiate disciplinary actions.

Section 2 - Commitments of the Bidder(s)/ Contractor(s)

2.1 The Bidder(s)/ Contractor(s) commit himself to take all measures necessary to prevent corruption. The Bidder(s)/ Contractor(s) commits himself to observe the following principles during participation in the tender process and during the contract execution.

2.1.1 The Bidder(s)/ Contractor(s) will not, directly or through any other person or firm, offer, promise or give to the Principal or to any of the Principal's employees involved in the tender process or the execution of the contract or to any third person any material, immaterial or any other benefit which he/ she is not legally entitled to, in order to obtain in exchange any advantage of any kind whatsoever during the tender process or during the execution of the contract.

2.1.2 The Bidder(s)/ Contractor(s) will not enter with other Bidder(s) into any illegal or undisclosed agreement or understanding, whether formal or informal. This applies in particular to prices, specifications, certifications, subsidiary contracts, submission or non-submission of bids or any other actions to restrict competitiveness or to introduce cartelization in the bidding process.

2.1.3 The Bidder(s)/ Contractor(s) will not commit any penal offence under the relevant Indian Penal Code (IPC) and Prevention of Corruption Act; further the Bidder(s)/ Contractor(s) will not use improperly, for purposes of competition or personal gain, or pass on to others, any information or document provided by the Principal as part of the business relationship, regarding plans, technical proposals and business details, including information contained or transmitted electronically.

2.1.4 Foreign Bidder(s)/ Contractor(s) shall disclose the name and address of agents and representatives in India and Indian Bidder(s)/ Contractor(s) to disclose their foreign principals or associates. The Bidder(s)/ Contractor(s) will, when presenting his bid, disclose any and all payments he has made, and is committed to or intends to make to agents, brokers or any other intermediaries in connection with the award of the contract.

2.2 The Bidder(s)/ Contractor(s) will not instigate third persons to commit offences outlined above or be an accessory to such offences.

2.3 The Bidder(s)/ Contractor(s) shall not approach the Courts while representing the matters to IEMs and shall await their decision in the matter.

Section 3 - Disqualification from tender process and exclusion from future contracts

If the Bidder(s)/ Contractor(s), before award or during execution has committed a transgression through a violation of Section 2 above, or acts in any other manner such as to put his reliability or credibility in question, the Principal is entitled to disqualify the Bidder(s)/ Contractor(s) from the tender process , terminate the contract, if already awarded, exclude from future business dealings and/ or take action as per the separate "Guidelines on Banning of Business dealings with Suppliers/ Contractors", framed by the Principal.

Section 4 - Compensation for Damages

4.1 If the Principal has disqualified the Bidder (s) from the tender process before award / order acceptance according to Section 3, the Principal is entitled to demand and recover the damages equivalent to Earnest Money Deposit/ Bid Security.

4.2 If the Principal is entitled to terminate the Contract according to Section 3, or terminates the Contract in application of Section 3 above , the Bidder(s)/ Cotractor (s) transgression through a violation of Section 2 above shall be construed breach of contract and the Principal shall be-entitled to demand and recover from the Contractor an amount equal to 5% of the contract value or the amount equivalent to Security Deposit/ Performance Bank Guarantee , whichever is higher, as damages, in addition to and without prejudice to its right to demand and recover compensation for any other loss or damages specified elsewhere in the contract.

Section 5 - Previous Transgression

5.1 The Bidder declares that no previous transgressions occurred in the last 3 (three) years with any other company in any country conforming to the anti-corruption approach or with any other Public Sector Enterprise in India that could justify his exclusion from the tender process.

5.2 If the Bidder makes incorrect statement on this subject, he can be disqualified from the tender process or the contract, if already awarded, can be terminated for such reason or action can be taken as per the separate "Guidelines on Banning of Business dealings with Suppliers/ Contractors", framed by the Principal.

Section 6 - Equal treatment of all Bidder (s)/ Contractor (s) / Sub-contractor (s)

6.1 The Principal will enter into Integrity Pacts with identical conditions as this Integrity Pact with all Bidders and Contractors.

6.2 In case of Sub-contracting, the Principal Contractor shall take the responsibility of the adoption of Integrity Pact by the Sub-contractor(s) and ensure that all Sub-contractors also sign the Integrity Pact.

6.3 The Principal will disqualify from the tender process all Bidders who do not sign this Integrity Pact or violate its provisions.

Section 7 - Criminal Charges against violating Bidders/ Contractors /Subcontractors

If the Principal obtains knowledge of conduct of a Bidder, Contractor or Subcontractor, or of an employee or a representative or an associate of a Bidder, Contractor or Subcontractor which constitutes corruption, or if the Principal has substantive suspicion in this regard, the Principal will inform the Vigilance Office.

Section 8 -Independent External Monitor(s)

8.1 The Principal appoints competent and credible panel of Independent External Monitor (s) (IEMs) for this Integrity Pact. The task of the IEMs is to review independently and objectively, whether and to what extent the parties comply with the obligations under this Integrity Pact.

8.2 The IEMs are not subject to instructions by the representatives of the parties and performs his functions neutrally and independently. He reports to the CMD, BHEL.

8.3 The IEMs shall be provided access to all documents/ records pertaining to the Contract, for which a complaint or issue is raised before them as and when warranted. However, the documents/records/information having National Security implications and those documents which have been classified as Secret/Top Secret are not to be disclosed.

8.4 The Principal will provide to the IEMs sufficient information about all meetings among the parties related to the Contract provided such meetings could have an impact on the contractual relations between the Principal and the Contractor. The parties offer to the IEMs the option to participate in such meetings.

8.5 The advisory role of IEMs is envisaged as that of a friend, philosopher and guide. The advice of IEMs would not be legally binding and it is restricted to resolving issues raised by a Bidder regarding any aspect of the tender which allegedly restricts competition or bias towards some Bidders. At the same time, it must be understood that IEMs are not consultants to the Management. Their role is independent in nature and the advice once tendered would not be subject to review at the request of the organization.

8.6 For ensuring the desired transparency and objectivity in dealing with the complaints arising out of any tendering process or during execution of Contract, the matter should be examined by the full panel of IEMs jointly, who would look into the records, conduct an investigation, and submit their joint recommendations to the Management.

8.7 The IEMs would examine all complaints received by them and give their recommendations/ views to the CMD, BHEL at the earliest. They may also send their report directly to the CVO, in case of suspicion of serious irregularities requiring legal/ administrative action. Only in case of very serious issue having a specific, verifiable Vigilance angle, the matter should be reported directly to the Commission. IEMs will tender their advice on the complaints within 30 days.

8.8 The CMD, BHEL shall decide the compensation to be paid to the IEMs and its terms and conditions.

8.9 IEMs should examine the process integrity, they are not expected to concern themselves with fixing of responsibility of officers. Complaints alleging mala fide on the part of any officer of the Prinicpal should be looked into by the CVO of the Principal.

8.10 If the IEMs have reported to the CMD, BHEL, a substantiated suspicion of an offence under relevant Indian Penal Code / Prevention of Corruption Act, and the CMD, BHEL has not, within reasonable time, taken visible action to proceed against such offence or reported it to the Vigilance Office, the IEMs may also transmit this information directly to the Central Vigilance Commissioner, Government of India.

8.11 After award of work, the IEMs shall look into any issue relating to execution of Contract, if specifically raised before them. As an illustrative example, if a Contractor who has been awarded the Contract, during the execution of Contract, raises issue of delayed payment etc. before the IEMs, the same shall be examined by the panel of IEMs. Issues like warranty/ guarantee etc. shall be outside the purview of IEMs.

8.12 However, the IEMs may suggest systemic improvements to the management of the Principal, if considered necessary, to bring about transparency, equity and fairness in the system of procurement.

8.13 The word `Monitor' would include both singular and plural.

Section 9 - Pact Duration

9.1 This Integrity Pact shall be operative from the date this Integrity Pact is signed by both the parties till the final completion of contract for successful Bidder, and for all other Bidders 6 months after the Contract has been awarded. Any violation of the same would entail disqualification of the bidders and exclusion from future business dealings.

9.2 If any claim is made/ lodged during currency of this Integrity Pact, the same shall be binding and continue to be valid despite the lapse of this Pact as specified above, unless it is discharged/ determined by the CMD, BHEL.

Section 10 - Other Provisions

10.1 This Integrity Pact is subject to Indian Laws and exclusive jurisdiction shall be of the competent Courts as indicated in the Tender or Contract, as the case may be.

10.2 Changes and supplements as well as termination notices need to be made in writing.

10.3 If the Bidder(s)/ Contractor(s) is a partnership or a consortium or a joint venture, this Integrity Pact shall be signed by all partners of the partnership or joint venture or all consortium members.

10.4 Should one or several provisions of this Integrity Pact turn out to be invalid, the remainder of this Integrity Pact remains valid. In this case, the parties will strive to come to an agreement to their original intentions.

10.5 Only those bidders / contractors who have entered into this Integrity Pact with the Principal would be competent to participate in the bidding. In other words, entering into this Integrity Pact would be a preliminary qualification.

10.6 In the event of any dispute between the Principal and Bidder(s)/ Contractor(s) relating to the Contract, in case, both the parties are agreeable, they may try to settle dispute through Mediation before the panel of IEMs in a time bound manner. In case, the dispute remains unresolved even after mediation by the panel of IEMs, either party may take further action as the terms & conditions of the Contract. The fees/expenses on dispute resolution through mediation shall be shared by both the parties. Further, the mediation proceedings shall be confidential in nature and the parties shall keep confidential all matters relating to the mediation proceedings including any settlement agreement arrived at between the parties as outcome of mediation. Any views expressed, suggestions, admissions or proposals etc. made by either party in the course of mediation shall not be relied upon or introduced as evidence in any further arbitral or judicial proceedings, whether or not such proceedings relate to the dispute that is the subject of mediation proceedings. Neither of the parties shall present IEMs as witness in any Alternative Dispute Resolution or judicial proceedings in respect of the dispute that was subject of mediation.

For & On behalf of the Principal
(Office Seal)

For & On behalf of the Bidder/ Contractor
(Office Seal)

Place _____
Date _____

Witness:_____
(Name & Address) _____
_____

Witness:_____
(Name & Address) _____
_____

FORMAT OF NO DEVIATION CERTIFICATE
(To be submitted in the bidder's letter head)

REF: ……. **Dated**…….

BHARAT HEAVY ELECTRICALS LIMITED,
TRANSMISSION BUSINESS GROUP,
5th Floor, BHEL SADAN,
Plot No- 25, Sector- 16A, Noida,
Distt. Gautambudh Nagar, UP-201301

SUB: TENDER FOR "ERECTION WORK OF STRUCTURE AND STRINGING AT 765/400/220 KV AIS SWITCHYARD AT POWERGRID, BIKANER-III PROJECT IN BIKANER, RAJASTHAN".

Tender Ref.: TBSM/BIKANER-III/EREC-STR/TENDER/24-25, DATE: 16.01.2025

Dear Sir,

With reference to above, this is to confirm that as per tender conditions, we have visited subject site before submission of our offer and noted the job content & site conditions etc.

We also confirm that we have not changed / modified the tender documents as appeared in the website and in case of observance at any stage, it shall be treated as null and void. We hereby confirm that we have not taken any deviation from tender clauses together with other references as enumerated in the above referred NIT and we hereby convey our unqualified acceptance to all terms and conditions as stipulated in the tender and NIT. In the event of observance of any deviation in any part of our offer at a later date whether implicit or explicit, the deviations shall stand null & void.

We confirm to have submitted offer strictly in accordance with tender instructions.

Thanking you,

Yours faithfully,

(Signature, date & seal of authorized representative of the bidder)

DECLARATION FOR RELATION IN BHEL

(To be typed and submitted in the Letter Head of the Company/Firm of Bidder failing which the offer of Bidder is liable to be summarily rejected)

Ref: **Date……..**

To,
Sr. DGM/TBSM
Transmission Business Group,
Bharat Heavy Electricals Limited,
6th Floor, BHEL SADAN,
Plot No. 25, Sector-16A, Noida,
Distt. – Gautam Buddh Nagar, UP-201301

Dear Sir,

Sub: Declaration for relation in BHEL

Ref: 1) NIT/Tender Specification No.: TBSM/BIKANER-III/EREC-STR/TENDER/24-25 Date: 16.01.2025

I/We hereby submit the following information pertaining to relation/relatives of Proprietor/ Partner(s)/Director(s) employed in BHEL

Tick (√) any one as applicable:

1. The Proprietor, Partner(s), Director(s) of our Company/Firm DO NOT have any relation or relatives employed in BHEL

OR

2. The Proprietor, Partner(s), or Director(s) of our Company / Firm HAVE relation / relatives employed in BHEL and their particulars are as below:

a)

b)

Signature of the Authorized Signatory

Note:

1) Attach separate sheet, if necessary.
2) If BHEL Management comes to know at a later date that the information furnished by the Bidder is false, BHEL reserves the right to take suitable against the Bidder/ Contractor.

DECLARATION BY AUTHORISED SIGNATORY OF BIDDER

(To be typed and submitted in the Letter Head of the Company/Firm of Bidder)

To,

Sr. DGM/TBSM
Transmission Business Group,
Bharat Heavy Electricals Limited,
6th Floor, BHEL SADAN,
Plot No. 25, Sector-16A, Noida,
Distt. – Gautam Buddh Nagar, UP-201301

Dear Sir,

Sub : Declaration by Authorized Signatory regarding Authenticity of submitted documents.

Ref : 1**) NIT/Tender Specification No: TBSM/BIKANER-III/EREC-STR/TENDER/24-25 Date: 16.01.2025**

2) **All other pertinent issues till date**

I/We, hereby certify that all the documents submitted by us in support of possession of "Qualifying Requirements" are true copies of the original and are fully compliant required for qualifying / applying in the bid and shall produce the original of same as and when required by Bharat Heavy Electricals Limited.

I / We hereby further confirm that no tampering is done with documents submitted in support of our qualification as bidder. I / We understand that at any stage (during bidding process or while executing the awarded works) if it is found that fake / false / forged bid qualifying /supporting documents / certificates were submitted, it would lead to summarily rejection of our bid / termination of contract. BHEL shall be at liberty to initiate other appropriate actions as per the terms of the Bid / Contract and other extant policies of Bharat Heavy Electricals Limited.

Yours faithfully,

(Signature, Date & Seal of Authorized
Signatory of the Bidder)

Date:

Place

FORMATS FOR EPAYMENTS

To,

Sr.DGM (Finance)
Transmission Business Group
BHEL, TBG Finance,
Plot no. - 25, Sector - 16A
Noida - 201301; U.P.

Subject: E-Payments vide RTGS/NEFT

I/We request and authorise you to effect Epayment vide any of the above two modes to my/our bank account as per the details given below:

Vendor Name	:
Title/Name of Account in the bank	:
Account Type(Saving /current)	:
Bank Account Number	
Name & address of Bank	
Bank /Branch contact person's name	:
Bank /Branch Tele Numbers with STD code	:
Bank Branch MICR code	(please enclose a copy of a cheque. This cheque should not be a payable at par cheque)
Bank Branch RTGS IFSC code	
Bank Branch NEFT IFSC code	(you can obtain this from branch where you have your account)
Your Email address	: **(not more than 20 character)**
Name of the Authorised Signatory	: (Please mention here name of person from your organization signing this letter.)
Contact Person's name	: (please mention here the name of a person in your company/organization)

I/We confirm that information provided above is correct & any consequences due to any mistake in above will be borne by us.

Thanking you

For
(Autorised Signatory)

We confirm that we are enabled for receiving RTGS/NEFT credits and we further confirm that the account number of (Please mention here name of the account holder), the signature of the authorised signatory and the MICR and IFSC Codes of our branch mentioned above are correct.

Bank's Verification
(Manager's/Officers signature under
bank Stamp)

Note:- Please attach cancelled original Cheque leaf.